RAD CONFERENCE

THIRTEENTH INTERNATIONAL CONFERENCE ON RADIATION,
NATURAL SCIENCES, MEDICINE, ENGINEERING, TECHNOLOGY AND ECOLOGY

BOOK OF ABSTRACTS

JUNE 16-20, 2025

HUNGUEST HOTEL SUN RESORT, HERCEG NOVI, MONTENEGRO

TABLE OF CONTENTS

Click on the title of the abstract to access it

PLENARY LECTURES

Marek Wisniewski, *How surface chemistry affects material properties* *1*

Tibor Kovacs, *Using po-210 as natural tracer for biomonitoring of norm contaminated sites* *2*

Coleman Cariker, Denis Mamaluy, Normand Modine, William Wampler, Shei Sia Su, Gyorgy Vizkelethy, Miaomiao Wang, Huimei Zhou, Vijay Narayanan, Alex Belianinov, Reza Arghavani, Michael Titze, *Displacement damage physics in gate-all-around nanosheet field effect transistors* ... *3*

ARTIFICIAL INTELLIGENCE IN SCIENCE

Ewa Kudlak, Magdalena Kisiel, *Clinical use of AI-based software for autocontouring in radiotherapy* *4*

Korcan Küçüköztaş, Bilgin Kaftanoğlu, Çiğdem Turhan, *Data-driven modeling and artificial intelligence approaches for optimizing physical vapor deposition of boron nitride coatings* *5*

BIOCHEMISTRY

Šaćira Mandal, *Association of plasma free fatty acids and C-reactive protein levels as marker of inflammation in patients with Type 2 diabetes* *6*

Ana Georgieva, Donika Ivanova, *Investigation of amino acids profile of human and donkey milk samples: A comparative analysis for the nutritional value and proteins quality in both type milk samples* *7*

Lina Misevičienė, Marie-Pierre Golinell-Cohen, Visvaldas Kairys, Audronė Marozienė, Narimantas Čėnas, *Plasmodium falciparu NADH:ubiquinone oxidoreductase as a source of free radicals of nitroaromatic xenobiotics* *8*

BIOLOGICAL SCIENCES

Mariia Bochkareva, Dmitrii Grechko, Zukhra Khasanshina, *Adaptive strategies for high-cell-density cultivation of Escherichia coli: Balancing metabolic burden and oxygen efficiency* *9*

Velida Bakić, Sabina Trakić, Edina Muratović, *Allergenic ragweed pollen (Ambrosia artemisiifolia L.) in honey samples from Bosnia and Herzegovina* *10*

Tsvetelina Gerasimova, Svetla Gateva, Gabriele Jovtchev, Ana Dobreva, Milka Mileva, *Assessment of cytotoxicity and genotoxicity potential of wastewater as a distillation by-product of Rosa damascena Mill. essential oil* *11*

Lujin Muhanna, Abdulbary Amin Mahuop Ahmed, *Association of BARD1 rs2229571 polymorphism with choroidal neoplasms in Russian population* *12*

Jana Žiarovská, Aqsa Abbas, *DNA based marker techniques of coding regions in the analysis of genomic polymorphism of flax in remediated Chernobyl area*.....*13*

Alena Makarova, Alexander Kruchinin, Anastasia Gromova, Eugeniy Shilkin, Elizaveta Boldinova, *DNA translesion synthesis in cellular response to oxidative stress and ionizing radiation* *14*

Srđan Kesić, Đurđica Ignjatović, Maja Misirkić Marjanović, Ljubica Vučićević, Goran Đmura, Branka Petković, *Effect of continuous in-utero exposure to ELF-MF (50 Hz, 0.5 mT) on liver function in peripubertal rats* *15*

Jovana Tubić Vukajlović, Nevena Djordjevic, Snežana Simić, Darko Grujičić, Marina Radović Jakovljević, Olivera Milošević-Djordjević, *Effect of cyanobacteria biomass extract on human DNA in vitro* *16*

Dušan Sokolović, Mihailo Sokolović, Danka Sokolović, Miloš Dičić, Aleksa Djokić, *Effect of melatonin on arginine metabolism in brain tissue of rats after chronic exposure to microwave radiation* *17*

Bertalan Pintér, Zsófia Szilágyi, Györgyi Kubinyi, György Thuróczy, *Investigating the potential effects of 26 GHz 5G microwaves on UV-induced CPD levels in HaCaT keratinocytes in vitro* *18*

Monika Majewska, Małgorzata Kapusta, Anna Aksmann, *Isolated spinach chloroplasts and thylakoids reveal how diclofenac affects photosynthetic apparatus* *19*

Maria Duca, Steliana Clapco, Oana Craciunescu, Elena Iulia Oprita, *Sustainable sunflower management: Climate resilience and bioactive compound valorization in the circular economy* *20*

BIOMEDICINE

Avramović Nataša, Marković Suzana, Jadranin Milka, Miladinović Zoran, Gavrilović Aleksandra, Takić Marija, Tasic Ljubica, Krstić Gordana, Savić Danica, Tešević Vele, Mandić Boris, *Comprehensive LC–HRMS lipidomics of serbian schizophrenia patient cohort* *21*

Avramović Nataša, Jadranin Milka, Miladinović Zoran, Gavrilović Aleksandra, Tasic Ljubica, Miljević Čedo, Janković Milan, Tešević Vele, Mandić Boris, *Exploratory LC–HRMS lipidomic profile of bipolar disorder patients in Serbia* *22*

BIOPHYSICS

Albert Guskov, *Integrative structural biology: Insights into disease mechanisms* *23*

Andrei Zupnik, *Investigation of oligomeric states of Mj CorA* *24*

Olga Selyutina, Maya Ulyanova, Oksana Gulyaeva, Elena Dmitrienko, Nikolay Polyakov, *Study of light-induced interaction of quinone derivatives with guanosine and guanosine-rich oligonucleotides* *25*

Lubomir Traikov, Todor Bogdanov, Katerina Smejkalova, Todor Hikov, Biljana Piperkova, Maria Todorova, Maxim Kalayanov, Akira Ushiyama, Chiodji Ohkubo, *Application of intravital microscopy for evaluation of cold microwave argon plasma action on vasomotion at the microcirculatory bed in vivo* *26*

CANCER RESEARCH

Dušica Popović, Kosta Popović, Zana Dolićanin, Dejan Miljković, Dušan Lalošević, Ivan Čapo, Jovan Popović, *Construction, analysis and correlation of dose response logistic curves for repurposed drugs anticancer effects on fibrosarcoma in hamsters* *27*

Srđan Milićević, Jovana Dedeić, Katarina Vidojević, Jelena Ivetić, Marija Delić, *Model-based meta-analysis of adverse events in metastatic melanoma immunotherapy: The importance of quantifying heterogeneity* *28*

Kosta Popović, Dušica Popović, Dejan Miljković, Dušan Lalošević, Zana Dolićanin, Ivan Čapo, Jovan Popović, *Rescue control experiments to regain the knockdown anticancer effects of repurposed drugs on fibrosarcoma in hamsters* *29*

Olena Sulima, Volodymyr Sulyma, Leonid Mescheryakov, *Scientific and technical solution of the device for mini-gamma-quantum diagnostics of body tissues* *30*

Volodymyr Sulyma, Olena Sulima, Volodymyr Gaponov, *Technical parameters determining the functional, quantitative (numerical) and qualitative characteristics of the developed device for mini-gamma diagnostics* *31*

CHEMICAL SCIENCES

Donika Ivanova, Zvezdelina Yaneva, Milena Tzanova, Ana Georgieva, *Extraction method and qualitative identification of lignin form common wheat and spelt, based on selectivity of deep eutectic solvents: A preliminary study* *32*

Maja Vitorović-Todorović, Tamara Vujatović-Velimirov, Aleksandar Ćitić, Nataša Pajić, Danica Bajić, *Functional polyvinylbutyral nanofibers decorated with $Zr(OH)_2$ and CeO_2 nanoparticles for the destruction of chemical and biological agents* *33*

Arkadii Bikbashev, Libor Kvitek, *Nickel oxide (NiO) of different morphologies and with various dopants in CO_2 methanation* *34*

Serhii Zaruba, Zuzana Zahornacká, Vasil Andruch, *Solvent-assisted dispersive solid-phase extraction for copper determination* *35*

ELECTRONIC ENGINEERING

Maksims Piskunovs, Anatolijs Lucanskis, Victor Ivanov, Valerijs Ivanovs, *A compact device for measuring nanoampere-range currents in high-voltage DC circuits* *36*

Aleksandra Stojković, Aneta Prijić, Zoran Prijić, *Consideration of TEG-microporous heatsink assemblies' capability to power thermal energy harvesting systems under natural convection* *36*

Nikola Mitrović, Sandra Veljković, Vojkan Davidović, Srboljub Stanković, Snežana Djorić-Veljković, Emilija Živanović, Danijel Danković, *Equivalent electrical circuit modeling of the irradiation and NBTS induced threshold voltage shift in p-channel power VDMOSFETs* *38*

Sandra Veljković, Nikola Mitrović, Miloš Marjanović, Emilija Živanović, Vojkan Davidović, Srboljub Stanković, Goran Ristić, Danijel Danković, *Influence of Pre-Stress Conditions on the Self-Heating Behavior of Power MOSFETs* *39*

Sorin Ioan Deaconu, Marcel Topor, Feifei Bu, *Solar energy conversion system into green hydrogen and electric energy for own consumption* *40*

Danijel Danković, Nikola Mitrović, Sandra Veljković, Miloš Marjanović, Emilija Živanović, Vojkan Davidović, *Stress-induced degradation and lifetime estimation in commercial power VDMOS transistors* *41*

Altynov Alexey, Alexander Chernikov, *Automation of control of the complex of superconducting magnet support equipment* *42*

Roba Carmen, Brisan Nicoleta, *Assessment of heavy metals seasonal variation and contamination in sediments of Parches and Babele lakes (Danube delta)* *43*

ENVIRONMENTAL POLLUTION

Ivana Mihajlović, Srđan Kovačević, Dušan Milovanović, Nevena Živančev, *Impact of precipitation on the physico-chemical properties and ecosystem dynamics of Velika Rusanda soda lake* *44*

Bartosz Skibniewski, Michał Skibniewski, Izabela Dębska, Ewa Skibniewska, Iwona Lasocka, *Scales as an indicator of mercury biomagnification in consumption fishes* *45*

Sergej Šemčuk, Galina Lujanienė, Danguolė Montvydienė, Algirdas Selskis, Vidas Pakštas, Martynas Talaikis, Virginijus Bukauskas, Kęstutis Mažeika, Jonas Mažeika, Kęstutis Jokšas, Živilė Jurgelėnė, *Studies on the sorption of Cr^{3+}, Co^{2+}, Ni^{2+}, Cu^{2+} and Eu^{3+} ions on chitosan coated with Fe_3O_4 nanoparticles in different aquatic environments* *46*

ENVIRONMENTAL SCIENCES

Leila Kebbab, Djillali Ghobrini, Ali Ahmed Djamila, *Diet of nocturnal raptors in El Goléa (Northern Sahara, Algeria)* *47*

Nina Dudorova, Boris Belan, Sergey Kotelnikov, *Ground-level ozone as a factor of increase in community-acquired pneumonia rate in Moscow in warm seasons* *48*

Liga Proskina, Agnese Eizenberga, *Innovative utilization of agro-industrial by-products: Brewers' spent grains in aquaculture feed* *49*

Laurent Pourcelot, Olivier Masson, Anne Meyer, Béatrice Boulet, *Isotopic characterization of the sources of uranium, decay products and artificial actinides in the terrestrial environment of a uranium conversion facility* *50*

Mirjana Radenkovic, Inga Zinicovscaia, Mikhail Kapralov, Dusan Topalovic, Mirjana Cujic, Ljiljana Matovic, *Morphological characteristics of fine air particulate matter collected in the suburban area* *51*

Gunta Kizane, Ingars Reinholds, Larisa Baumane, Ugis Eismonts, Rihards Alps, Armands Egleskalns, Maris Bertins, *Novel composite/sorbents containing carbonaceous nanomaterials carbon nanotubes and magnetic oxide for the purification of aquatic environment from toxic metal and radionuclide ions* *52*

FOOD SAFETY AND HEALTH

Marijana Ačanski, Marko Ilić, Kristian Pastor, Đura Vujić, Aleksandra Ilić, Mirjana Vasić, *A GC-MS analysis of amino acids in legumes: Method for discrimination of bens and faba beans* *53*

Yoonhee Jung, Jiyeon Ryoo, Min-Ju Lee, Sang-Han Lee*, Measurement of tritium concentration and internal dose assessment from the consumption of bottled drinking water in Korea* *54*

GREEN CHEMISTRY

Ahmed Dawood, Laura Micheli, Clara Piccirillo, Alessandra Minchella, Bianca Gustavino, *Cyto-genotoxicity studies on green carbon dots developed from biomass for biosensing applications* *55*

HEALTH AND ENVIRONMENT

Rostyslav Musiy, Iryna Yaremak, *Application of solar devices for enhancing human safety and quality of life* *56*

Emilia Bankova, Vanya Birdanova, Tsvetelina Vitkova, Dima Tsanova, Suzana Nikolova, Ivan Traykov, *Chromium Content in drinking water in the Pleven region, Bulgaria – Sources and health control* *57*

Vanya Birdanova, Tsvetelina Vitkova, Ivelina Ruseva, Manoela Bogdanova, Iveta Petrova, Emilia Bankova, *Influence of heavy metals on metabolism. Oxidative stress* *58*

Klaudia Tetfejer, Anna Czarnecka-Skwarek, Agnieszka Rożek, Laboratory synthesis methods of ferromagnetic greigite for its application in cancer hyperthermia *59*

Nesade Muja-Bajraktari, Ferdije Zhushi-Etemi, Përparim Kadriaj, Kurtesh Sherifi, *Monitoring of Aedes albopictus (Skuse) in Southwestern part of Republic of Kosovo* *60*

INFORMATICS

Guido Russo, Stefania Conte, Lorenza Laccetti, Yahya Momtaz, *The MAGIC project - Guaranteeing access to ancient books* *61*

MATERIALS SCIENCE

Ondřej Pašta, *Advanced data processing of ATF claddings* *62*

Amin Shahrokhi, Lordford Tettey-Larbi, Esther Osei Akuo-ko, Tibor Kovács, *Brief overview on the potential possibility of integrating nanotechnology for corrosion control and material enhancement in nuclear industry applications* *63*

Alexander Pogrebnjak, Svitlana Borba-Pohrebniak, Volodymyr Ivashchenko, Martin Sahul, Richard Webster, *Comparison of physical and mechanical properties of carbide coatings based on TiZrNbC and TiZrMoC: Microstructure, elemental composition and tribological characteristics* *64*

Marija Prosheva, Andrea Petanova, Jadranka Blazhevska Gilev, *Determination of water uptake and diffusion coefficient of polymer/lignin composites* *65*

Sergei Baranovskii, *Effects of disorder in materials for X-ray detectors* *66*

Oksana Gutsul, Rene Pfeifer, Ondrej Szabo, Dhananjay K. Sharma, Jaroslav Kuliček, Nirmal Kumar, Alexander Kromka, Bohuslav Rezek, *Electrochemical impedance spectroscopy of a boron-doped microcrystalline diamond electrode in $NaNO_3$ aqueous electrolytes* *67*

Eugenijus Norkus, Loreta Tamašauskaitė-Tamašiūnaitė*, Ina Stankevičienė, Aldona Jagminienė, Aldona Balčiūnaitė, *Electroless deposition of copper-indium coatings for CO_2 reduction* *68*

Eugenijus Norkus, *Electroless metal and metal alloys deposition using multivalent metal ions as reducing agents* *69*

Marius Stef, Carla Schornig, Gabriel Buse, Philippe Veber, Maria Poienar, Daniel Vizman, *Growth and characterization of TmF_3 doped fluorite crystals* *70*

Assemgul Kissabekova, Aleksei Krasnikov, Volodymyr Tsiumra, *Luminescence and energy transfer processes in $Ca_3Ga_2Ge_3O_{12}$:Bi,Eu* *71*

Yu. Zorenko, V. Gorbenko, S. Witkiewicz-Lukaszek, Y. Syrotych, T. Zorenko, J. Winiecki, Sh. Sagimbayeva, A. Kenzhebayeva, K. Shunkeyev, *Luminescence of the isoelectronic impurities in garnet compounds under X-ray and synchrotron radiation excitations* *72*

Milena Marinović-Cincović, Marija Krstić, Suzana Samaržija-Jovanović, Katarina Stepić, Slobodan Ćirić, Vojislav Jovanović, Tijana Jovanović, *Modified urea-formaldehyde resins as dye adsorbents* *73*

Sabina Weronika Jaros, Julia Fiszer, Chris H. J. Franco, Barbara Bażanów, Alexander M. Kirillov, Piotr Smoleński, *New antiviral composites based on self-assembled silver(I) coordination polymers* *74*

Natalia Pawlik, Joanna Śmiarowska, Marta Kuwik, Maciej Zubko, Tomasz Goryczka, Wojciech Pisarski, *Peculiarities of luminescent oxyfluoride sol-gel nano-glass-ceramics doped with Ho^{3+}, Tm^{3+}, and Pr^{3+} ions* *75*

Alexander Pogrebnjak, Arcadie Sobetkii, Yaroslav Babitski, Martin Kusy, Igor Gorlachev, *Production and study of thin films based on refractory metals WNbTa, WMoRe, TiWV(Mo, Zr, Nb), deposited on a substrate of Si* *76*

Andrea Petanova, Marija Prosheva, Jadranka Blazhevska Gilev, *Pulsed laser fabrication technique: A sustainable solution for the production of carbon-based nanomaterials* *77*

Željka Nikitović, Zoran Raspopović, *Rate coefficients for H_2^+ ions in Ar gas* *78*

Tetiana Bulavinets, Oleksandr Bezvikonnyi, Bohdan Bulavinets, Khrystyna Ivaniuk, Dmytro Volyniuk, Pavlo Stakhira, Iryna Yaremchuk, *Self-assembly silver nanoparticles for localized surface plasmon resonance in organic optoelectronics* *79*

Tetiana Bulavinets, Mariana Shepida, Khrystyna Ivaniuk, Ihor Helzhynskyy, Pavlo Stakhira, Iryna Yaremchuk, *Silver nanoparticles for surface-enhanced Raman applications* *80*

MEDICAL ENGINEERING

Mihai Costache, *Artificial memory activated by neural network infrared transmission – An electronic model* *80*

Sergii Miroshnychenko, Oleksandra Miroshnychenko, Yurii Khobta, *The first year experience of X-ray cabins for veterinary clinics* *81*

MEDICAL IMAGING

Olga Irina Girjoaba, *An analysis of ionizing radiation medical examinations frequencies in the period 2017-2023* *83*

Sharmazanova O.P., Fedulenkova Y.Ya., Shapovalova V.V., *Assessment of the diagnostic value of the fine-needle aspiration and core needle ultrasound-guided biopsy of malignant tumors of the breast* *84*

Wojciech Ciszek, Aleksandra Woźnica, Marek Kijonka, Lukasz Kapek, Joanna Prazmowska, Beata Niewiadomska, Aneta Wajda, Bozena Wozniak, Adam Bekman, Jacek Wendykier, Andrzej Orlef, Maria Sokol, *Comparison of the average glandular doses displayed and measured in mammography systems: A phantom study* *84*

Hande Unal, Ismail Hakki Sarpun, Merve Arslan, Nigora Nizomova, *Effects of dose on OARs in ICRP pediatric phantoms in CT scan* *86*

Hande Unal, Ismail Hakki Sarpun, Busra Yilmazer, Senanur Kutlu, *Investigation of the Effect of photon energy and number on dose in CT scan* *87*

Fedulenkova Y.Ya., Sharmazanova O.P., Volkovskaya O.V., *Possibilities of assessing the morphological and functional state of the liver using ultrasonography and computed tomography in patients with breast cancer during complex treatment* *88*

Svetlana N. Dubrovskikh, Alexander V. Chursin, Alena V. Tatarina, Elmira Anvarovna Gumerova, Yulia A. Stepanova*, Ultrasonic and morphological comparisons in gunshot injuries to peripheral nerves* *89*

Yuliia Mykhaliuk, Andrii Pavlusenko, Oleh Lesyk, Yuliia Muravska, Using a mobile radiology team to improve the efficiency of medical care for the rural population *90*

Oleksandra Miroshnychenko, Sergii Miroshnychenko, Yurii Khobta, Andrii Nevgasymyi, *Comparison of thoracic spine images of digital radiography and tomosynthesis mode* *91*

MEDICAL PHYSICS

Alice Casali, Aurora Madonnini, Ricardo Luis Ramos, Francesca Ballarini, Mario Pietro Carante, *A mechanistic approach to predict the probability of complication in the rat spinal cord following particle irradiation* *92*

Helen Melino, Lisa Bhatia, Kirstin Davidson, Viorica (Ibi) Bondici, Sebastian Schoeder, Michael Farquharson, Fiona McNeill, *An investigation of the absorption of lead (Pb) through skin with hair using synchrotron x-ray techniques* *93*

Aziz Safi, Haluk Yücel, *Anthropomorphic breast phantom production with 3D printer technique to find more accurate factors for average glandular dose calculation* *94*

Aleksandra Woznica, Joanna Prazmowska, Marek Kijonka, Bozena Wozniak, Lukasz Kapek, Beata Niewiadomska, Adam Bekman, Jacek Wendykier, Aneta Wajda, Andrzej Orlef, Maria Sokol, *Comparison of patient specific quality assurance (PSQA) results for trigeminal neuralgia (TN) patients receiving CyberKnife stereotactic radiosurgery* *95*

Veselina Georgieva, Georgi Tankovski, Nikoleta Traikova, Yordan Marinov, Ginka Exner, Elizabet Dzhambazova, *Composite hydrogels as tissue* *96*

Dragana Krstic, Dario Faj, Hrvoje Brkić, Željko Cimbaljević, Milena Živković, Marija Jeremić, Ana Krstić, Nicolas Arbor, Paolo Ferrari, Christelle Huet, *Estimation of fetal dose for Tena phantom in abdominal radiography using MCNP code* *97*

Stavroula Pallada, Anastasios Kanellakopoulos, Quentin Rogliardo, Ashley Cooper, *GAMMA-MRI: Revolutionizing medical imaging with radioactive hyperpolarized xenon* *98*

Osman Vefa Gul, Turan Sahmaran, *Investigation of the effect of different silver concentrations on dose distribution in radiotherapy: A Monte Carlo Study* *99*

Bożena Woźniak, Beata Niewiadomska, Adam Bekman, Marek Kijonka, Joanna Prażmowska, Aleksandra Woźnica, Jacek Wendykier, Łukasz Kapek, Aneta Wajda, Wojciech Ciszek, Maria Sokół, Andrzej Orlef, *Patient dose analysis in Total Skin Electron Irradiation procedure using Gafchromic films* *100*

Marija Delić, Martin Horvat, Katja Strašek, Daniel Huff, Robert Jeraj, *Quantifying risks in immunotherapy using bayesian modelling of quantitative imaging biomarkers* *101*

Beata Niewiadomska, Bożena Woźniak, Łukasz Kapek, Marek Kijonka, Aleksandra Woźnica, Jacek Wendykier, Aneta Wajda, Barbara Bekman, Joanna Prażmowska, Adam Bekman, Andrzej Orlef, Maria Sokół, *Ring artifacts on Ethos HyperSight kV cone beam CT (kV-CBCT) scans: a comparative study using patient images, QA phantoms and an anthropomorphic phantom supporting on-couch adaptive radiotherapy* *102*

Aleksandra Klimkowicz-Mrowiec1, Renata Franczak, Kamil Brudecki, *Searching for biomarkers of Parkinson's disease using mass spectrometry methods* *103*

Gizem Şişman, Ayşegül Yurt, Hakan Epik, Kadir Akgüngör, *A novel method for simulating the X-ray dose distribution of a digital mammography system with GEANT4* *104*

MEDICAL SCIENCES

Tibor Kovacs, Noemi Kovacs, Domokos Mathe, Imre Hegedus, Kalman Nagy, Eliana Gianolio, Roberta Napolitano, Bengt Långström, Krisztian Szigeti, Miklos Toth, Christer Halldin, Silvio Aimé, *A ^{68}Ga-isotope /Gd-atom labeled PET/MR imaging probe for pH assessment* *105*

Silvia Vargas Castrillón, Francisco Cutanda, *A biomedical application of robust logistic regression: Effect of outliers* *106*

Albana Shahini, Bledi Kreka, Altin Malaj, *Breast cancer awareness, findings from a cross sectional - Study among Albanian women* *107*

Polina Navrátilová, Martin Štípal, Markéta Vejvodová, Tomáš Vaculovič, Luděk Ryba, Monika Pávková Goldbergová, *Exploring the potential of magnesium in reducing nickel toxicity in the context of orthopaedic implants* *108*

Immanuels Taivans, Gunta Strazda, Normunds Jurka, Valentina Gordjusina, *Lung function in Covid-19 pneumonia survivors 3 months after the discharge from the hospital* *109*

Vanya Birdanova, Preslav Vasilev, Ivelina Ruseva, Ivelina Jordanova, Iveta Petrova, Valentina Kozova, *Nutrition and acne: Exploring the connection* *110*

Dariusz, Adam Szkutnik, Krzysztof Bochenek, *On the relationship between medicine and philosophy in the context of health, life, and the biological organization of the human being* *111*

Lucie Válková, Jan Štingl, Michaela Krchová, Alessandro De Felice, Konstantinos Chatzichristou, Monika Pávková Goldbergová, *Surface modifications of titanium: an in vivo biocompatibility study* *112*

Majlinda Jusufi, Mihail Kochubovski, *The correlation between dental caries prevalence and parents' education of children 12-15 years in Kosovo* *113*

Claudia Gabriela Chilom, Cazacu Nicoleta, Cosmin Adrian, Costin Minoiu, *Upper abdominal MRI – From sequences to applications* *114*

Masaki Tan, Application of humanistic existentialism to personalized and precision medicine (PPM) *115*

MEDICINAL CHEMISTRY

Dunja Jovanović, Ana Filipović, Bojan Bondžić, Aleksandra Bondžić, *Alkyl chain-dependent modulation of blood-brain barrier permeability in N-aryl-tetrahydroisoquinolines* *116*

Branka Dražić, Andreja Leskovac, Sandra Petrović, Vojislav Stanić, Mirjana Antonijević Nikolić, Slađana Tanasković, *Cytotoxic activity of macrocyclic Lu (III) complexes* *117*

Tamara Vujatović-Velimirov, Milan Nikolić, Nataša Pajić, Maja Vitorović-Todorović, *Rational design, synthesis and biological evaluation of dual-binding reversible inhibitors of cholinesterase's with mild inhibitory potency toward monoamine oxidase B* *118*

MEDICINE - CASE REPORTS

Anna Maria Sotgiu, *A relapse of multiple sclerosis classifiable as an acute clinical event with stable magnetic resonance imaging (MRI) (ACES)* *119*

Zorana Djaković, *Polarized microscopy in genetic hair disorders: case series* *120*

MICROWAVE, LASER, RF, UV AND SOLAR RADIATIONS

Roberto De Angelis, Alessandro Agugliaro, Sebastiano Albergo, Ivana Di Bari, Rino Persiani, Valerio Scimone, Antonella Sciuto, Alessia Tricomi, *Absorption spectra measurements of riboflavin with a novel dual-line spectrophotometer* *121*

Jelena Jovanovic, Nebojsa N. Begovic, Vesna Panic, Borivoj Adnadjevic, *How the operating parameters of the Venturi cavitation reactor efects on the quntity of OH· radicals fornation* *122*

Victoria Zaryabova, *Information about the public concern regarding the EMF exposure from base stations for mobile communication* *123*

Nantakan Wongkasem*, Investigation of cancer cell occurrence due to non-ionizing radiation in high microwave frequency range* *124*

Mihaela Ivanova, Michel Israel, *Problems of control in the scope of Directive 2006/25/EC on the health and safety of workers using lasers in the work environment* *125*

Michel Israel, Mihaela Ivanova, Victorya Zaryabova, Tsvetelina Shalamanova, *Some difficulties in risk assessment of exposure to physical factors* *126*

Alessandro Agugliaro, Rino Persiani, Sebastiano Albergo, Roberto De Angelis, Alessia Tricomi, *Theoretical description of a dual-line spectrometer for absorption measurements based on integrating cavities* *127*

NEUROSCIENCE

Elena Slobina, Tatsyana Dakukina, Fedor Khlebokazov, Nikolai Misyuk, *18-FDG PET/CT in the diagnosis and treatment of drug-resistant epilepsy with autologous bone marrow mesenchymal stem cells (ABMMSC)* *128*

Graziella Orru, Ciro Conversano, Giorgia Papini, Aleandra Viti, Angelo Gemignani, *Cognitive and functional resilience as markers of longevity and successful ageing* *129*

Maria Lazarova, Miroslava Stefanova, Elina Tsvetanova, Almira Georgieva, Krasimira Tasheva, Lyubomira Radeva, Krassimira Yoncheva, *Resveratrol loaded micelles with recognition memory protective effect and acetylcholine esterase inhibitory activity in hippocampus of rats with scopolamine induced memory impairment* *130*

Maria Lazarova, Miroslava Stefanova, Elina Tsvetanova, Almira Georgieva, Krasimira Tasheva, *Salvia aethiopis extract from cultivated plants–effects on spatial memory, acetylcholine and monoaminergic brain neurotransmissions in rats with scopolamine-induced model of dementia* .. *131*

NEUTRON AND HEAVY ION RADIATIONS

Marek Scholz, *The role of neutron diagnostics in thermonuclear reactors* 132

NUCLEAR MEDICINE

David Ohm, Bernd Neumeier, Johannes Ermert, Erik Strub, Marco Michel, Andreas Dragoun, Christoph Langer, Michael Butzek, Thomas Gutberlet, Eric Mauerhofer, Doruntin Shabani, Tarek El-Kordy, Clemens Walther, *A novel accelerator-based setup for national scale ^{99}Mo production: Radiation protection aspects* 133

Noémi Anna Buczkó, Boglárka Maróti, Zoltán Kis, Katalin Gméling, László Szentmiklósi, *Activation of radioisotopes used for medical purposes in the Budapest Neutron Centre* 134

Duygu Tuğçe Baran, Elif Yağmur Erdem, Kadriye Buşra Karatay, Levent Akman, Fazilet Zümrüt Biber Müftüler, *From nature to nuclear application: The anticancer potential of radiolabeled Pinus pinea extract* 135

ONCOLOGY

J. Winiecki, B. Sobiech, S. Witkiewicz-Łukaszek, M. Akselrod, Y. Zorenko, *In situ dose measurements in brachytherapy and teleradiotherapy using scintillation detectors based on the tissue-equivalent Al_2O_3:C, Al_2O_3:C,Mg and heavy GAGG:Ce crystals* 136

OTHER TOPICS

Victor Rizov, *Analysis of multiple delamination in viscoelastic multilayered beams with rectangular section subjected to pure torsion*.....137

Victor Rizov, *Lengthwise fracture analysis of inhomogeneous frames at non-linear creep* 138

Victor Rizov, *Non-linear viscoelastic beams with two-directional material inhomogeneity: A longitudinal fracture analysis* 139

Zakaria Ghobrini, Tomas Branyik, Djillali Ghobrini, Tomas Potocar, *The Impact of hydrodynamic conditions on Chlorella vulgaris adhesion in biofilm reactors* 140

Velislav Bonev, Deyan Lesigyarski, Varbin Varbanov, Boika Zlateva, *Archaeometrical study of Roman silver coins using portable X-ray fluorescence*..... 141

Deyan Lesigyarski, Kalin Madzarov, Elena Vasileva, Velislav Bonev, *X-ray fluorescence and rock-magnetic analysis applied for a provenance and technology study of a set a Iron Age ceramic amphorae: preliminary results* 142

Boika Zlateva, Deyan Lesigyarski, Mariana Slavova, Ilya Prokopov, *XRF analyses of ancient coins from South Bulgaria (RIM Haskovo)*.....143

Danilo Kostic, Sladjana Vukovic, Zoran Tomic, *Evaluation of thyroid gland ultrasonographic abnormalities in nuclears medicine staff*.....144

Nika Golob, Maja Hmelak, Tomaž Bratina, Eva Kranjec, Irena Petrušić, Promoting STEM education through student challenges.....145

PHARMACEUTICAL SCIENCES

Alyona Kabanova, *Development of a method for the quantitative determination of kanamycin in the active pharmaceutical substance of insulin Degludec* 145

Polina Astrelina, *DoE approach to investigating protein aggregation mechanisms: A case study on Fc-fusion protein* 147

Nikolay Lumov, Kameliya Anichina, Simeon Stoyanov, Denitsa Yancheva, *Electrochemical studies on the reduction of nitro-containing imidazole and benzimidazole compounds as antiparasitic agents* 148

Abdirash Akilbekov, Arseny Kiryakov, Damir Bajtimirov, Alexey Podshivslov, Zhuldyz Ospanova, Alma Dauletbekova, *Defects creation by irradiation with 220 MeV Xe of $MgAl_2O_4$ (100), (110), and (111) single crystals* 149

PHYSICAL SCIENCES

Yury Usov, *Dubna, ultra-low temperature, usage, history and traditions* 150

Alma Dauletbekova, Abdirash Akilbekov, Nuraiym Pirzadayeva, Valentyn Laguta, Vitaliy Gorbenko, Artur Majewski -Napierkowski, Yurii Syrotych, Sandra Witkiewicz-Lukaszek, Yuriy Zorenko, *Effect of 24.5 MeV ^{14}N ion irradiation on the EPR spectra and luminescent properties of $R_3Al_5O_{12}$:Ce (R=Lu, Y, Tb) single crystalline films scintillators* 151

Maria Lachowicz, Ireneusz Linert, Tomasz J. Wąsowicz, *Exploring the excited states of tetrahydropyran using electron energy loss spectroscopy* 152

Aleksandra Strinić, Milan Petrović, *Power-dependent walk-off in bias-free nematic liquid crystals: Numerical results* 153

Alexander Tikhomirov, George Gulbekyan, Boris Gikal, Igor Kalagin, Nikolay Kazarinov, Vasiliy Semin, Kirill Gikal, Oleg Chernyshev, *Simulation of vacuum conditions and ion beam losses for designing vacuum systems of heavy ion accelerators and radiation facilities* 154

Aleksandra Paveleva, Ksenia Busuek, *Solution to the problem of occurrence of higher harmonics when using pyrolytic graphite PG (002) as a device for monochromatization of neutron flux* 155

Mykola Shevchuk, Serhiy Malynych, Taras Demkiv, Iryna Moroz, Roman Gamernyk, Andriy Pushak, Oleh Antonyak, Anatolii Voloshynovskii, *Up-conversion luminescence and energy levels structure of $CsPbCl_3$:Yb,Nd single crystals* 156

The SND@LHC Collaboration represented by Marco Dallavalle, *Recent results from SND@LHC, the Scattering and Neutrino Detector at the CERN LHC* 157

Moreno Comelli, Nicola Zoppetti, Bruno Spataro, Mostafa Behtouei, Martina Carillo, *An online procedure for evaluating the magnetic flux density emitted by complex conductor systems* 158

Ferhan Akdeniz, Unal Yildirir, Ismail Hakki Sarpun, Abdullah Aydin, *Evaluation of angular differential cross section of tungsten isotopes by interaction potentials obtained from nucleon densities* 159

PO AND RADIOACTIVE PB IN THE ENVIRONMENT

Sheldon Landsberger, Mete Bayrak, Brandon De Luna, In-field measurements of ^{226}Ra and ^{228}Ra in oil-scale with a Ce:LaBr3 Detector 160

*E*dit Tóth-Bodrogi, Dániel Vincze, Beatrix Jancsek-Turóczi, Anita Csordás, Tibor Kovács, *$^{210}Po/^{210}Pb$ activity concentration in resuspended aerosols* 161

Sheldon Landsberger, Christopher Martin, Kayla Cockerline, *Challenges in the determination of Pb-210 in oil scale* 162

Begy Robert-Csaba, Bozsik Anita, Szwarczewski Piotr, Mazeika Jonas, Tonkov Sapassimir, Tănăselia Claudiu, *Eastern European peatlands as living archives of anthropogenic pollution: Insights from ^{210}Pb dating* 163

Nguyen Duc Toan, Thanh-Xuan Pham-Thi, Tien Chu Trung, Hong Nguyen Thi, Nga Phung Thi, Van-Hao Duong, Serwaa Adjei-Kyereme, Miklós Hegedűs, Tibor Kovács, *Effect of traffic on Po-210 and trace elements in urban aerosol in Hanoi, Vietnam* 164

Begy Robert-Csaba, Bozsik Anita, Szwarczewski Piotr, Mazeika Jonas, Tonkov Sapassimir, Nikolov Jovana, Tănăselia Claudiu, *Environmental signals in peat: A ^{210}Pb-based study of climate and pollution history in Eastern and Southeastern Europe* *165*

Brisan Nicoleta, Roba Carmen, Begy Robert-Csaba, *Heavy metal historical trends in sediments of Casla and Somova Lakes (Danube Delta)* *166*

Miklós Hegedűs, Juzsakova Tatjána, Svetlana Zh Kuzhamberdieva, Bakhytbek B Abzhalelov, Máté Novák, Gergely Tóth, Edit Tóth-Bodrogi, Amin Shahrokhi, Tibor Kovács, *Preliminary investigation of Po-210 and heavy metals in cigarettes sold in Kazakhstan* *167*

Bálint Farkas - Áron, Begy Róbert – Csaba, *Preliminary results in: Simultanious determination of ^{210}Bi and ^{210}Po with spontaneus deposition on wire surfaces by Liquid Scintillation Counting* *168*

Brisan Nicoleta, Roba Carmen, Begy Robert-Csaba, *Reconstructing sediment accumulation histories in Casla and Somova lakes (Danube delta) using ^{210}Pb dating* *169*

RADIATION CHEMISTRY

Ivana Landripet, Ivan Marić, Ivan Ilakovac, Anđela Pustak, Marijan Gotić, Tanja Jurkin, *A study on the importance of controlling precursor concentration, pH, polymer concentration and molecular mass on obtaining well-defined magnetic iron oxide nanoparticles using γ-irradiation* *170*

Gazimagomed Magomedov, Irina Antropova, Sergey Kalenov, Phyo Myint Oo, Eldar Magomedbekov, *Application of aqueous extract of Ledum palustre in "green" synthesis of selenium nanoparticles for assessment of radiation sensitivity of yeast cells* *171*

Ivan Ilakovac, Ivana Landripet, Ivan Marić, Anđela Pustak, Tanja Jurkin, *Microstructural and magnetic properties of radiolytically synthesized iron-oxide ferrofluids and their SAR values for hyperthermia treatment with respect to iron concentration, stabilizer and absorbed dose* *172*

Jakub Józiewicz, Masza Góralczyk, Sławomir Kadłubowski, Marcin Kozanecki, *Synthesis of POEGMA Hydrogels via Polymerisation and Crosslinking Induced by various types of radiation – comparative studies.* *173*

RADIATION DETECTORS

Valentina Bulavina, Vasil Milkov, *Development of a new wide-aperture backscattering detector for a High-Resolution Fourier Diffractometer at the IBR-2 reactor* *174*

Georgios Mystridis, Fabio Acerbi, Benedetto Di Ruzza, *Development of accurate dosimetry SiPM-based detectors for FLASH RT* *175*

Giuseppe Ferdinando D'Agata, Martorana Nunzia Simona, Alice Barbon, Giuseppe Cardella, Elena Geraci, Luis Acosta, Carmen Altana, Andrea Castoldi, Enrico De Filippo, Saverio De Luca, Pierpaolo Figuera, Brunilde Gnoffo, Chiara Guazzoni, Concettina Maiolino, Emanuele Vincenzo Pagano, Sara Pirrone, Giuseppe Politi, Lucia Quattrocchi, Fabio Risitano, Francesca Rizzo, Paolo Russotto, Giuseppe Sapienza, Marina Trimarchi, Salvatore Tudisco, Cristina Zagami, *Innovative silicon carbide detectors for ribs: timing, energy resolution, and simulation insights* *176*

Gintautas Tamulaitis, Saulius Nargelas, Arnoldas Solovjovas, Sarunas Scefanavicius, Gabija Soltanaite, Zydrunas Podlipskas, Monika Skruodiene, Aivaras Kareiva, *Novel cost-efficient scintillators for fast radiation detection* *177*

Nataliya Karavaeva, Ilarion Khromiuk, Anton Krech, Igor Lazarev, Sergiy Makhota, Eugenia Martynenko, Oleg Tarasenko, *Triplet exciton reflection in organic composite scintillator grains: Modeling with cubic symmetry* *178*

Dritan Prifti, Gani Demiraj, Kozeta Tushe, *Vlora radiation portal monitor failure analysis and repair in Albania* *179*

Jelena Jovanovic, Nebojsa Begovic, Ekaterina Kuznetsova, Predrag Milenovic, *The effects of cathodic materials on CF3+ degradation process obtained by quantum chemical calculation* *180*

RADIATION EFFECTS

Arbab Imtiaz, Vincenzo Izzo, Riccardo Vari, Antonio Vanzanella, Claudio Principe, Pierluigi Casolaro, Alberto Aloisio, *Investigating total ionizing dose effects on LVDS receivers with impedance spectroscopy* *180*

Marko Milovanovic, *The ATLAS Forward Proton (AFP) sub-detector and the adverse effects of radiation from Large Hadron Collider (LHC) collimators during pp-collisions at 13.6 TeV*.....*182*

David Zoul, Marián Zelený, *The effect of metallic materials on the filtering of the bremsstrahlung spectrum of mobile X-ray generators with regard to the possible initiation of improvised explosive devices* *183*

RADIATION MEASUREMENTS

Alessia Embriaco, Alessia Ciccotelli, Vanessa De Coste, Alvaro de Farias Soares, Maria Cristina D'Oca, Beatrice D'Orsi, Fabio Di Martino, Maurizio Marrale, Giuliana Milluzzo, Francesco Romano, Jessica Scifo, Luca Silvi, *Alanine Dosimetry in Italian National Institute of Ionizing Radiation Metrology (ENEA-INMRI)*.....*184*

Lachhab Abdeslam, Otmani Anas, Nachab Abdellatif, Chakir El Mahjoub, *Assessment of Radon concentrations and environmental correlations in public schools of Safi, Morocco: a spatial and statistical analysis*.....*185*

Michał Sądel, Pawel Bilski, Jan Swakoń, Leszek Grzanka, Anna Mrozik, *Characterization of optically stimulated luminescence silicone foils based on MgB_4O_7:Ce,Li material – towards a high-resolution and reusable tool for 3D dosimetry* *186*

Minju Lee, *Development of large-scale soil reference material for improving the quality of gamma-ray measurements in environmental radioactivity monitoring* *187*

Şamil Osman Gürdal, *Development of Neutron Dosimetry System*..... *188*

Collin Jonathan, Nourreddine Abdel-Mjid, Arbor Nicolas, Horodynski Jean-Michel, Schutz Yves, Lacaze Guilhem, *Estimation of activation around a proton cyclotron CYRCé: Modelling approach and validation with gamma spectrometry* *189*

Kemal Firat Oğuz, Talat Aydin, *Influence of heating rate on thermally stimulated luminescence properties of LiF:Mg,Cu,P dosimeter* *190*

Manjola Shyti, Hermes Plaku, Erjon Spahiu, *Intercomparison exercise on the characterization of norm samples by gamma spectrometry* *191*

Fábio Sabará Dias, Brena Peres, Paulo Victor dos Santos Tavares, Dalton Giovanni Nogueira da Silva, Orlando Rodrigues Jr, Cibele Bugno Zamboni, Maria da Penha Albuquerque Potiens, *Low-energy X-Ray dosimetry using a parallel plate chamber and fricke gel* *192*

Isidora Najdhefer, Lazar Tomic, Nevena Zdjelarevic, Natasa Lazarevic, Dalibor Arbutina, Tijana Vujic, *Radionuclide analysis of the simulated contaminated surface sample for the purpose of iaea-terc-2024-01 proficiency test* *193*

Iwona Grabska, Wioletta Ślusarczyk-Kacprzyk, Marcin Szymański, *Routine calibrations of ionizing radiation dosimeters in the context of the sustainability of measurements in radiotherapy* *194*

Iva Ambrožová, Jakub Šlegl, Marek Sommer, Lucie Švihrová, Martin Kákona, Ondřej Ploc, *Secondary cosmic radiation variations at ground and flight altitudes in the Czech Republic during autumn 2024*.....*195*

Jessica Scifo, Roberto Bedogni, Abner Ivan Castro Campoy, Rocco Carcione, Ilaria Di Sarcina, Beatrice D'Orsi, Miguel angel Caballero Pacheco, Luigi Russo, Adriano Verna, Alessia Cemmi, *Semiconductor-based detectors and conventional dosimeters comparison performed at the Calliope ^{60}Co gamma facility (ENEA Casaccia research centre)* *196*

Péter Pál Necz, Zsuzsanna Vecsei, Péter János Varga, Márk Tamás Baross, György Thuróczy, *Spectral EMF measurement in educational institutes in Hungary* *197*

Ionel Elisei, Ioana Lalau, *Studies for alpha particle spectroscopy using TASTRAK (CR-39) Detectors* *198*

Engin Aşlar, Şule Kaya-Keleş, Gaye Özgür Çakal, G.S. Polymeris, *Thermal quenching effect on the glow curves of lithium and magnesium borate dosimeters at different doses* *199*

Şule Kaya Keleş, Engin Aşlar, Zuhal Akyürek, Gaye Özgür Çakal, *Thermoluminescence signals of natural and synthetic zeolite materials: A preliminary study* *200*

Engin Aşlar, Şule Kaya Keleş, Gaye Özgür Çakal, *TL glow curve analysis of potassium chloride using deconvolution method at different beta radiation doses* *201*

RADIATION PHYSICS

Tamara Krasta, Anastasiia Chekhovska, David Chvatil, Daina Riekstina, *Activation of ^{165}Dy isomer states by neutrons from the photodisintegration of ^{164}Dy nuclei* *202*

Ksenia Shilova, Vladimir Krasnyuk, Roman Goncharov, Komer Sharipov, Anastasia Kakotkina, *Preliminary assessment of different irradiation regimens for large-volume breast cancer metastases in the brain, taking into account the immunohistochemical variant of the tumor* *203*

Michelle Yap, Michael Farquharson, Fiona McNeill, *The development of a ^{109}Cd-based XRF system for the detection of iron in human skin* *204*

RADIATION PROTECTION

Rolf Behrens, *Angular dependence of $H_p(3)$ – Radial vs. polar rotation* *205*

Natasa Pajic, Maja Vitorović-Todorović, Tamara Vujatović-Velimirov, *Assessment of the effectiveness of the personal protective equipment against the impact of radiological contaminants* *206*

Jason Harris, *Development of integrated safety and security risk criteria for radiation protection in nuclear and radiological facilities* *207*

Kozeta Tushe, Manjola Shyti, Florinda Cfarku, *Education and training in radiation protection in Albania: Current challenges* *208*

Chiara Ferrari, Guglielmo Manenti, Andrea Malizia, *Empowering medical physicists in radiation emergencies: Bridging expertise with frontline response* *209*

Behnam Khanbabaee, Rolf Behrens, Onur Erdem, *Eye lens dosimetry: Does the direction of rotation (vertical or horizontal) play a role in type testing?* *210*

Rolf Behrens, Oliver Hupe, *From dosemeter development to routine use – Standards and uncertainties* *211*

Manssour Fadil, Fabienne Lemaire, Nicolas Ménard, Bertrand Rannou, Christelle Stodel, Yoann Trehudic, *Neutron activation in GANIL facilities: Quantification and safety issues* *212*

Dae Hyung Cho, Hyun Suk Yoon, *Package classification in IAEA safe transport regulation: review change history and performance in Republic of Korea* *213*

Luljeta Disha, Irena Mucolari, Florinda Cfarku, *Quality control assessment for different X-ray fluoroscopy units in Albania* *214*

Vojislav Antic, *Radiation brainscreen protector/interface* *215*

Setareh Fatemi, Ricardo Luis Ramos, Silva Bortolussi, Laura Bagnale, Giovanni Garini, Barbara Marcaccio, Cristina Pezzi, Ian Postuma, Lorenzo Airoldi, Umberto Anselmi Tamburini, Valerio Italo Vercesi, *Radiation protection calculations in the design of the AB-BNCT facility for the PNC-PNRR-ANTHEM Project* *216*

Oksana Morozova, *Scientific activity of the Arab Atomic Energy Agency in 2024-2025* *217*

Karoly Bodor, *The Virtual Radioactive Source System (VRSS)* *218*

RADIOBIOLOGY

Silvia Vargas-Castrillon, Francisco Cutanda Henriquez, *Biological treatment plan optimization: A novel computational solution* *219*

Oldřich Zahradníček, Katarína Bláhová, Irina Danilova, Hasanul Banna, Alena Davídková, *Development and validation of a dose-response calibration curve for the cytokinesis-block micronucleus assay in peripheral blood lymphocytes for radiation dose assessment* *220*

Tijana Stojanović, Miroslava Stanković, *Improvement of biodosimetry and radiation dose assessment: Future challenges* *221*

Enis Çam, Rumeysa Çelik, İlayda Sapmaz, Sinan Hoca, Mutlu İçhedef, Yasemin Parlak, Ajda Turhan, Emine Serra Kamer, Mustafa Ateş, Fazilet Zümrüt Biber Müftüler, *Isolation of radiation resistant bacteria from radon rich freshwater and uptake assay* *222*

Igor Belyaev, Pavol Kosik, Matus Durdik, Lukas Jakl, Sachin Gulati, Eva Markova, Milan Skorvaga, Volodymyr Vinnikov, Lucian Zastko, Dominika Kochanova, Katarina Vigasova, Karol Martinka, Armin Rebernig, Lea Tomasova, Diana Seresova, *Molecular markers for cancer risk assessment, biodosimetry, and optimizing radiotherapy* *223*

Alina Elena Andone, Speranta Radu, Ana Maria Catrina, Cerasela Haidoiu, Oana Voinea, Lucia Elena Ionescu, Octavian Calborean, Sonia Maria Spandole-Dinu, *Potential radioprotective effects of natural antioxidants on testicular tissue exposed to ionizing radiation* *224*

Sangho Lee, Youngho Seo, Kondapa Naidu Bobba, Robert Flavell, Wonku Kim, Gyohyeok Song, Jaehyun Park, Hyunbin Yun, Deokseong Kim, Gyuseong Cho, *Preliminary study on the radiobiological effect of Ce-134 therapy using TOPAS-nBio* *225*

RADIOCHEMISTRY

Małgorzata Kazimierowicz, Małgorzata Kardaś, *Concentration of Sr-90 and Cs-137 in selected herbs from two regions of Poland* *226*

Małgorzata Kazimierowicz, Małgorzata Dziubałtowska, Małgorzata Kardaś, *Radioactive concentrations of Sr-90 and Cs-137 in the diet of Polish residents over five years: 2020 – 2024* *227*

Ilijana Zelić, Greg Brennecka, Derek Hoffman, Ivan Grujanac, Danijela Soldatović, Jovana Nikolov, Dalibor Arbutina, *Rare earth elements patterns of uranium ore concentrate using ICP-MS technique - application in nuclear forensics* *228*

RADIOECOLOGY

Pavel Krivitskiy, Natalya Larionova, Assan Aidarkhanov, Almira Aidarkhanova, Andrey Panitskiy, Vyacheslav Bozhko, Assiya Kunduzbayeva, Yuliya Baklanova, *Analysis of methodological approaches and guidelines to define the radiological stress on the components of natural ecosystems when setting up NPP in the republic of Kazakhstan* *229*

Hue Nguyen Thanh Kim, Van-Hao Duong, Trung-Tien Chu, Thanh-Xuan Pham-Thi, Duc-Thinh Ta, Obid Tursunov, Mohamed Saiyad Musthafa, Thomas Onumah, Anita Csordas, Tibor Kovacs, *Application of Po-210 measurements in aerosol to assess emissions of the Núi Pháo Masan Mine* . *230*

Andrey Panitsky, Symbat Baigazy, Zhanat Baigazinov, Ivan Alexandrivich, Togzhan Baiserkenova1, Serwaa Adjei-Kyereme, Miklos Hegedus, Tibor Kovacs, *Assessment of fission and activation products in the fish from the waters of the Semipalatinsk Test Site* *231*

Hue Nguyen Thanh Kim, Duong Van-Hao, Chu Trung-Tien, Pham-Thi Thanh-Xuan, Nguyen Thanh-Nam, Khai M. Nguyen, Thomas Onumah, Miklos Hegedus, Tibor Kovacs, *Assessment of natural radionuclides and associated radiation indices in beach sand in Binh Thuan province, Vietnam* ... *232*

Paweł Czerski, Magdalena Gembal, *Concentrations of ^{137}Cs in cereal plants intended for animal feeding* *233*

Magdalena Gembal, Paweł Czerski, *Concentrations of ^{137}Cs in forest mushrooms from the region of Eastern Poland* *234*

Anita Csordás, Edit Tóth-Bodrogi, Tibor Kovács, *Correlations between soil's physical properties and radon exhalation rates in Hungarian soil samples* *234*

Almira Aidarkhanova, Natalya Larionova, Ainur Mamyrbayeva, Zhanna Tleukanova, Rinata Yermakova, *Distribution of radionuclide contamination in water bodies at the excavation explosions areas at the territory of the Semipalatinsk test site* *236*

Vadym Korovin, Yurii Pohorielov, Yurii Shestak, Aleksandr Valiaiev, *Equilibrium of uranium recovery with ion-exchange resins from the uranium-containing solution simulated groundwater in the radioactive waste tailing site* *237*

Yelena Polivkina, Yelena Zhanuzakova, Yelena Syssoeva, Ludmila Nemytova, *HTO uptake by vegetable crops by aerial and root pathway* *238*

Natalya Larionova, Anna Toporova, Pavel Krivitskiy, Lubov Timonova, Assan Aidarkhanov, *Radionuclides in the land cover at hydronuclear test locations of the Semipalatinsk test site* *239*

Tatiana Paramonova, Alexander Zhernenkov, Maria Godyaeva Natalia Kuzmenkova, Leonid Turykin, *Transfer of ^{137}Cs from radioactively contaminated soils to potato and its subcellular distribution in tubers* *239*

RADIOPHARMACOLOGY

Yannick Verbelen, Mahmoud Bakr-Arby, Alicja Szczepanska, Thomas Scott, *Progress on the Bristol Proton Accelerator* *241*

RADIOTHERAPY

Aslı Bozkurt, Gaye Ö. Çakal, Ayşe Kaşkaş Öztepe, *h-BN as a novel implant material: Monte Carlo simulations of the dose distributions in radiotherapy* *242*

Vladimir Krasnyuk, Ksenia Shilova, Roman Goncharov, Komer Sharipov, Anastasia Kakotkina, *Preliminary assessment of radiosurgical treatment of breast cancer metastases using the Gamma Knife ICON device, taking into account their immunohistochemical features* *243*

RADON AND THORON

Anna Maria Sotgiu, Naglaa Hazm Hassan Awad, Monica Buchetti, *Characterization and calibration of a batch of five thousand SSNTD Columbia Resin 39 detectors* *244*

Behnam Khanbabaee, Stefan Röttger, Anja Honig, *Defined solid-angle alpha spectrometry: Geometrical sensitivities in absolute Rn-222 activity measurements* *245*

Mohammad Alem Sultani, Martin Bulko, Markus Helej, Ivan Sýkora, Terézia Eckertová, Monika Müllerová, Jozef Masarik, *Estimating the contribution of anthropogenic fine particulate matter to urban air pollution using radon and its progeny measurements* *246*

Hugo Corcelle, Quentin Rogliardo, Alessandro Curioni, Stefano Romano, Gilles Triscone, Stavroula Pallada, *Radon mitigation and dosimetry* *247*

Szabolcs Tóth, Ákos Horváth, László Sajó-Bohus, *Time-series analysis of radon monitoring in various underground environments: Case of abandoned Kővágószőlős uranium mine* *248*

SENSORS

Stefan D. Ilić, Marija V. Pergal, Ivan Pešić, Milena Rašljić Rafajilović, Marko Spasenović, *Characterization of a commercial pulse assessment simulator using a custom-developed MXene-based sensor* *249*

Iva Dimitrievska, Katarina Aleksić, Perica Paunović, Smilja Marković, Anita Grozdanov, *Electroconductive polymer-based nanocomposite ink for enhanced electrochemical detection of doxorubicin using modified screen-printed electrodes* *250*

Ahmed Dawood, Beatrice Ercolani, Clara Piccirillo, Bianca Gustavino, Mohsen Ghali, Medhat Hashem, Laura Micheli, *Green carbon dots developed from biomass for sensing marine biotoxin* ..*251*

Iva Dimitrievska, Katarina Aleksić, Perica Paunović, Smilja Marković, Anita Grozdanov, *Polymer-modified screen-printed gold electrode for sensitive electrochemical detection of doxorubicin* *252*

Olena Aksimentyeva, Bohdan Tsizh, Yuliia Horbenko, Roman Holyaka, *Sensor nanostructures for the detection of toxic gases* *253*

TECHNOLOGICAL SCIENCES

Renoldas Zujus, Povilas Poškas, Robertas Poškas, *Modelling of heat transfer in helically coiled tube* *254*

Camelia Traista, Eugen Traista, Tiberiu Rusu, Ciprian Danciu, Tudor Andrei Rusu, *Trials on the reduction of zinc content in Romanian blast furnace slag for use in the steel industry* *255*

Maksim Bulavin, *Universal cryogenic pelletized moderator for research neutron sources of any power and intensity* *256*

WASTE MANAGEMENT

Anna Matveenko, Anna Basova, Vladimir Petrov, Yin Yihang, *Clay-based matrices for chloride- and fluoride-containing radioactive wastes* *257*

Noémi Anna Buczkó, Mariann Papp, Boglárka Maróti, Zoltán Kis, László Szentmiklósi, *Determination of the internal structure of electronic waste items using a combination of neutron and X-ray radiography* *258*

Edda Baek, Olav Kalvig, *Environmental and regulatory challenges in organic radioactive waste management*..... *259*

Maria Elisso Stamati, Andrea Gomes, Matteo Magistris, Raphael Neugebauer, Christian Theis, *Machine learning and transfer functions to characterise radioactive waste for particle accelerators* *260*

Kęstutis Račkaitis, Robertas Poškas, Povilas Poškas, *Modeling of the flow features in the burners air supply channel*.....*261*

Dalia Grigaliuniene, Povilas Balcius, *Modelling of radionuclide release from a near-surface repository taking into account sorption changes due to concrete barriers degradation* *262*

Jurgis Jankauskas, Arūnas Sirvydas, Robertas Poškas, Povilas Poškas, *Purification of acidic condensate using a reverse osmosis test unit* *263*

Rumeysa Çelik, Enis Çam, Duygu Tuğçe Baran, İrem Kaya, Didem Hepağuşlar, Emre Uygur, Fazilet Zümrüt Biber Müftüler, *Transformation of food waste by green synthesis: Radiolabelled Ch/AgNP-C for infection control* *264*

YOUNG SCIENTISTS IN MATERIAL CHEMISTRY - FROM IDEAS TO APPLICATIONS

Virginija Ulevičienė, Aldona Balčiūnaitė, Daina Upskuvienė, Galina Dobele, Aleksandrs Volperts, Ance Plavniece, Aivars Zhurinsh, Loreta Tamašauskaitė-Tamašiūnaitė, Eugenijus Norkus, *Application of nitrogen-doped biomass-based activated carbon catalysts modified with Co and Cu crystallites for hydrazine-hydrogen peroxide fuel cells* *265*

Marta Konieczka, Joanna Skopińska-Wiśniewska, *Inulin as an innovative ingredient in inks for 3-D printing in the production of dressings* *266*

Kseniya Sasim, Sylwia Studzińska, *Application of amino acid–based adsorbents for the extraction of antisense oligonucleotides* *267*

Julia Moszczyńska, Marek Wiśniewski, *CO_2 high temperature adsorption over C@C nanocomposites – Mechanistic studies* *268*

Agnieszka Marczyńska, Marek Wiśniewski, *Dyes adsorption from water - Increasing the adsorption capacity of the carbon material by the hydrovoltaic effect* *269*

Julia Pachniewska, Piotr Kamedulski, Piotr Gauden, *Green hydrogen vs nanomaterials. Electrolysis potential using doped graphene* *270*

Marita Samburska, Marek Wiśniewski, *Influence of hard and soft corona on the catalytic activity of proteins immobilized on modified carbon fibers* *271*

Marta Kozub, Joanna Skopińska-Wiśniewska, *Kappa-carrageenan as a potential, vegan alternative to gelatine hard capsules* *272*

Daria Gwiazda, Dorota Chełminiak-Dudkiewicz, *Materials based on polysaccharides enriched with plant extract as potential wound dressing* *273*

Joanna Śmiarowska, Natalia Pawlik, Bartosz Handke, Maciej Sitarz, Wojciech Pisarski, *NIR emission in sol-gel glass-ceramic materials singly- and doubly-doped with RE^{3+} ions* *274*

*R*einis Putrālis, Kristapts Krims Dāvis, Meldra Ķemere, Anatolijs Šarakovskis, Aleksandra Gluščenko, Kārlis Pajuste, Aiva Plotniece, *Self-assembling styrylpyridinium compounds forming liposome nanoparticles for near-infrared photodynamic therapy* *275*

Filip Marinov, Ivo Petrov, Tsvetoslav Lazhovski, Krum Stoilov, Peter Temnishki, Silviya Simeonova, Peter Georgiev, Lyuben Mihaylov, Evelina Vassileva, Konstantin Balashev, *UV-visible spectroscopy, atomic force microscopy and transmission electron microscopy analysis of gold nanoparticles exposed to varying doses of ionizing radiation* *276*

How surface chemistry affects material properties

Marek Wisniewski*

Nicolaus Copernicus University in Toruń, Faculty of Chemistry, Department of Materials Chemistry, Adsorption and Catalysis, Torun, Poland

https://doi.org/10.21175/rad.abstr.book.2025.1.1

All physical or chemical processes require appropriate intermolecular or interatomic interactions. In addition to the structure of the material used, the respective chemical properties of the surface also play here a significant role.

Surface chemistry is an intriguing interdisciplinary field of study, with a focus on the examination of chemical processes that predominantly occur on the surface of solids. It involves the study of phenomena such as adsorption, migration, assembly, activation, reaction, and desorption of atoms and molecules on surfaces. In the context of bulk crystalline materials, atoms or molecules are arranged in a three-dimensional periodic table, thereby exhibiting similar properties. However, when these substances are positioned on the surface, the periodicity in the vertical direction is interrupted, which consequently leads to the manifestation of remarkable electronic, magnetic, optical, and chemical properties due to changes in the chemical environment. This phenomenon results in wide-ranging applications in the fields of materials, chemistry, physics, energy, etc.

The central objective in this field is to comprehend the structures and properties of the surface of solids, and to ascertain the fundamental principles that govern the physical and chemical changes occurring on them. Surface chemistry is an interdisciplinary field that draws upon knowledge from various disciplines, including chemistry, physics, biology, mathematics, materials science and engineering. It serves as a crucial conduit between the core disciplines and the various areas of application. Surface chemistry has a pivotal role and exerts a substantial impact on materials science, catalysis, energy, and other. Over the past century, surface chemistry has undergone rapid development and achieved significant advances, with at least two Nobel prices: I. Langmuir, being awarded the in Chemistry in 1932 for his pioneering contributions to the proposal and study of surface chemistry. Also, G. Ertl, was awarded in Chemistry in 2007 for his groundbreaking research in solid surface chemistry.

However, this field also harbours significant drawbacks, including the toxic nature of nanoplastics, which can arise from changes in surface chemistry due to an increase in hydrophilicity as a consequence of rise in surface acidity. Recent findings suggest that environmentally relevant nanoplastics are toxic even at very low concentrations, by increasing the proportion of the polar layer of nanoparticles formed during oxidation processes. In light of the pressing need for comprehensive research on nanoplastics, we have established a correlation between in vitro human cell toxicity and in vivo effects on a highly resistant organism, such as the American cockroach (*Periplaneta americana*), with the physicochemical properties of PE nanoplastics. It is our hope that the results presented herein will address the knowledge gap and facilitate further research on the effects of nanoplastics on animals and humans.

Using Po-210 as natural tracer for biomonitoring of NORM contaminated sites

Tibor Kovacs[1,2]*

[1] Hungarian Centre of Excellence for Molecular Medicine (HCEMM) Szeged, Hungary
[2] University of Pannonia, Veszprém, Hungary

https://doi.org/10.21175/rad.abstr.book.2025.1.2

In the case of NORM from industrial activities, uranium and its daughter elements are generally the most serious concern as Po-210 dominates the ingestion dose from both the uranium and the thorium series. In particular, by-products from oil mining, coal mining and other ore mining and processing activities e.g. bauxite processing are a major problem just by volume alone, but various processes can also lead to the enrichment of radionuclides in the by-products. In recent years, the environmental impact of the dumping of these by-products and the transfer of pollutants to plants and water bodies has been investigated. Po-210 was found to be the best indicator element representing the environmental impact of various NORM sites, such as coal and uranium mines, coal fired power plants, bottom ash and red mud depositories, allowing to track environmental processes through the determination of Po-210 in various environmental media, including the application of biomonitor and bioindicator species such as tobacco plants, moss and mushrooms. Po-210 is volatile, so it is an excellent tracer for tracking various processes involving combustion, but it also can be used to track direct dust emissions or water-born releases as well, while a good selection of the biomonitoring and bioindicator species can capitalise on natural processes such as bioaccumulation or large surface areas efficiently scavenging aerosol particles. In addition to the concentration of Po-210, which can be a valuable tool in and of itself, its ratio with its parent radionuclides may also provide valuable information.

Displacement damage physics in gate-all-around nanosheet field effect transistors

Coleman Cariker[1], Denis Mamaluy[1], Normand Modine[1], William Wampler[1], Shei Sia Su[1], Gyorgy Vizkelethy[1], Miaomiao Wang[2], Huimei Zhou[2], Vijay Narayanan[2], Alex Belianinov[1], Reza Arghavani[1], Michael Titze[1]*

[1] Sandia National Laboratories, Albuquerque, New Mexico, USA
[2] IBM Research Albany, Albany, New York, USA

https://doi.org/10.21175/rad.abstr.book.2025.1.3

Introduction

All major integrated device manufacturers have introduced Gate All Around Nanosheet Field Effect Transistors (GAA NSFETs) as the next generation technology for CMOS applications. The design of GAA NSFETs is similar to Silicon-On-Insulator (SOI) technology, which is recognized for its radiation-hardness [1]. The GAA NSFET architecture features a channel that is isolated from the substrate, potentially leading to the development of radiation-hard consumer electronics. However, GAA NSFETs are being targeted for sub 3 nm logic technology nodes, which are significantly smaller when compared to most other SOI devices. Therefore, a single neutron damage cascade can generate DD volumes comparable to the GAA NSFET device volume [2]. Although the probability of a neutron strike within the active device volume decreases as devices scale, interaction with single neutrons may significantly alter device performance due to the small number of atoms within the active device volume, potentially leading to complete failure from a single particle interaction [3]. Since the vacancy concentration is thought to be a factor leading to failure, scaled CMOS devices may be more susceptible to DD than previously thought.

Here, we present a statistical model of displacement damage in extremely scaled devices, along with experimental data of GAA-NSFET device response to DD and TID after single transistor irradiation. We present modeling results using fully quantum and charge self-consistent contact block reduction (CBR) code. The modeling shows that adequate modeling of extremely scaled devices requires quantum treatment of charge transport through devices. We will discuss how individual DD-induced defects lead to the observed increase of subthreshold leakage current.

Acknowledgement

Sandia National Laboratories is a multimission laboratory managed and operated by National Technology & Engineering Solutions of Sandia, LLC, a wholly owned subsidiary of Honeywell International, Inc., for the U.S. DOE's National Nuclear Security Administration under contract DE-NA-0003525.

References

1. B.L. Ringel, *et al.*, IEEE Transactions on Nuclear Science, 72, 2, 154-163, 2025
2. W.R. Wampler, *et al.*, Journal of Applied Physics, 136, 20, 204501, 2024
3. M. Titze, *et al.*, ACS Applied Electronic Materials, 6, 8, 5759-5765, 2024

Clinical use of AI-based software for autocontouring in radiotherapy

Ewa Kudlak*, Magdalena Kisiel

St. Lucas Hospital, Tarnow, Poland

https://doi.org/10.21175/rad.abstr.book.2025.2.1

Introduction: Radiotherapy is one of the primary methods of treating cancer patients. The first step in preparing a treatment plan in radiotherapy involves contouring anatomical structures. Manually defining organs at risk is a time-consuming process that requires significant experience from the operator. The availability of reliable AI-supported software tools would be highly beneficial, as it could greatly improve the radiotherapy workflow and reduce the time needed for segmentation. The aim of this study is to present specific cases where the clinical use of AI requires technician intervention or even replacement by manual contouring.

Materials and Methods: A deep learning–based autocontouring system (syngo.via RT Image, Siemens Healthineers) was used to delineate anatomical structures in all 150 patients treated in the chest, head and neck, and pelvic regions. The operator visually identified and recorded any contouring inaccuracies based on professional experience.

Results: In all patients immobilized using a vacuum mattress, the mattress was not delineated. Similarly, the head and neck immobilization mask was not identified in any of the patients where it was used. In the chest region, the most common issue was the presence of fluid in the lungs. Altered lung tissue was often incorrectly contoured despite clearly visible boundaries. In the head and neck region, the main issue involved delineation of the larynx. Additionally, lung fragments visible on the CT scan were not marked. In the pelvic region, the system failed to contour the cauda equina and portions of the spinal cord when its length was less than 10 cm. Any anatomical anomalies (e.g., missing kidney, abdominal or inguinal hernia, or bones destroyed by disease) resulted in incorrect boundary detection or misplacement of the structures (e.g., a hernia was contoured as the urinary bladder). Despite the use of Dual Energy and IMAR during CT imaging, metallic elements continued to pose problems for automatic contouring and were delineated inaccurately.

Discussion: The difficulty in contouring the larynx observed in this study is also reported in the literature. It is believed that the lack of standardized larynx boundaries and the anatomical complexity of this small structure make its automatic segmentation on CT particularly challenging. Poor visibility of the structure's boundaries may also contribute to this issue. Similar explanations apply to the problems with delineating immobilization devices such as vacuum mattresses and head masks.

Another challenge involves atypical patient anatomy. While structures may be well-defined, their unusual location or shape can confuse the system. A potential solution would be to collect and use such cases to train the system, thereby improving its performance. However, extremely atypical cases—such as the presence of a hernia or metallic implants—may continue to be problematic. Many studies evaluate the accuracy of automatic contouring using metrics such as the Dice coefficient. Values above 0.7 are generally considered acceptable. However, in radiotherapy, this criterion may not be appropriate for certain structures like the spinal cord. Considering the complexity of the issue, the use of mathematical apparatus was abandoned in this work and a qualitative assessment of the operation of the automatic contouring system was made.

Conclusion: The use of automatic contouring systems in clinical practice is highly advantageous and significantly accelerates the workflow. However, reliance on automatic systems does not eliminate the need to verify the accuracy of the generated contours. Furthermore, there are still cases in which structures are either not contoured or contoured incorrectly, necessitating manual intervention.

Data-driven modeling and artificial intelligence approaches for optimizing physical vapor deposition of boron nitride coatings

Korcan Küçüköztaş*, Bilgin Kaftanoğlu, Çiğdem Turhan

ATILIM University, Ankara, Turkey

https://doi.org/10.21175/rad.abstr.book.2025.2.2

This study introduces an innovative machine learning framework designed to enhance the physical vapor deposition (PVD) process of boron nitride (BN) coatings on D2 steel substrates via magnetron sputtering. By methodically adjusting process parameters and employing a broad range of surface characterization techniques—including pin-on-disk testing, nano-indentation, and film thickness measurements—an extensive dataset is generated that integrates both experimental and synthetic data. Advanced statistical analyses explore the relationships between deposition variables and coating performance. A suite of predictive machine learning models is developed and benchmarked using regression evaluation metrics, culminating in an automated model selection process that informs the optimization of deposition parameters. This novel approach accelerates decision-making, enhances the efficiency of the coating process, and improves the overall performance of boron nitride coatings.

Association of plasma free fatty acids and C-reactive protein levels as marker of inflammation in patients with Type 2 diabetes

Šaćira Mandal*

University of Sarajevo-Faculty of Pharmacy, Sarajevo, Bosnia and Herzegovina

https://doi.org/10.21175/rad.abstr.book.2025.3.1

Type 2 diabetes (T2D), as a common type of *diabetes mellitus*, is influenced by various factors such as genetics and environment. One of the most important risk factors for the development of T2D is insulin resistance (IR), the underlying mechanisms of which include impaired free fatty acid (FFA) metabolism and inflammation. Chronically elevated levels of plasma free fatty acids appear to disrupt normal glucose homeostasis, while increased levels of a key inflammatory marker, C-reactive protein (CRP), lead to endothelial dysfunction and other T2D complications. The aim of this study was to examine the relationship between plasma FFA concentration and CRP as an inflammatory marker in patients with diabetes. The research included 82 participants, 42 of whom were patients with type 2 diabetes and 40 healthy individuals as a control group, aged 40 to 65 years. Clinical and biochemical characteristics including body mass index (BMI), fasting glucose levels, HbA1c, insulin, CRP and lipid profile were determined using standard clinical methods, while the levels of individual FFAs were measured by gas chromatography. The results showed a positive correlation between myristic acid (C14:0) and CRP levels, as well as a negative association of docosapentaenoic acid (C22:5) with CRP levels ($p<0.05$) in control subjects. In the group of diabetics, a negative correlation of gamma-linolenic acid (C18:3) with CRP levels was observed ($p<0.001$). These findings suggest that concentrations of individual free fatty acids, with different chain lengths and degrees of saturation, such as C14:0 and C18:3, can be used as potential markers of low-grade inflammation and disease prognosis in T2D patients.

Investigation of amino acids profile of human and donkey milk samples: A comparative analysis for the nutritional value and proteins quality in both type milk samples

Ana Georgieva[1], Donika Ivanova*[2,3]

[1] Department of Animal husbandry – ruminants and animal product technologies, Agricultural Faculty, Trakia University, Stara Zagora, Bulgaria
[2] Department of Pharmacology, Animal Physiology, Biochemistry and Chemistry, Faculty of Veterinary Medicine, Trakia University, Stara Zagora, Bulgaria
[3] Department of Medical Chemistry and Biochemistry, Medical Faculty, Trakia University, Stara Zagora, Bulgaria

https://doi.org/10.21175/rad.abstr.book.2025.3.2

BACKGROUND: The recognized as a "super food" the milk is the best option for feeding for the newborns, special adapted to their daily nutrient needs. Due to its chemical composition and the abundance of bioactive compounds, milk is classified as one of the most complete and highly nutritious foods. The Word Health Organization recommenders an intensive breastfeeding of young children in the first 4 to 6 months after birth. However, there are a few health conditions affecting mother may cause a temporary or permanent recommendation against breastfeeding. The chronic diseases, prescribed antibiotic therapy, insufficient breast milk supply as well as stress factors are some of the medically justify the use of breast milk substitutes. Sine in the ancient times, when the ruminant's domestication was started, humans have realized how to use milk for production of dairy products and as a food source. Chemically composition of the milk, obtained by individual mammals, ranges depending many factors, such as type of the animals, intensity of their growth, terms for animal husbandry and etc. Regarding to the organoleptic characteristics, low fats, cholesterol and protein contents, as well as high levels of whey protein, lactose, microelements and fat-soluble vitamins, donkey milk is distinct from the other ruminant species milk, but there is information that it resembles human breast milk. In terms to its amino acid composition, donkey milk is characterized by a low content of amino acids compared to mare's or cow's milk. It could be explained by the lower protein content in donkey milk, compared to the other ruminant's milk types. Amino acid profile is a key aspect to studying human milk proteins quality and their nutritional benefits. The aim of our study is to provide a detail exploration of amino acids contents both in human and in donkey milk, which could be on help for elaboration of better breast milk substitutes.

RESULTS: Breast milk collection was approved by the ethics committee of the Medical Faculty of Trakia University (protocol number 33/09.09.2024). Thirteen women volunteers (from 28 to 40 years old) from southeastern Bulgaria participated in the study, from all which the informed consent was obtained. The breastmilk samples (total 54 samples) were collected from mothers with full-term babies in the lactation stage from 10 days to 12 mouths post-partum, according strict adherence to the breast milk collection procedure, described in the informed consent. The group from 60 animals from a farm for breeding local Bulgarian donkeys was formed. Similar to the breast milk, the monitored lactation period for donkeys is from 10 days to 12 mounths. The animals are on pasture throughout the period, during the autumn-winter period they are fed with grain feed, and milking is done manually once a day. The milk samples were obtained from the morning milking, proportional to the milk yield, according to the rules for milk sampling. The classical acid-hydrolysis method is used for detection of amino acids containing into human and donkey milk samples. The comparison between obtained results for amino acids profile of human and donkey milk samples was conducted. All twenty amino acids were detected and their quantity per 100 grams into human and donkey milk samples were estimated.

CONCLUSION: According to obtained results donkey milk can be considered as the natural milk close to human milk. Also, it could be considered an alternative food targeted at children's health.

Acknowledgements: This work was funded by the Scientific project № 3/2023 FVM in Trakia University.

Plasmodium falciparum NADH:ubiquinone oxidoreductase as a source of free radicals of nitroaromatic xenobiotics

Lina Misevičienė[1], Marie-Pierre Golinell-Cohen[2], Visvaldas Kairys[3], Audronė Marozienė[1], Narimantas Čėnas*[1]

[1] Institute of Biochemistry of Vilnius University, Vilnius, Lithuania
[2] ICSN, CNRS, Gif-sur-Yvette, France
[3] Institute of Biotechnology of Vilnius University, Vilnius, Lithuania

https://doi.org/10.21175/rad.abstr.book.2025.3.3

In order to detail the antiplasmodial effects of quinones (Q) and nitroaromatic compounds ($ArNO_2$), we investigated their reduction mechanism by *Plasmodium falciparum* flavoenzyme type II NADH:ubiquinone oxidoreductase (*Pf*NDH2). The reactivity of Q and $ArNO_2$ (n = 29) follows a common trend and exhibits a parabolic dependence on their single-electron reduction potential (E^1_7), albeit with significantly scattered data. The reactivity of quinones with similar E^1_7 values increases with their lipophilicity. Quinones are reduced by *Pf*NDH2 in a two-electron way, but $ArNO_2$ are reduced in a single-electron way. The inhibition studies using NAD^+ and ADP-ribose showed that quinones oxidize the complexes of reduced enzyme with NADH and NAD^+. This suggests that, as in the case of other NDH2s, quinones and the nicotinamide ring of NAD(H) bind at separate sites.A scheme of *Pf*NDH2 catalysis is proposed, consistent with both the observed 'ping-pong'mechanism and the presence of two substrate binding sites. Molecular docking showed that Q and $ArNO_2$ bind in a similar manner and that lipophilic quinones have a higher affinity for the binding site. One may expect that *Pf*NDH2 can be partially responsible for the previously observed enhanced antiplasmodial activity of aziridinylbenzoquinones caused by their two-electron reduction, as well as for the redox cycling and oxidative tress-type action of $ArNO_2$.

Adaptive strategies for high-cell-density cultivation of *Escherichia coli*: Balancing metabolic burden and oxygen efficiency

Mariia Bochkareva*, Dmitrii Grechko, Zukhra Khasanshina

RnD GEROPHARM, Saint-Petersburg, Russia

https://doi.org/10.21175/rad.abstr.book.2025.4.1

Industrial bioprocesses require robust microbial strains capable of sustaining productivity under high-cell-density cultivation (HCDC). A critical limitation in HCDC is dissolved oxygen (pO_2) depletion, which triggers metabolic inefficiencies and overflow metabolites. In this work, we aimed to address oxygen transfer limitations by integrating the VHb gene into the E. coli genome. VHb binds oxygen at low concentrations, acting as an oxygen buffer for terminal oxidases. This modification increases the oxygen affinity of the electron transport chain (ETC), reducing overflow metabolism (e.g., acetate accumulation) and sustaining aerobic respiration.

Genetic constructs were designed to integrate the VHb gene, under either the native Vhb or hybrid Tac/T7 promoter, into the *E. coli* genome. Stabilization of VHb-expressing strains was achieved through serial passaging under selective pressure with tetracycline and CO_2-enriched conditions.

Co-expression of VHb in *E. coli* improved oxygen utilization under bioreactor conditions:

- Post-induction, VHb-expressing strains maintained pO_2 near setpoints, unlike wild-type strains that fully depleted oxygen;
- 62% increase in specific productivity;
- However, biomass decreased by 25% due to metabolic burden from heterologous VHb synthesis, which diverted resources (e.g., ATP, amino acids) away from growth.

Optimized cultivation parameters were identified using Design of Experiments (DoE) and validated in 1L bioreactors. Culture media optimization increased volumetric productivity by 40%, counteracting VHb-associated biomass loss. Defined media formulations minimized acetate accumulation. While VHb imposes a growth penalty, media optimization offset this by streamlining metabolic flux, enabling higher total product yield.

E. coli strains expressing genomically integrated VHb reduced pO_2 demand during high-density bioreactor cultivation. However, this modification introduced metabolic burden, leading to reduced biomass accumulation. Standardization of culture medium composition and induction conditions partially compensated for this limitation, though total target protein titers did not exceed baseline strain levels. This strategy shows promise for other microbial systems or products but did not enhance productivity in strains under current experimental parameters.

Allergenic ragweed pollen (*Ambrosia artemisiifolia* L.) in honey samples from Bosnia and Herzegovina

Velida Bakić*, Sabina Trakić, Edina Muratović

University of Sarajevo, Faculty of Science, Department of Biology, Sarajevo, Bosnia and Herzegovina

https://doi.org/10.21175/rad.abstr.book.2025.4.2

Honey is a natural substance produced by honey bees (*Apis mellifera* L.) from nectar, plant secretions, or the excretions of insects that feed with juices of living plant tissues. It contains hundreds of phytochemical compounds contributing to its various biological properties, including antimicrobial, antioxidant, anti-inflammatory, immunomodulatory, antitumor, and probiotic effects. The biological properties of honey are influenced by its botanical origin, particularly the proportion of pollen derived from honey-producing plants within the sample. This study aimed to assess the presence and quantity of allergenic ragweed pollen in honey samples collected from various regions of Bosnia and Herzegovina (B&H). A total of 100 honey samples of different types from B&H were gathered and analyzed. The melisopalynological preparations were conducted in accordance with the Rulebook on methods for the control of honey and other bee products in Bosnia and Herzegovina, as well as the guidelines established by the International Commission for Bee Botany (ICBB). The identification of plant species was conducted through the examination of micromorphological characteristics of pollen grains, accompanied by a qualitative and quantitative analysis of honey samples. The melissopalynological analysis identified 50 distinct types of pollen within a total of 30,000 counted pollen grains, representing 25 different plant families. The palynological profile analysis revealed that ragweed allergens were present in 4% of the honey samples, with a total of 160 identified allergenic ragweed pollen grains. Biochemically, ragweed pollen is distinguished by eleven specific allergenic proteins (Amb a 1 to Amb a 11), with Amb a 1 being recognized as the most potent natural allergen. The allergenic potential of ragweed pollen is further amplified by various antigens (AgK, Ra3, and AgE) contained within the pollen grain, as well as lactone compounds, flavonoids, monoterpenes, and bitter flavonoids. The presence of allergenic ragweed pollen in honey raises significant biological concerns, as noted by the European Food Safety Authority, which suggests that it may compromise the safety of human consumption.

Keywords: pollen, honey plants, ragweed

Assessment of cytotoxicity and genotoxicity potential of wastewater as a distillation by-product of Rosa damascena Mill. essential oil

Tsvetelina Gerasimova*[1], Svetla Gateva[1], Gabriele Jovtchev[1], Ana Dobreva[2], Milka Mileva[3]

[1] Institute of biodiverstity and ecosystem research, Bulgarian Academy of Sciences, Sofia, Bulgaria
[2] Institute for Roses and Aromatic Plants, Kazanlak, Bulgaria
[3] The Stephan Angeloff Institute of Microbiology, Bulgarian Academy of Sciences, Sofia, Bulgaria

https://doi.org/10.21175/rad.abstr.book.2025.4.3

Wastewaters (ww) as a by-product of the rose oil water-vapor distillation process represent a significant proportion of the whole distillation products. The serious amount of ww discharged is a real problem as soil and water pollutant in the areas of R. damascena Mill. essential oil extraction. Nevertheless, ww is known as a source of bioactive compounds with valuable properties, which would be beneficial to reuse.

This study aimed to determine genotoxic/cytotoxic potential of R. damascena wastewater using a complex of classical cytogenetic analyses: structural chromosome aberrations (SCA), mitotic index (MI) and micronuclei (MN) formation as genetic endpoints in bone marrow and peripheral polychromatic erythrocytes (PCE) of ICR laboratory mice in vivo. To accomplish the aim of the study, an experimental scheme was set up with a single-dose regimen applied. Two groups of four male and four female mice were intraperitoneally (ip) administered with ww at doses of 11 % or 20 % solution (0.01 mL/b.w.). Bone marrow samples were collected 24 h or 48 h after the last treatment following standard protocol, whereas the peripheral blood samples were collected 48 h post ip treatment.

A single ww treatment did not induce significant enhancement in frequency of SCA and MN in PCE. The frequencies of SCA were between 3- to 6-fold lower than those received after N-methyl-N-nitro-N'-nitrosoguanidine (MNNG) supplementation (10.75% of cells with aberrations) ($p < 0.001$). A relatively low antiproliferative responses were shown after the mitotic index (MI) analysis when compared with the control frequencies ($p > 0.05$) and were also quite lower than the values of the positive (MNNG) control group ($p < 0.001$).

The lack of genotoxic effect and the slight suppression of proliferative activity in somatic mammalian cells are a basis for future research and appropriate valorization and practical application of the ww's.

Keywords: Rosa damascena Mill. wastewater, distillation by-products, cytotoxicity, genotoxicity, chromosome aberrations, in vivo micronucleus assay

Acknowledgement: The team expresses heartfelt thanks to the financial support of Project of Bulgarian National Sciences Fund КП-06 Н36/17 (granted to Assoc. prof. M. Mileva, PhD)

Association of BARD1 rs2229571 polymorphism with choroidal neoplasms in Russian population

Lujin Muhanna*, Abdulbary Amin Mahuop Ahmed

RUDN University, Moscow, Russia

https://doi.org/10.21175/rad.abstr.book.2025.4.4

Uveal melanoma (UM) is one of the most primary intraocular tumors. Patients with a family history and susceptibility of cancer are more likely to develop UM. Many of gene mutations like BAP1 and GNAQ and GNA11 are implicated in this disease. Gene BARD1 (BRCA1-associated Ring domain protein-1), located on 2q34-35, plays vital roles in the aforementioned cellular molecular mechanisms. The Bard1 protein makes a stable heterodimeric complex with BRCA1. This heterodimeric complex exhibits significant E3 ubiquitin ligase activity as well as can independently induce p-53 dependent apoptosis pathway, thus any inhibiting mutation in this gene may lead to UM. The BARD1gene polymorphism rs2229571 evokes the heterodimer ubiquitin ligase activity, contributing to cell cycle regulation, transcription regulation, and DNA repair. Our study investigated the prevalence of BARD1 gene polymorphism rs2229571 in Russian population and its contribution to developing UM in patients from Central Russia. Genomic DNA was extracted from peripheral blood of 42 patients with UM as a case group, 23 individuals with benign choroidal nevus as a risk group and 61 healthy individuals as a control group, and population group of 100 randomly selected Russian volunteers. Polymerase chain reaction-restriction fragment length polymorphism (PCR-RFLP) was used for amplification. DNA fragments were separated by 2% agarose gel electrophoresis and visualized by ethidium bromide and UV. The Chi-square test was used for estimation of distribution of genotypes and alleles and the significant differences between the studied groups. Our results exhibited a significantly higher frequency of GG homozygotes in the case group (21.4%) when compared with the control (1.6%, p=0.0001). Frequency of the GG genotype was found also higher in the risk group than its frequency in the control however did not achieve the significant level (13.0%, p=0.091). These results reflect that the development of UM and progressive choroidal nevus is associated with the homozygous GG genotype in patients (OR=13.025; 95% CI 2.964-57.242). Based on the population analysis, the genotype frequencies of BARD1 gene polymorphism rs2229571 are CC 42%, GC 47%, GG 11%, and alleles frequencies C 65.5%, G 34.5%, which is consistent with the results of our case-control study. Our findings of the population are in large consistence with the frequencies reported in NCBI; East Asian (C 65.87%, G 34.13%) and African population (C 62.10%, G 37.90), whereas disagreeing with the frequencies in European population (C 35.88%, G 64.12%). The BARD1 rs2229571 polymorphism is recommended as a predictive genetic biomarker for choroidal neoplasms.

DNA based marker techniques of coding regions in the analysis of genomic polymorphism of flax in remediated Chernobyl area

Jana Žiarovská*, Aqsa Abbas

Slovak University of Agriculture, Nitra, Slovakia

https://doi.org/10.21175/rad.abstr.book.2025.4.5

The nuclear reactor catastrophe in Chernobyl, Ukraine, had consequences not only locally, but in the more remote areas, too. The majority of the polluted regions were agricultural fields and woodlands. Experimental fields were built near Chernobyl, including radioactively polluted fields located 5 km from the nuclear power plant and remediated soil in the town of Chernobyl itself. This study analysed the seeds of two flax varieties grown under prolonged exposure to ionising radiation: the local Ukrainian variety Kyivskyi and the commercial variety Bethune. CDDP (Conserved DNA-derived polymorphism) and BBAP (Bet v 1 based amplified polymorphism) fingerprinting analyses were performed to characterize the length polymorphism generated markers of coding regions. In the CDDP analyze, varietal specific amplicons were obtained for both Kyivskyi and Bethune, but no difference in fingerprints between control and irradiated plants was resulted. In the cased of BBAP, that has its background in the PR-10 proteins homologs relevant to te plant defence mechanism, polymorphism was obtained for both of the analysed varies, as well as for control and irradiated plants. For the Kyivskyi variety, amplicon deletion was found in the seeds from the radioactive contaminated field and for the Bethune variety, amplicon insertion was found in the obtained fingerprints. In summary, the data resulted from the sudy show the genetic diversity between control and irradiated subgroups of flax seeds from Chernobyl area and the presence of active genomic answer of flax genome due to the irradiation stress.

Acknowledgement: This research was founded by the project 001SPU-4/2025 Internationalization of teaching texts of genetic and molecular safety subjects in the context of activating education and support of the PhD study was funded by the EU NextGenerationEU through the Recovery and Resilience Plan for Slovakia under the project No. 09I03-03-V02-00043.

DNA translesion synthesis in cellular response to oxidative stress and ionizing radiation

Alena Makarova*, Alexander Kruchinin, Anastasia Gromova, Eugeniy Shilkin, Elizaveta Boldinova

Institute of Gene Biology of Russian Academy of Sciences, Moscow, Russia

https://doi.org/10.21175/rad.abstr.book.2025.4.6

Oxidative stress and ionizing radiation is a source of DNA damage causing replication stress, mutagenesis and cell death. The DNA damage response (DDR) includes evolutionarily conserved mechanisms of DNA repair (such as base excision repair and homologues recombination) and DNA translesion synthesis.

We analyzed the mutagenic and cytotoxic potential of 8-oxoguanine (8-oxoG) and 8-oxoadenine (8-oxoA) – two major DNA lesions caused by reactive oxygen species. We carried out DNA polymerase reactions with five human DNA polymerases involved in base excision repair (Pol beta, Pol lambda), DNA translesion synthesis (Pol iota, Pol eta, Pol kappa) and human DNA primase-polymerase PrimPol. We showed the efficient and relatively accurate replication past 8-oxoG by Pol lambda, Pol iota and PrimPol as well as accurate and efficient synthesis across 8-oxoA by Pol kappa. Surprisingly, the accuracy of Pol beta and Pol lambda opposite 8-oxoA was dependent on a DNA size gap. Using the A549 *POLI*$^{-/-}$ and *PRIMPOL*$^{-/-}$ deficient human cells we also demonstrated the role of Pol iota and PrimPol in response to oxidative stress and ionizing radiation.

This work was supported by RSF grant 23-14-00209

Effect of continuous *in-utero* exposure to ELF-MF (50 Hz, 0.5 mT) on liver function in peripubertal rats

Srđan Kesić*[1], Đurđica Ignjatović[2], Maja Misirkić Marjanović[1], Ljubica Vučićević[1], Goran Đmura[3], Branka Petković[1]

[1] Department of Neurophysiology, Institute for Biological Research "Siniša Stanković", National Institute of the Republic of Serbia, University of Belgrade, Belgrade, Serbia
[2] Department of Biochemistry, Institute for Biological Research "Siniša Stanković" – National Institute of the Republic of Serbia, University of Belgrade, Belgrade, Serbia
[3] Animal Rearing Facility, Institute for Biological Research "Siniša Stanković" – National Institute of the Republic of Serbia, University of Belgrade, Belgrade, Serbia

https://doi.org/10.21175/rad.abstr.book.2025.4.7

Objectives: An extremely low-frequency magnetic field (ELF-MF) generated by domestic installations, household appliances, and power grids could have various adverse health effects [1]. Previously, subchronic exposure of adult male rats to ELF-MF (0.02 mT, 0.1 mT, and 0.5 mT) for 2 hours daily for 4 weeks did not produce any biochemical changes in the blood associated with liver health [2]. However, there is scarce information on whether continuous in-utero exposure to ELF-MF affects liver function. This study fills the gap and addresses the effect of continuous in-utero exposure to ELF-MF (50 Hz, 0.5 mT) on blood levels of albumin, alkaline phosphatase (ALP), alanine transaminase (ALT), aspartate aminotransferase (AST), gamma-glutamyl transferase (GGT) and bilirubin in peripubertal age.

Methods: Adult male and female rats (Wistar IGS) were placed near the on/off electromagnet generating ELF-MF (50 Hz, 0.5 mT) until conception and the pregnant females thereafter until the offspring were born. Immediately after birth, the mothers and their offspring were removed from the ELF-MF exposure system. Blood was collected from the trunk of each animal between 09:00 and 10:00 in the morning, and the sera were isolated and stored at -80°C until analysis. Serum parameters of liver function were analyzed using an automated biochemical analyzer (BS-240 Vet). The Kruskal–Wallis and Mann-Whitney tests were used to evaluate the changes in each parameter.

Results: Continuous in-utero exposure to ELF-MF causes the following significant effects in peripubertal offspring: (1) Decreased albumin concentration in males, (2) Increased ALT, AST, and GGT in males and decreased ALT, AST, and GGT in females, and (3) Decreased bilirubin concentration in both sexes.

Conclusion: These results suggest that continuous in-utero exposure to ELF-MF alters liver function at peripubertal age.

Acknowledgment: This work was funded by the Ministry of Science, Technological Development and Innovation of the Republic of Serbia (Contract No. 451-03-136/2025-03/200007).

References:

1. Klimek, A., & Rogalska, J.. Brain Sciences, 2021, 11, 2, 174.
2. Luo, X., et al., Toxicology and Industrial Health, 2017, 33(4), 365-372.

Effect of cyanobacteria biomass extract on human DNA *in vitro*

Jovana Tubić Vukajlović*[1], Nevena Djordjevic[1], Snežana Simić[1], Darko Grujičić[1], Marina Radović Jakovljević[1], Olivera Milošević-Djordjević[1,2]

[1] Department of Biology and Ecology, Faculty of Science, University of Kragujevac, Kragujevac, Serbia
[2] Department of Genetics, Faculty of Medical Sciences, University of Kragujevac, Kragujevac, Serbia

https://doi.org/10.21175/rad.abstr.book.2025.4.8

This study aimed to investigate the *in vitro* effect of cyanobacteria biomass extract of *Aphanizomenon flos-aquae* and *Microcystis aeruginosa* from the water supply reservoir (Gruža reservoir, Republic of Serbia) on the genome stability of human peripheral blood lymphocytes (PBLs). Biomass sampling was conducted in October 2023 from the shallowest part of the reservoir, where the biomass was most abundant, along with phytoplankton sampling (EN 16698:2016). The percentage of DNA (%DNA) damage and the Genetic Damage Index (GDI) in PBLs, treated with different concentrations (10, 25, 50, 75, and 100 μg/ml) of methanol extract of cyanobacteria biomass was evaluated using the alkaline single-cell gel electrophoresis (comet assay). These cyanobacteria accounted for 98.5% of the reservoir's phytoplankton (4 656 450 cells/mL), with the most dominant species being *A. flos-aquae* (3 105 120 cells/mL), followed by *M. aeruginosa* (1 480 130 cells/mL). All tested concentrations of the methanolic extract of biomass significantly increased ($p < 0.0005$) the average %DNA damage (from 35.67 ± 4.93 to 95.67 ± 1.53) and GDI (from 0.61 ± 0.02 to 2.39 ± 0.07) compared to the negative control (16.33 ± 1.15 for %DNA damage and 0.24 ± 0.03 for GDI). The genotoxic effect of the extract was dose-dependent (Pearson correlation coefficient: $r = 0.968$, $p = 0.000$ for %DNA damage and $r = 0.996$, $p = 0.000$ for GDI). Furthermore, as the extract concentration increased, the percentage of undamaged cells decreased compared to the lowest concentration (1.44% vs. 21.44%), and the negative control (1.44% vs. 27.89%). This research underscores the significant genotoxic effect of cyanobacteria biomass of *A. flos-aquae* and *M. aeruginosa* on human PBLs *in vitro*. The dose-dependent rise in DNA damage observed highlights the importance of water quality monitoring and management, especially in reservoirs used for drinking water, to protect public health.

Keywords: cyanobacteria; *Aphanizomenon flos-aquae*; *Microcystis aeruginosa*; genotoxic effect; comet assay.

Acknowledgements: This research was supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia (Agreement No. 451-03-136/2025-03/200122).

Effect of melatonin on arginine metabolism in brain tissue of rats after chronic exposure to microwave radiation

Dušan Sokolović*[1], Mihailo Sokolović[2], Danka Sokolović[3], Miloš Dičić[2], Aleksa Djokić[2]

[1] Department of Biochemistry, Faculty of Medicine, University of Niš, Niš, Serbia
[2] Faculty of Medicine, University of Niš, Niš, Serbia
[3] Blood Transfusion Institute Niš, Niš, Serbia

https://doi.org/10.21175/rad.abstr.book.2025.4.9

Exposure to microwave radiation (MW), used for mobile telephony, satellite communication, radio transmitters, radars, microwave heating devices, and medical diathermy, leads to various disorders in the nervous system. In brain tissue, citrulline and nitrogen monoxide (NO) are created from L-arginine, and on the other hand, under the action of arginase, L-ornithine and polyamines (necessary for cell growth, proliferation, and regeneration) are created. Melatonin is a neurohormone primarily synthesized and released by the pineal gland during the night and exhibits a significant antioxidant effect. This research aimed to determine the activity of arginase and the level of citrulline, as well as the effect of melatonin on the metabolism of arginine, in the brain tissue of rats after exposure to microwave radiation from a mobile phone (40 days). Wister rats were divided into 4 experimental groups: I (control), II (Mel) - animals that were given daily melatonin (2mg/kg body weight), III (MW) - animals that were exposed to MW radiation (4h/day), IV (MW+Melatonin) - rats administered melatonin and exposed to MW radiation (4h/day). 8 animals from each group were successively sacrificed after 40 days of the experiment. In the brains of rats exposed to MW radiation after 40 days of the experiment, a decrease in arginase activity ($p<0.001$) and a significant increase in citrulline levels ($p<0.001$) were recorded, compared to the control. Application of melatonin to irradiated rats led to a decrease in the level of citrulline ($p<0.01$), as well as an increase in arginase activity ($p<0.001$). Finally, it can be concluded that the application of melatonin to rats exposed to microwave radiation led to the prevention of arginine metabolism disorders in the brain tissue, and thus this substance shows a significant neuroprotective effect.

This work was supported by the project funded by the Ministry of Education, Science, and Technological Development of the Republic of Serbia (Grant No: 451-03-66/2024-03/200113).

Investigating the potential effects of 26 GHz 5G microwaves on UV-induced CPD levels in HaCaT keratinocytes *in vitro*

Bertalan Pintér*, Zsófia Szilágyi, Györgyi Kubinyi, György Thuróczy

National Center for Public Health and Pharmacy, Budapest, Hungary

https://doi.org/10.21175/rad.abstr.book.2025.4.10

The 5G, the fifth generation of wireless cellular network technology, promises faster speeds, higher data transfer, and lower latency. It is being deployed globally, making it crucial to understand how exposure to 5G networks affects human tissues. In Europe, the 26 GHz frequency band has been approved for 5G telecommunications. While radiofrequency used in 4G networks has been extensively studied, millimeter-wavelength microwaves like those in the 26 GHz range remain less researched. As frequency increases, penetration into human tissue decreases, therefore 26 GHz microwaves mainly absorbed by the skin.

Ultraviolet (UV) radiation, part of the electromagnetic spectrum, includes UVA (315–400 nm), UVB (280–315 nm), and UVC (100–280 nm) ranges. While UVA and part of the UVB range reach the Earth's surface, UVC and 95% of UVB are absorbed by the ozone layer. Humans are also exposed to artificial UVC radiation from sterilizing lamps. The genetic material suffers significant damage during the absorption of UV radiation, especially in the UVC and UVB ranges, causing cross-links between constituent nucleic acids. The absorption of UV can result in the formation of intrastrand cyclobutane-pyrimidine dimers in DNA, which can lead to mutations or cell death. Therefore, solar UV radiation has high carcinogenic activity and gives rise to a long-term risk of skin cancer. As a result, solar UV radiation is carcinogenic, classified by the World Health Organization's IARC as a Group 1 carcinogen to humans.

Both 26 GHz microwaves and solar UV radiation are absorbed in the upper layers of the skin, making it essential to study their combined effects.

HaCaT cells were cultured in Dulbecco's Modified Eagle Medium (DMEM) with fetal bovine serum (FBS) and antibiotics, maintained at 37°C with 5% CO2. Cells were seeded into 96-well plates or 35 mm Petri dishes before exposure to UV and microwave radiation. UV exposure was conducted using a SOL-500 solar simulator equipped with a filter to transmit UVB and UVA wavelengths. The UV dose delivered was controlled by adjusting exposure time and lamp distance, with an effective dose of 40 J/m².

For 26 GHz microwave exposure, the cells were irradiated using a horn antenna, with an average power density of 5–10 W/m². A software-defined radio (SDR) system generated a 5G signal, up-converted to the 26 GHz band, amplified, and transmitted to the cells. The exposure system was placed in a CO_2 incubator, and the temperature was carefully monitored to stay below 37°C.

DNA damage was assessed using the T4 enzyme-modified single-cell gel electrophoresis (comet) assay, which detects DNA strand breaks and UV-induced pyrimidine dimers. After irradiation, cells were harvested, mixed with 1% low-melting point agarose, dropped onto agarose pre-coated slides and covered with coverslips. Cells were lysed in lysis solution overnight at 4°C, then treated with a 1:1000 dilution of FPG enzyme (New England Biolabs, USA) and incubated at 37°C for 30 minutes. After alkaline treatment (pH>13) and electrophoresis, the slides were stained and analyzed using Comet Assay IV software (Instem, UK).

The aim of this study was to assess the combined effects of 26 GHz microwave and UV radiation exposure on CPD formation in keratinocytes. The findings will provide insight into the potential risks of combined exposure to these non-ionizing radiations, which could have significant implications for human health as 5G technology becomes more widespread.

Isolated spinach chloroplasts and thylakoids reveal how diclofenac affects photosynthetic apparatus

Monika Majewska*, Małgorzata Kapusta, Anna Aksmann

University of Gdańsk, Gdańsk, Poland

https://doi.org/10.21175/rad.abstr.book.2025.4.11

Human activity significantly contribute to environmental pollution with numerous biologically active substances. Among these, pharmaceuticals — particularly non-steroidal anti-inflammatory drugs (NSAIDs) — are of growing concern due to their increasing production and consumption. Diclofenac (DCF) is one of the most hazardous NSAIDs because of its frequent detection in freshwater systems, its ineffective removal in sewage treatment plants, and its slow degradation in the environment. Although DCF is detected in seas, lakes, rivers, and groundwater, little is known about its impact on higher plants and algae, which are vital components of aquatic ecosystems.

This study was designed to verify the hypothesis that DCF interferes with the photosynthetic apparatus. As a model, isolated chloroplasts and thylakoids of spinach (*Spinacia oleracea* L.) were used. Chloroplasts and thylakoids were exposed to DCF at concentrations ranged between 125 and 4000 µM. After 15 minutes of incubation, photosynthetic electron transport efficiency was assayed using chlorophyll *a* fluorescence induction analysis (OJIP-test) and chloroplasts structure was visualised using confocal microscopy.

The results indicate that DCF induces the conversion of some PS II reaction centres into non-photochemical energy dissipators, leading to reduced efficiency of photosynthetic electron transport chains. These disturbances were more pronounced in isolated thylakoids compared to chloroplasts. No specific binding of DCF to particular components of the electron transport chain was observed, suggesting a narcotic mechanism of action of this drug. Confocal microscopy revealed degradation of chloroplast structure following DCF exposure, which has not been previously reported in the literature.

In conclusion, diclofenac's effects appear to originate from non-specific interactions with photosynthetic membranes, disrupting electron transport chain functioning. This results in transformation of some PS II reaction centers into heat sinks, and increased non-photochemical energy dissipation. The non-specific nature of DCF's effects on biological membranes raises concerns about its potential impact on other cellular organelles.

Funding: This work was supported in part by the SmallGrants Programme—UGrants (1220.6010.192.2022), University of Gdańsk, Poland (laboratory equipment purchase), and in part by grant UMO-2023/49/N/NZ8/02077 from the National Science Centre, Poland (all other costs related to the investigations described in the present work).

Sustainable sunflower management: *Climate resilience and bioactive compound valorization in the circular economy*

Maria Duca*[1], Steliana Clapco[1], Oana Craciunescu[2], Elena Iulia Oprita[2]

[1] Moldova State University, Chisinau, Moldova
[2] National Research and Development Institute for Biological Sciences, Bucharest, Romania

https://doi.org/10.21175/rad.abstr.book.2025.4.12

Sunflower (*Helianthus annuus L.*) represents a vital crop with significant economic, ecological, and industrial importance, serving as a key pillar of the circular economy due to its diverse applications in food production, biofuels, and high-value industrial products. Ensuring the sustainability of sunflower cultivation necessitates an integrated approach that optimizes agronomic practices, enhances genetic resilience, and leverages precision technologies to improve productivity while conserving environmental resources.

Globally, sunflower cultivation plays a crucial role in sustainable agriculture by contributing to soil health, crop diversification, and resource efficiency. In the Republic of Moldova, sunflower is among the most extensively cultivated crops, significantly influencing the agri-food sector and national economy. Between 2016 and 2023, the cultivated area fluctuated between a minimum of 358.6 thousand hectares in 2019 and a maximum of 440.2 thousand hectares in 2022. The production of sunflower seeds is highly susceptible to climatic variability, particularly in the absence of a well-established irrigation infrastructure. The lowest recorded yield was 492.5 thousand tons in 2020, a year marked by severe drought, while the highest production reached 960.1 thousand tons in 2021. These fluctuations underscore the necessity of adopting resilient agricultural practices to mitigate climate-induced risks.

This study examines key aspects of sustainable sunflower crop management, including site selection, optimized agronomic practices and genetic improvement, et all. Given the increasing impact of climate change, research on biotic and abiotic stress factors is essential for the development of stress-tolerant hybrids. Rising temperatures, irregular precipitation patterns, and soil degradation necessitate breeding programs focused on drought-resistant, disease-resistant, and high-yield hybrids. Additionally, sustainable agricultural strategies, including crop rotation, biological pest control, and soil fertility management, contribute to ecological balance and long-term productivity.

Beyond its agronomic significance, sunflower has substantial potential for industrial and pharmaceutical applications through the valorization of its by-products. The extraction of biologically active compounds, such as polyphenols, flavonoids, and biopeptides, presents a valuable opportunity for the development of high-value-added products in nutraceuticals, cosmetics, and pharmaceuticals. These bioactive substances exhibit antioxidant, antimicrobial, and anti-inflammatory properties, reinforcing the multifunctionality of sunflower cultivation within the circular economy. By maximizing the utilization of sunflower biomass and derivatives, economic efficiency is enhanced while minimizing agricultural waste.

The future of sunflower cultivation lies in the convergence of advanced biotechnological research, eco-friendly agricultural practices, and efficient resource management. Strengthening resilience to climatic stressors, enhancing oil yield quality, and expanding industrial applications will ensure the long-term sustainability of this crop. Through the implementation of sustainable strategies, sunflower can significantly contribute to food security, economic development, and environmental sustainability, positioning itself as a cornerstone of modern agro-industrial systems.

The study was developed within the framework of Subprogram 011101 *Genetic and biotechnological approaches to the management of agroecosystems in the conditions of climate change*, funded by the Ministry of Education and Research of the Republic of Moldova and the research project (PN-IV-P8-8.3ROMD-2023-0269) *Comprehensive valorization of Helianthus annuus L. by-products for the development of new products with biomedical potential*, funded by UEFISCDI, Romania.

Comprehensive LC–HRMS lipidomics of serbian schizophrenia patient cohort

Avramović Nataša*[1], Marković Suzana[2,3], Jadranin Milka[4], Miladinović Zoran[5], Gavrilović Aleksandra[6], Takić Marija[7], Tasic Ljubica[8], Krstić Gordana[3], Savić Danica[4], Tešević Vele[3], Mandić Boris[3]

[1] Institute of Medical Chemistry, University of Belgrade – Faculty of Medicine, Belgrade, Serbia
[2] Institute of Forensic Medicine, University of Belgrade – Faculty of Medicine, Belgrade, Serbia
[3] University of Belgrade – Faculty of Chemistry, Belgrade, Serbia
[4] University of Belgrade – Institute of Chemistry, Technology and Metallurgy, Department of Chemistry, Belgrade, Serbia
[5] Institute of General and Physical Chemistry, Belgrade, Serbia
[6] Special Hospital for Psychiatric Diseases "Kovin", Kovin, Serbia
[7] Center of Research Excellence for Nutrition and Metabolism, Institute for Medical Research, National Institute of Republic of Serbia, University of Belgrade, Belgrade, Serbia
[8] Institute of Chemistry, Organic Chemistry Department, Universidade Estadual de Campinas, UNICAMP, Sao Paulo, Brazil

https://doi.org/10.21175/rad.abstr.book.2025.5.1

Schizophrenia (SCH) is a serious psychiatric disorder characterized by positive symptoms, negative symptoms, and cognitive impairments, leading to long-term disability and invalidity. Therefore, the need for reliable biomarkers for its early diagnosis and treatment is crucial. This study aimed to conduct untargeted lipidomics of serum samples from a Serbian cohort, consisting of 30 schizophrenia patients and 31 non-psychiatric control individuals, using liquid chromatography (LC) combined with high-resolution mass spectrometry (HRMS) and chemometric analyses. Principal component analysis (PCA) of all samples showed no distinct separation between SCH and control groups but revealed clear gender separation within the control group. Multivariate statistical analyses (PCA and orthogonal partial least squares discriminant analysis OPLS-DA) of gender-differentiated SCH and control groups identified forty-nine differential lipids distinguishing male SCH (SCH-M) patients from male controls (C-M), and sixty potential biomarkers differentiating female SCH patients (SCH-F) from female controls (C-F). The lipidomic analysis of gender-differentiated groups (SCH-M vs. C-M and SCH-F vs. C-F) confirmed altered lipid metabolism, with decreased levels of the most affected lipid classes: glycerophospholipids (GP), sphingolipids (SP), glycerolipids (GL), and fatty acids (FA), compared to controls. Among the differential lipid metabolites with higher content in both SCH-M and SCH-F patient groups compared to their non-psychiatric controls, four common lipid molecules were identified: ceramides Cer 34:2 and Cer 34:1, lysophosphatidylcholine LPC 16:0, and triacylglycerol TG 48:2. The notable changes in lipid metabolism highlight the crucial role of metabolic pathways in the development of schizophrenia.

Exploratory LC–HRMS lipidomic profile of bipolar disorder patients in Serbia

Avramović Nataša*[1], Jadranin Milka[2], Miladinović Zoran[3], Gavrilović Aleksandra[4], Tasic Ljubica[5], Miljević Čedo[6], Janković Milan[7], Tešević Vele[7], Mandić Boris[7]

[1] Institute of Medical Chemistry, University of Belgrade – Faculty of Medicine, Belgrade, Serbia
[2] University of Belgrade – Institute of Chemistry, Technology and Metallurgy, Department of Chemistry, Belgrade, Serbia
[3] Institute of General and Physical Chemistry, Belgrade, Serbia
[4] Special Hospital for Psychiatric Diseases "Kovin", Kovin, Serbia
[5] Institute of Chemistry, Organic Chemistry Department, Universidade Estadual de Campinas, UNICAMP, Sao Paulo, Brazil
[6] Institute of Mental Health, Faculty of Medicine, University of Belgrade, Belgrade, Serbia
[7] University of Belgrade – Faculty of Chemistry, Belgrade, Serbia

https://doi.org/10.21175/rad.abstr.book.2025.5.2

Bipolar disorder (BD) is a psychiatric illness characterized by fluctuating mood states, including euthymia, major depression, and mania. Diagnosis relies solely on subjective symptom recognition, lacking objective methods like clinical tests or biomarkers, leading to misdiagnosis, inadequate treatment, and poor clinical outcomes. The lipidomic profiles of serum samples from patients with bipolar disorder (BD) and healthy controls (C) were thoroughly analyzed and compared. This study involved a cohort of 31 individuals diagnosed with BD and 31 non-psychiatric control subjects. To achieve a comprehensive understanding of the lipid profiles, an untargeted lipidomics approach was employed, utilizing liquid chromatography (LC) coupled with high-resolution mass spectrometry (HRMS). Multivariate statistical analyses were conducted to interpret the complex data obtained from the lipidomic study. Principal component analysis (PCA) and partial least squares discriminant analysis (PLS-DA) were used to identify patterns and differences between the BD patients and control groups. These analyses revealed fifty-six differential lipids that were significantly altered in BD patients compared to healthy controls. The findings of this study indicated notable alterations in lipid metabolism within the BD patient sera. Specifically, changes were observed in the metabolic pathways of glycerophospholipids, sphingolipids, glycerolipids, and sterol lipids. These lipid classes play crucial roles in cellular function and signaling, and their dysregulation may contribute to the pathophysiology of bipolar disorder.

Integrative structural biology: Insights into disease mechanisms

Albert Guskov*

University of Groningen, Groningen, Netherlands

https://doi.org/10.21175/rad.abstr.book.2025.6.1

Understanding the intricate workings of membrane transporters is fundamental to deciphering their roles in both normal physiology and disease. In this presentation, I will report how recent advancements in integrative structural biology techniques enabled us to shed new light on the ASCT2 and ASCT1 transporters—key proteins implicated in diverse pathological conditions ranging from metabolic disorders to cancer and neurological diseases.

Using a multidisciplinary approach that combines high-resolution cryo-electron microscopy, X-ray crystallography, and molecular dynamics simulations, we have characterized multiple conformational states of ASCT2 and ASCT1. Our findings reveal critical insights into substrate recognition, binding affinity, and the transition mechanisms that underlie the transport cycle. Complementary functional assays and computational modeling further link these structural states to known malfunctions of these transporters that could be a starting point to develop new routes for therapeutic intervention.

Investigation of oligomeric states of Mj CorA

Andrei Zupnik*

The University of Groningen, Groningen, Netherlands

https://doi.org/10.21175/rad.abstr.book.2025.6.2

Magnesium (Mg^{2+}) is an essential cellular cation involved in numerous enzymatic and metabolic processes. Its transport across cell membranes requires specialized proteins due to its large hydrated radius. CorA is one such membrane protein found in bacteria and archaea, facilitating the movement of Mg^{2+} and other divalent cations. Prior studies on Thermotoga maritima (Tm) CorA demonstrated a homo-pentameric state regardless of Mg^{2+} presence. This study investigates the oligomeric states of Methanocaldococcus jannaschii (Mj) CorA using mass photometry, cryo-electron microscopy, and high-speed atomic force microscopy (hsAFM) to explore the role of Mg^{2+} in its structural configuration.

Cryo-electron microscopy revealed that in the presence of EDTA, two oligomeric subpopulations—tetramers and pentamers—were observed, while the addition of magnesium resulted exclusively in pentamers. This suggests that Mg^{2+} stabilizes the pentameric form of Mj CorA. In contrast, mass photometry did not show significant changes before and after EDTA treatment, implying that Mg^{2+} might not directly influence the oligomeric state under the tested conditions.

These observations differ from earlier findings on Tm CorA, indicating potential species-specific differences in CorA's structural dynamics. The lack of consistent oligomeric changes suggests that other factors, such as membrane potential or protein interactions, could play a more significant role in influencing Mj CorA's structural states.

Further research is required to elucidate the mechanisms governing Mj CorA's oligomeric transitions. Future studies should investigate the effects of varying Mg^{2+} concentrations and environmental conditions (e.g., pH and ionic strength) and incorporate additional biophysical methods. A deeper understanding of Mj CorA's oligomeric behaviour will provide valuable insights into the regulatory mechanisms of magnesium transport in archaea and bacteria.

Study of light-induced interaction of quinone derivatives with guanosine and guanosine-rich oligonucleotides

Olga Selyutina*[1], Maya Ulyanova[1], Oksana Gulyaeva[2], Elena Dmitrienko[2], Nikolay Polyakov[1]

[1] Institute of Chemicel Kinetics and Combustion SB RAS, Novosibirsk, Russia
[2] Institute of Chemical Biology and Fundamental Medicine SB EAS, Novosibirsk, Russia

https://doi.org/10.21175/rad.abstr.book.2025.6.3

Quinones are a broad class of compounds of both synthetic and natural origin that are actively used in medicine, particularly in anticancer therapy. Their main mechanism of cytotoxicity is associated with interaction with DNA. This type of interaction is possible due to the flat aromatic system of quinones.

Model processes of interaction of the naphthoquinone derivative N-(2-chloro-1,4-naphthoquinonyl)-b-alanine (Nap) as well as the anthraquinone 2-phenyl-4-(butylamino)-naphtholquinoline-7,12-dione (Q1) with 5'-guanidylic acid (GMP) and oligonucleotide sequences of different lengths (2G, 3G, 4G, where G is guanosine) were investigated by NMR.

Both quinones were found to form weak complexes with GMP mainly due to stacking interactions. The study of chemical induced dynamic nuclear polarization (CIDNP) occurring under irradiation showed that Q1 and Nap participate in photoinduced electron transfer reactions with GMP. It was found that in the Q1-GMP and Nap-GMP systems, photoexcitation results in quinone excited states quenching with the formation of anion and cation radicals Q1-- and GMP-+, Nap-- and GMP-+, respectively.

It is also shown that quinones form complexes with all investigated oligonucleotide sequences. The CIDNP effect was observed only in the experiments with Nap; this effect was not observed for the mixture of Q1 with oligonucleotides. Analysis of the resulting polarized signals showed that naphthoquinone is capable of electron transfer reactions with 2G, 3G, and 4G regardless of the sequence length.

Since the cytotoxicity of quinones is associated with the ability to interact with DNA, these results are important for the mechanisms of activity and photochemical properties of this class of compounds, as well as for the development of new chemotherapeutic agents.

This work was supported by RNF (grant № 25-23-00243).

Application of intravital microscopy for evaluation of cold microwave argon plasma action on vasomotion at the microcirculatory bed in vivo

Lubomir Traikov*[1], Todor Bogdanov[1], Katerina Smejkalova[2], Todor Hikov[1], Biljana Piperkova[1], Maria Todorova[1], Maxim Kalayanov[1], Akira Ushiyama[3], Chiodji Ohkubo[4]

[1] Medical University-Sofia, Faculty of Medicine, Department Medical Physics and Biophysics, Sofia, Bulgaria
[2] Brno University of Technology, Faculty of Chemistry, Brno, Czech Republic
[3] National Institute of Public Health-NIPH, Tokyo, Japan
[4] Japan EMF Information Center, Tokyo, Japan

https://doi.org/10.21175/rad.abstr.book.2025.6.4

Recent reports have demonstrated that EMF has a positive effect on various stages of tissue healing and regeneration. The processes affected by EMF include, but are not limited to, cell migration and proliferation, growth factor expression, nitric oxide synthase activation, NO generation, and cytokine modulation. These effects have been found even when applying low frequencies (range: 30–300 kHz) and extremely low frequencies (range: 3–30 Hz).

In this regard, a special emphasis in this project is on the applications of high-frequency electromagnetic fields from the microwave range, as they are the main component of cold Argon microwave plasma. Despite the numerous evidences and already known effects of extremely low-frequency EMF, their biosafety and therapeutic efficacy remain a topic of interest.

Tissues are complex cellular structures where multiple environmental factors such as nutrients, waste products, chemokines, cell types (e.g. fibroblasts, macrophages, T and NK cells), as well as structures (e.g. blood vessels, extracellular matrix-ECM) interact with each other. All these microenvironmental factors potentially influence the response to external-physical influences such as cold microwave Argon plasma. In our preliminary studies, the extremely rapid coagulation effect induced by Argon plasma was established (in 30 seconds, it stops bleeding from an arterial blood vessel). In the preliminary organization of the experiment, we used 20 BALB-C mice, each of which was implanted with a Dorsal Skin Fold Chamber-DSC, after which the animals were divided into two groups of 10 animals, one experimental and the other control. In chronic experiments lasting 14 days, it was established using intravital microscopy chambers previously implanted in the experimental animals, a significant increase in the density of newly formed blood vessels by 40% compared to animals not irradiated with cold microwave Argon plasma. The exposure was made in special restrainers for conscious animals with a regime of 14 days for 30 seconds per animal. The control animals of the studied group were kept in a restrainer for 30 seconds every day for 14 days.

As a conclusion, a hypothesis can be formulated about the regeneration-promoting process of irradiation with cold Microwave Argon plasma, that the rapid healing of wounds (2 times faster than the non-irradiated control) is probably due to stimulation of angiogenesis processes by means high frequency electromagnetic component of cold microwave Argon plasma.

More detailed studies are needed to determine the likely regulatory mechanisms behind the stimulation of neoangiogenesis processes under the action of cold Microwave Argon Plasma.

Construction, analysis and correlation of dose response logistic curves for repurposed drugs anticancer effects on fibrosarcoma in hamsters

Dušica Popović*[1], Kosta Popović[2], Zana Dolićanin[1], Dejan Miljković[2], Dušan Lalošević[2], Ivan Čapo[2], Jovan Popović[2]

[1] State University of Novi Pazar, Novi Pazar, Serbia
[2] Faculty of Medicine, University of Novi Sad, Novi Sad, Serbia

https://doi.org/10.21175/rad.abstr.book.2025.7.1

Logarithmic dose response curves are typically „S"-shaped, monotonic and can be fit to a classical Hill equation. The Hill equation is logistic curve – an extension of the sigmoid functions.Although *in vitro* (cell lines) anticancer effects of some nononcological pleiotropic drugs, such as metformin and itraconazole are reported, *in vivo* (experimental animals) and clinical investigations, especially of their combinations, are not yet conducted. The study was conducted on Syrian golden hamsters (10-12 weeks old; weight, ~80 g). The animals were randomized into groups (6 hamsters per group). The subcutaneous inoculation of 1 ml of BHK-21/C13 cell suspension ($2x10^6$ cells/ml) was performed for development of a fibrosarcoma in hamsters. During 18 days after tumor inoculation, animals with experimental fibrosarcoma were treated orally (via a metal gastric tube) with investigated drugs. We compared anticancer effects and safety of examined repurposed drugs combination (doses equivalent to usual human doses by normalization to body surface area) in hamster fibrosarcoma with: a) control (with inoculated tumors, to test efficacy and toxicity); b) two drug combination (metformin and itraconazole); c) doubled doses of each drug from examined combination given alone (to enhance possible anticancer effects of each single drug); d) dose response effectivity validation experiments (tumor dimensions vs. percent of human equivalent doses of each drug in combination: 0%, 50%, 100% and 200%, obtaining typical logarithmic S-shaped sigmoid curve - Hill logistic dose response curve characteristic for pharmacodynamic effect), in order to definitely confirm anticancer efficacy of the combination; furthermore, comparing results of c) and d) will enable to differ additive effect from potentiating synergism (Combination Index - CI analysis). The animals were sacrificed 19 days (tumors ~2-3 cm) post-inoculation. To sacrifice the animals, a dose of 90 mg/kg pentobarbital was administered intraperitoneally. The volume (2-3 ml) of the total collected blood was used for blood hematological and biochemical analyses. Following exsanguination and animal death, vital organs (heart, lungs, liver, kidneys and brain) were removed. After sacrifice, the tumors were excised, photographed and weighed, their diameters were exactly measured, and the exact tumor volume was determined using the standard water volume displacement method. Tumor slices (4 μm) were assessed pathohistologically (for the verification of tumor growth, tissue penetration, expansion of necrosis and hemorrhagic areas, proliferation), and immunohistochemically to assess: mutational status (p53); tumor proliferation (Ki-67 and PCNA); neoangiogenesis (CD34 and CD31); glucose metabolism (GLUT1); NO metabolism (iNOS) and apoptosis (COX4, Cytochrome C and caspase 3) in the tumor specimens. The weight of the hamsters was recorded to evaluate possible side effects of examined drug combinations. The vital animal organs (brain, heart, lungs, liver and kidneys) were analyzed histopathologically, and toxicologically. Validation of combinatory anticancer effects by dose response effect (Hill S-shaped curves and Combination Index – CI analysis) confirmed our earlier findings of synergistic metformin and itraconazole interaction *in vivo*. Metformin and itraconazole combination have CI>1 for all investigated anticancer effects in the experiment. As metformin and itraconazole combination shows synergistic dose response antitumor effects on hamster fibrosarcoma without toxicity, with CI>1 for all analysed tumor characteristics, the combination is recommended for further investigations in oncology.

Keywords: hamster fibrosarcoma; metformin; itraconazole; synergism; dose response

Acknowledgements: Republic of Serbia, Autonomous Province of Vojvodina, Provincial Secretariat for High Education and Scientific Research, grants no. 003074336-2024-09418-003-000-000-001/1 (JM) and 142-451-2626/2021 (DL).

Model-based meta-analysis of adverse events in metastatic melanoma immunotherapy: The importance of quantifying heterogeneity

Srđan Milićević, Jovana Dedeić*, Katarina Vidojević, Jelena Ivetić, Marija Delić

Faculty of Technical Sciences, University of Novi Sad, Serbia

https://doi.org/10.21175/rad.abstr.book.2025.7.2

In recent years, immune checkpoint inhibitors (ICIs) have reshaped the management of advanced melanoma, offering a substantial survival advantage over conventional therapies. However, the therapeutic benefits of ICIs are accompanied by substantial immune-related adverse events (irAEs), which may severely impact patients' quality of life and treatment adherence. These toxicities, arising from immune system dysregulation, vary in frequency and severity across treatment types, particularly between monotherapy and combination immunotherapy. This variability underscores the need for rigorous statistical analysis to understand the prevalence and distribution of such adverse events and to support evidence-based treatment decisions.

This study presents a meta-analytic evaluation of selected irAEs, specifically pneumonitis, colitis, and hypothyroiditis, in the context of ICI-based treatment for melanoma. Our primary aim is to investigate how statistical model choice influences the estimation of adverse event rates and to explore the role of heterogeneity in interpreting aggregated clinical trial data. By comparing monotherapy and combination therapy groups across multiple studies, we assess whether reported differences in toxicity profiles are consistent across modeling approaches. Furthermore, adequately capturing and quantifying heterogeneity is essential for deriving clinically meaningful conclusions from meta-analytic data.

Our meta-analysis included 10 studies with a total of 2 846 patients treated with ICI monotherapy, and 6 studies with 1,801 patients receiving combination immunotherapy. We applied three complementary statistical frameworks: the fixed effects model (FEM), which assumes a common true effect; the random effects model (REM), which incorporates between-study variability; and the generalized linear mixed model (GLMM), which accounts for both outcome distributions and hierarchical data structure. These models differ in their assumptions about data structure and heterogeneity, affecting both point estimates and uncertainty bounds. For each adverse event and treatment group, we calculated point estimates and 95% confidence intervals of prevalence, along with I^2 statistics and their interval estimates to assess heterogeneity magnitude. The results showed that confidence intervals vary notably by model across all evaluated irAEs and both therapy groups, reflecting increasing sensitivity to heterogeneity. In several cases, the intervals for monotherapy and combination therapy did not overlap, suggesting clinically meaningful differences in adverse event risks that may otherwise be obscured under less flexible models.

The study highlights the importance of incorporating heterogeneity assessment into the meta-analytic modeling of immune-related adverse events in melanoma immunotherapy. Differences in modeling assumptions can significantly alter risk estimates and, consequently, affect clinical interpretation. Through the careful use of FEM, REM, and GLMM frameworks, and by explicitly quantifying heterogeneity, we provide a nuanced statistical perspective that complements clinical insight and informs safer, more personalized treatment strategies.

Acknowledgment: This research was supported by the Science Fund of the Republic of Serbia, Grant No. 9393, "Optimization and Prediction in Therapy Treatments of Cancer – OPTIC."

Rescue control experiments to regain the knockdown anticancer effects of repurposed drugs on fibrosarcoma in hamsters

Kosta Popović[1], Dušica Popović[2], Dejan Miljković[1], Dušan Lalošević[1], Zana Dolićanin[2], Ivan Čapo[1], Jovan Popović*[1]

[1] Faculty of Medicine, University of Novi Sad, Novi Sad, Serbia
[2] State University of Novi Pazar, Novi Pazar, Serbia

https://doi.org/10.21175/rad.abstr.book.2025.7.3

Literature analysis shows that repurposed non-oncological drugs, such as metformin and disulfiram, act through a lot of same anticancer mechanisms, on the same targets, in the same direction. Also, for majority of these mechanisms, non-oncological drug deoxycholic acid acts in the opposite pro-cancer direction. If the rescuing target/protein is expressed at sufficient level that it can reciprocally modulate the pathway of interest, the rescue experiment provide evidence for underlying mechanism of investigated process. To test whether NF-kB and HIF-1a inhibition underlies the anticancer mechanism of examined drug combination, metformin and disulfiram, we comedicated a NF-kB and HIF-1a stimulator deoxycholic acid in order to rescue NF-kB and HIF-1a activity and block the hypothesized anticancer mechanism of the examined repurposed drug combination. For better understanding how the metformin and disulfiram combination exhibits the hypothesized anticancer effect, we overexpressed NF-kB, HIF-1a and downstream targets (VEGF, P-gp, MRPs) by deoxycholic acid.The study was performed on Syrian golden hamsters (age, 10-12 weeks; weight, ~80 g). The hamsters were randomized into groups (n=6 hamsters/group). The subcutaneous inoculation of 1 ml of BHK-21/C13 cell suspension ($2x10^6$ cells/ml) was performed for development of a hamster fibrosarcoma tumors. During 18 days after tumor inoculation, animals with experimental fibrosarcoma were treated orally (via a metal gastric tube) with investigated drugs. We compared anticancer effects and safety of metformin and disulfiram combination (doses equivalent to usual human doses by normalization to body surface area) in hamster fibrosarcoma with: a) control (with inoculated tumors, to test efficacy and toxicity); b) two drug combination (metformin and disulfiram); c) doubled doses of each drug from examined combination given alone (to enhance possible anticancer effects of each single drug); d) metformin and disulfiram combination with addition of deoxycholic acid (doses equivalent to human), in order to definitely confirm anticancer efficacy of the combination and to elucidate potential mechanism of anticancer action; e) deoxycholic acid alone. The animals were sacrificed 19 days (tumors ~2-3 cm) post-inoculation. The blood was collected for hematological and biochemical analyses. After sacrifice, the tumors were excised, photographed and weighed, their diameters were exactly measured, and the exact tumor volume was determined using the standard water volume displacement method. Tumor sections (4 μm) were evaluated pathohistologically for the verification of tumor growth, tissue penetration, expansion of necrosis and hemorrhagic areas. Immunohistochemical staining was used to determine: mutational status (p53); tumor proliferation (Ki-67, PCNA); neoangiogenesis (CD34, CD31); glucose metabolism (GLUT1); NO metabolism (iNOS) and apoptosis (COX4, Cytochrome C, caspase 3) in the tumor slices. The vital animal organs (brain, heart, lungs, liver and kidneys) were analyzed histopathologically and toxicologically. As metformin and disulfiram combination shows synergistic anticancer effects on hamster fibrosarcoma, that can be aborgated with deoxycholic acid, NF-kB and HIF-1a can be possible underlying cancer modulatory mechanism. There were no notable toxicity on main organs. These are the reasons that the metformin and disulfiram combination can be recommended for further investigations in oncology.

Keywords: hamster fibrosarcoma; metformin; disulfiram; NF-kB; HIF-1a

Acknowledgements: Republic of Serbia, Autonomous Province of Vojvodina, Provincial Secretariat for High Education and Scientific Research, grants no. 003074336-2024-09418-003-000-000-001/1 (JM) and 142-451-2626/2021 (DL).

Scientific and technical solution of the device for mini-gamma-quantum diagnostics of body tissues

Olena Sulima[1], Volodymyr Sulyma*[2], Leonid Mescheryakov[3]

[1] Dnipro City Hospital, Dnipro, Ukraine
[2] Dnipro State Medical University, Dnipro, Ukraine
[3] Firm, Dnipro, Ukraine

https://doi.org/10.21175/rad.abstr.book.2025.7.4

The novelty of the scientific and technical solution in the developed small-sized device for mini-gamma-quantum express diagnostics of tissues of the human body in the verification of oncological diseases is that the device is a portable medical device for non-invasive and non-contact differential express diagnostics of normal diseases and pathologically changed tissues of the human body based on the study of biopsies directly during surgical intervention.

The main novelty of the development is that the construction of the proposed device is based on the gamma absorption method - a method of elemental analysis based on measuring the degree of attenuation of the gamma radiation flux passing through the biological tissue under investigation, or, in other words, the dependence of the degree of absorption on the biological tissue of a monochromatic beam of gamma quanta with a low energy value ranging from 5 to 17 keB, at which a sample of biological tissue with a thickness of 3 to 5 mm will intensively absorb gamma quanta.

Irradiation of a tissue sample with a mini-gamma-quantum causes cells to lose their negative charge, thus creating a photoelectric effect (Stoletov effect), which will be strictly individual for tumor, inflammatory and normal tissues. To differentiate various pathological formations, the authors measure the intensity of absorption of gamma quanta by cells, as well as the characteristic emission of microelements present in the tissue.

A thallium-NaI (TL) activated sodium-iodine scintillation gamma spectrometric detector converts the energy of gamma quanta entering its sensitive area into flashes of visible light with a brightness proportional to the energy of the gamma quanta.

The photomultiplier converts the visible light flashes of the scintillation detector installed opposite the photocathode into electrical pulses with an amplitude proportional to the brightness of the visible light flashes.

Technical parameters determining the functional, quantitative (numerical) and qualitative characteristics of the developed device for mini-gamma diagnostics

Volodymyr Sulyma*[1], Olena Sulima[2], Volodymyr Gaponov[1]

[1] Dnipro State Medical University, Dnipro, Ukraine
[2] Dnipro City Hospital, Dnipro, Ukraine

https://doi.org/10.21175/rad.abstr.book.2025.7.5

Functions provided by the desired device for mini-gamma diagnostics:

1. It is used in non-invasive, non-contact medical research.
2. Has a level of complexity such that personnel who have learned only the device's operating instructions are allowed to work with it.
3. Differentiate tissues that are examined according to the following criteria: normal biological tissue without pathological formations; biological tissue with benign neoplasms; biological tissue with malignant neoplasms, and records the obtained results in the form of physical (digital) values.
4. It has the functional ability to ensure the following actions for express diagnostics: calibration with the help of specialized equivalents included in the device package, for working with defined tissue biopsies of a specific area of a person, as well as re-calibration when switching to another type of biological tissue during operation and use of the device from the same equivalents that are included in the device package; insertion of the biopsy specimen into the cassette of the device's research unit and the formation of determined sizes of samples of the biological tissue being examined using the cassette, the cutting mechanism and the cassette holder; positioning of the cassette holder with the inserted cassette with the sample to be examined in the formed form in the examination unit of the device; formation of a low-energy monochromatic collimated gamma-ray beam with energy from 5 to 17 keV for research through the sample; measurement of the intensity of the gamma quanta flow after passing through the sample of biological tissue under investigation using a scintillation detector and a photoelectron multiplier; performing mathematical processing of the received information; display on the monitor of the information of the final result in the form of a physical (digital) value and the corresponding category of the state of the biological tissue; maintaining a database with the necessary amount of information: numbering of the research list, data, patient's first and last name, male/female, birth data, address, digital research result, conclusion based on the research results; necessary preservation of the amount of information; has communication (wired and wireless) with electronic data entry devices; transfer for system entry of the database and use with the service of information on a higher-level device; processing information from the database using artificial intelligence.

Functions provided by the desired device for mini-gamma diagnostics:

1. It is used in non-invasive, non-contact medical research.
2. Has a level of complexity such that personnel who have learned only the device's operating instructions are allowed to work with it.
3. Differentiate tissues that are examined according to the following criteria: normal biological tissue without pathological formations; biological tissue with benign neoplasms; biological tissue with malignant neoplasms, and records the obtained results in the form of physical (digital) values.
4. It has the functional ability to ensure the following actions for express diagnostics: calibration with the help of specialized equivalents included in the device package, for working with defined tissue biopsies of a specific area of a person, as well as re-calibration when switching to another type of biological tissue during operation and use of the device from the same equivalents that are included in the device package; insertion of the biopsy specimen into the cassette of the device's research unit and the formation of determined sizes of samples of the biological tissue being examined using the cassette, the cutting mechanism and the cassette holder.

Extraction method and qualitative identification of lignin form common wheat and spelt, based on selectivity of deep eutectic solvents: A preliminary study

Donika Ivanova*[1], Zvezdelina Yaneva[1], Milena Tzanova[2], Ana Georgieva[3]

[1] Department of Pharmacology, Animal Physiology, Biochemistry and Chemistry, Faculty of Veterinary Medicine, Trakia University, Stara Zagora, Bulgaria
[2] Faculty of Agriculture, Department of Biological Sciences, Trakia University, Stara Zagora, Bulgaria
[3] Department of Animal husbandry – ruminants and animal product technologies, Agricultural Faculty, Trakia University, Stara Zagora, Bulgaria

https://doi.org/10.21175/rad.abstr.book.2025.8.1

BACKGROUND:

Lignin is the second most abundant biopolymer, approximate 30% of the total organic carbon content into the biosphere. Due to its complex chemical structure, as well as the presence of various functional groups, it serves as a precursor for producing resins, adhesives, lignin-based polymer composites, wastewater treatment and, importantly, has biomedical relevance in developing drug delivery systems. To obtain lignin derivatives with high purity, specific solvents and extraction methods are required, which significantly influence the structure, properties, and biological activity of the compound. Recently, the deep eutectic solvents (DES) have attracted attention in the scientific community, because of their easy synthesis, high selectivity, efficiency, biodegradability, and non-toxicity. DES offer a novel approach to processing and extracting numerous raw materials under relatively mild conditions. Scientific studies have demonstrated that DES exhibit near-total selectivity for lignin with minimal solubility for cellulose, making them effective for extracting lignin from various biomass types.

The aim of presented study is to focused on current extraction methods, based on application of DES and qualitative analysis of their lignin-extraction selectivity from common wheat (*Triticum aestivum*) and spelt (*Triticum spelta*) biomass.

METHODS AND RESULTS:

The lignin extraction methods from plant biomass had been elaborated using combinations between four DES (urea, lactic acid, citric acid and choline chloride), applied at different concentrations. Various temperature and pH parameters have been tested to obtain appropriate extraction techniques. During the lignin-extraction process from common wheat and spelt and the most relevant parameters and DES have been selected respectively. After four times purification and subsequently freeze-drying, the FTIR spectral analysis method have been used for qualitative identification of alkali lignin in both tested samples (common wheat and spelt).

CONCLUSION:

Because of the complexity of the standard procedures for isolation, purification, chemical modification and structural characterization of lignin from plant biomass, the utilization of a novel extraction methods, based on DES variations, in combination with changing the parameters during its extraction, could contribute to higher selectivity and obtaining of purified biopolymer.

***Acknowledgements*:** This work was funded by the Scientific project № 3/2023 FVM in Trakia University.

Functional polyvinylbutyral nanofibers decorated with $Zr(OH)_2$ and CeO_2 nanoparticles for the destruction of chemical and biological agents

Maja Vitorović-Todorović*, Tamara Vujatović-Velimirov, Aleksandar Ćitić, Nataša Pajić, Danica Bajić

Military Technical Institute, Belgrade, Serbia

https://doi.org/10.21175/rad.abstr.book.2025.8.2

Commercially available protective overgarments and masks against chemical and biological agents represent only physical barrier against these contaminants. This raises several major concerns regarding the spread of the secondary contamination, post use decontamination and disinfection procedures, storage of the large quantities of chemical and biological waste especially in pandemics or a warfare scenario. Moreover, traditional overgarments and masks are usually made of non-biodegradable long-lasting materials which raises ecological concerns. Having this in mind, we explored additional nanofiber composite designs, that would provide more comfortable protective materials with improved protective efficiency and a direct destruction of toxic agents, that would also minimize above stated environmental problems and problems related to the secondary spread of the contamination.

The novel composite materials obtained consisted of the polyvinylbutyral nanofibers (PVB) obtained by electrospinning decorated with the CeO_2 and $Zr(OH)_4$ nanoparticles. For the CeO_2 nanoparticles we used commercially available 2 nm-diameter (Sigma Aldrich) nanoparticles and the two other types obtained by the two different synthetic procedures. These are the so-called oxalate procedure and homeogenous hydrolysis, both starting from the same precursor, cerium-(III)nitrate hexahydrate, $Ce(NO_3)3x6H_2O$. After removal from the solvents both precipitates were dried in the oven at 110 °C and then calcined at 500 °C to induce crystallization of the nanoparticles. To obtain CeO_2-decorated PVB nanofibers, nanoparticles were dispersed in the ethanol and deagglomerated by ultrasonication, after that, PVB was added. Such solution was subjected to electrospinning with following parameters: voltage 25 kV, 25 °C, 43% relative humidity, syringe feed rate 1 mL/h, distance from the needle tip from the collector plate was 18 cm. We obtained two types of $Zr(OH)_4$ – decorated PVB nanofibers. One sample was obtained by the ultrasound dispersion of commercially available $Zr(OH)_4$ nanoparticles in the similar fashion described for CeO_2 samples. For another sample, we used the *in situ* procedure to generate $Zr(OH)_4$ decorated nanofibers. In the ethanol/isopropanol PVB solution the zirconia precursor – zirconium-acetate in diluted acetic acid (15%) was added and stirred overnight to obtain homogenous sol, which was subsequently subjected to electrospinning procedure using the same parameters as described above. The obtained mat was subjected to the hydrothermal treatment with NH_4OH, to induce hydrolysis of the zirconia precursor to the final $Zr(OH)_4$ evenly dispersed in PVB nanofibers.

The morphology of the nanofiberous mats was investigated by scanning electron microscopy. Majority of samples showed even and uniform morphology with fiber diameters from 220-350 nm. Their catalytic efficiency was investigated by gas chromatography – mass spectrometry using bis(2-chloroethyl) sulfide (HD, sulfur mustard) in non-aqueous and paraoxon-ethyl (PX) in humid environment. Both kinetic of degradation and the nature of degradation products was monitored. The samples with CeO_2 nanoparticles proved to be superior in case of HD degradation while samples with $Zr(OH)_4$ were more effective for degradation of PX. In conclusion, novel PVB nanofibers with incorporated CeO_2 and $Zr(OH)_4$ nanoparticles were proved to be promising for the development of novel materials aimed to be used in the personal protective equipment items.

Keywords: nanofibers, nanoparticles, chemical and biological protection, sulphur mustard, chemical degradation

Nickel oxide (NiO) of different morphologies and with various dopants in CO_2 methanation

Arkadii Bikbashev*, Libor Kvitek

Palacky University, Olomouc, Czech Republic

https://doi.org/10.21175/rad.abstr.book.2025.8.3

The synthesis of NiO micro-(MPs) and nanoparticles(NPs) with different morphologies is difficult process. The choice of chemical process, duration, and reaction conditions affect the size and properties of NiO MPs and NPs. In our work, we use solvothermal synthesis in the atmosphere of alcohols and high-temperature decomposition of nickel hydroxide.

In the CO2 methanation, nickel oxide MPs and NPs have found greater use due to their selectivity for methane CH4. The conversion rate for CO2 is more than 70%, while the selectivity for CH4 is around 100%! This makes nickel oxide MPs and NPs a promising direction in the industrial production of methane,especially with the growing attractiveness of DAC(direct air capture) technology.

Solvent-assisted dispersive solid-phase extraction for copper determination

Serhii Zaruba*, Zuzana Zahornacká, Vasil Andruch

Pavol Jozef Šafárik University in Košice, Košice, Slovakia

https://doi.org/10.21175/rad.abstr.book.2025.8.4

The solvent-assisted dispersive solid-phase extraction SA-DSPE method is very similar to dispersive liquid-liquid microextraction (DLLME) [1]: (a) both are based on the emergence of a cloudy or dispersive state of acceptor phase, and subsequently separated by centrifugation; as well as the fact that (b) the extraction efficiency is influenced by the quality of the dispersion formed; (c) both are considered as miniaturized extraction technique, since milligram amounts of sorbent (SA-DSPE) or microliter volumes of extraction solvent (DLLME) are used; and (d) they do not have a “memory effect”, since a new amount of sorbent (extraction solvent) is used for each determination.

A new approach in the SA-DSPE procedure using a supercooled liquid was used for copper determination with UV-Vis detection. It demonstrates the first use of a supercooled liquid for metal-ion determination. The method is based on the reduction of Cu(II) to Cu(I) with ascorbic acid solution at pH 5; formation of a coloured complex between Cu(I) and neocuproine (Cu-Nc), and subsequent extraction of the complex formed with a benzophenone sorbent generated in situ after injection of 300 µL its 5 % solution in an acetone:water 80:20 v/v mixture into an aqueous (donor) sample. It was found that the addition of sodium dodecylbenzene sulphonate (anionic surfactant), at concentration of 0.1 mmol L-1, significantly increased the extraction efficiency of the Cu-Nc complex. The resulting cloudy state was sedimented by centrifugation at 6000 rpm for 3 minutes. The addition of a few crystals of benzophenone then leads to the solidification of a supercooled solution of the sorbent, which facilitates the separation. Afterwards, the bulk of the aqueous phase was easily decanted, and the resulting sediment was dissolved with 250 µL of acetone. Absorbance measurements were carried out in a semi-microcuvette at 457 nm against acetone. The calibration plot was linear from 10 to 250 µg L-1 of Cu. The LOD and LOQ, were 3 and 10 µg L-1 of Cu, respectively.

The precision and accuracy of the suggested method were checked by performing three extractions of spiked water samples with standard Cu solution at two concentration levels (12,7 and 191 µg L–1) over two days. The relative standard deviation percentage (RSD, %) was used to calculate the precision of the method and was in the range 1.7 – 4.5%. The accuracy of the method was characterized by the recovery percentage (Recovery, %) and was in the range of 100 - 105%. The developed procedure was applied for the determination of copper in real water samples.

Funding: V.A. would like to thank to the Scientific Grant Agency of the Ministry of Education, Science, Research and Sport of the Slovak Republic (VEGA 1/0142/25). Funded by the EU NextGenerationEU through the Recovery and Resilience Plan for Slovakia under project No. 09I03-03-V01-00043.

1. ZARUBA, Serhii; MAKOŚ-CHEŁSTOWSKA, Patrycja; ANDRUCH, Vasil. The solvent-assisted dispersive solid-phase extraction method revisited. Application for the determination of anionic surfactants. Advances in Sample Preparation, 2025, 13: 100162.

A compact device for measuring nanoampere-range currents in high-voltage DC circuits

Maksims Piskunovs, Anatolijs Lucanskis, Victor Ivanov*, Valerijs Ivanovs

ZRF RITEC SIA, Riga, Latvia

https://doi.org/10.21175/rad.abstr.book.2025.9.1

When various electronic devices are designed and operating, it is often necessary to measure the current consumed by a specific device or its individual components. Digital multimeters are usually used to perform such measurements. However, digital multimeters are not suitable for such measurements in some specific cases: when it is necessary to perform measurements in high-voltage circuits with voltages above 1 kV or when it is necessary to measure currents in the nanoampere or even smaller ranges. An example of such a measurement is monitoring the leakage currents of various semiconductor nuclear radiation detectors. The operating voltages of such detectors range from several hundred volts to several kilovolts, depending on the detector type. The resulting leakage currents are usually in the range of 0.1 nA to tens of nanoamps and depend on several factors, such as the size and physical properties of the specific detector and the operating temperature. It is necessary to perform leakage current measurements during both the manufacturing process and normal operation of the detectors. A device that is used to monitor leakage currents should not introduce any significant additional interference, which can degrade the performance of the detectors.

Picoammeters and electrometers can be used to measure small currents in necessary ranges. These devices perform very accurate current measurements, but they are only applicable for measurements in the low-voltage part of the circuits. High-voltage power supplies with a built-in current meter provide convenient and simple measurements of small currents. However, the accuracy of these devices may be insufficient, the number of models available on the market is small, and their cost is relatively high. Therefore, there is a need to develop a device with the following parameters and functionality: simple and self-sufficient; high current measurement accuracy and resolution, starting from ±1 nA; current measurement in the high-voltage part of the circuit; not introducing significant parasitic interference; working with existing high-voltage power supplies; and relatively inexpensive.

We have developed a small-sized stand-alone device designed to measure currents in the nanoampere (starting from 1 nA) and higher ranges in high-voltage DC circuits with voltages up to 3 kV. The developed device is intended for a series connection with the output of a high-voltage power supply so that the current is measured directly in the high-voltage part of the circuit. The device is universal and works with almost all existing high-voltage power supplies and accepts both voltage polarities.

The measured current, polarity and units are displayed on a built-in indicator. The device has different selectable measurement ranges, so it is usable for a very broad range of currents. The measurement accuracy depends on the selected range and is equal to two counts in the least significant digit (±2 nA in the most sensitive range). The device is lightweight and compact; in terms of size and weight, it is similar to a portable multimeter. The device is powered by a +5 V or +6 V power supply.

This paper presents the selected measurement principle, a block diagram of the device and the test results.

This work was supported by the European Recovery and Resilience Facility Project NR. 5.1.1.2.i.0/2/24/A/CFLA/006/

Consideration of TEG-microporous heatsink assemblies' capability to power thermal energy harvesting systems under natural convection

Aleksandra Stojković*, Aneta Prijić, Zoran Prijić

University of Niš, Faculty of Electronic Engineering, Serbia, Niš, Serbia

https://doi.org/10.21175/rad.abstr.book.2025.9.2

Thermoelectric energy harvesting systems are usually powered by converting thermal energy from the environment into electrical energy using miniature thermoelectric generators (TEG). To generate the voltage, it is necessary to provide a temperature difference on the opposite sides of the TEG. When the TEG hot side is subjected to the constant heat flux, passive heatsinks are often used to remove excessive heat from its cold side and enhance the temperature difference. The paper presents experimental and simulation characterization results of TEG-heatsink assemblies intended for powering wireless sensor network (WSN) nodes under natural convection.

The assemblies formed by combining two miniature TEGs with five microporous and one aluminum heatsink are investigated. TEGs are selected based on the surface area of their plates, dimensions, number of thermoelectric pairs, and internal electrical resistance. The selection of heatsinks is determined by their fabrication material (aluminum, microporous alumina ceramics, and copper foam), geometry (flat or extruded), height, and the TEG plate dimensions.

In the experiment, the hot side of the TEG is attached to the heater, and the heatsink is glued by thermal tape to the cold side of the TEG. The electrical leads of the TEG are connected to a programmable active load. It simultaneously serves as a variable load and a multimeter that measures the voltage delivered to the load and the current flowing through it. During the experiment, all relevant temperatures are monitored by computer-controlled thermistors. The predefined values of the heater temperature are selected to obtain temperature differences between the TEG hot side and the ambient that correspond to the operating conditions of energy harvesting systems. The load values are determined by the input resistance of the typical power control and management circuit during the active mode of operation.

Based on the obtained results, it is concluded that copper foam heatsinks, characterized by interconnected open pores, may effectively replace the conventional aluminum heatsink when the TEG cold plate is smaller than the heatsink base. A flat microporous ceramics heatsink shows up to 12% lower performance, compared to the aluminum heatsink, although it has half its height.

For simulations, CAD software was used to model the assembly elements. The obtained models were imported into the multiphysics simulation software based on the finite element method. The steady state was considered by implementing coupled electro-thermal and computational dynamic flow analysis. The obtained simulation results show a good agreement with the experimental data. It was determined that radiation (direct and indirect) can contribute up to 30% of the total heat transfer, which significantly affects the accuracy of simulations in materials with a complex porous structure.

The overall conclusion is that electrical power delivered to the load can be sufficient to power a WSN node designed with a suitable power management circuit. It confirms the practical applicability of the investigated assembly configurations in energy harvesting systems under natural convection.

Acknowledgement: This work was supported by the Ministry of Science, Technological Development and Innovation of the Republic of Serbia [Grant number 451-03-137/2025-03/200102].

Equivalent electrical circuit modeling of the irradiation and NBTS induced threshold voltage shift in p-channel power VDMOSFETs

Nikola Mitrović*[1], Sandra Veljković[1], Vojkan Davidović[1], Srboljub Stanković[2], Snežana Djorić-Veljković[3], Emilija Živanović[1], Danijel Danković[1]

[1] University of Niš, Faculty of Electronic Engineering, Niš, Serbia
[2] University of Belgrade, Institute of Nuclear Sciences Vinća, Belgrade, Serbia
[3] University of Niš, Faculty of Civil Engineering, Niš, Serbia

https://doi.org/10.21175/rad.abstr.book.2025.9.3

Compact equivalent electrical circuit modeling is one of the types of modeling concrete device parameter shift in parameter dynamic surrounding. It is different from the physics based analytical modeling that centers around solving a big number of equations that describe certain processes or phenomena. Especially in surroundings where several types of different conditions (bias, temperature, radiation, humidity, magnetic field) are variable, solving particle-level equations can be a very demanding task, even for advanced simulators. Therefore, one of the approaches is to design a model that comprises of simpler Equivalent Electrical Circuit (EEC) and that will focus on a single device parameter, thereby reducing computational time for parameter modeling.

Irradiation of p-channel Metal Oxide Semiconductor devices (pMOS) devices degrades the threshold voltage, which is one of the most important operating parameters of MOS devices. Irradiation induced threshold voltage shift (ΔV_T) is noted also in the devices with greater oxide thickness, such as p-channel power Vertical Double-Diffused MOS devices (estimated oxide thickness is around 100 nm). Post irradiation Negative Bias Temperature Stressing (NBTS) leads to the partial recovery of the irradiation induced degradation, but is very dependent on the bias and temperature conditions. This paper gives insight into an EEC model that models both irradiation and NBTS induced threshold voltage shift.

The basis for modeling are experimental results. Samples for the experiment were commercial p-channel power VDMOSFETs IRF9520. Experiments consists of two phases, first one being the irradiation and the second one being NBTS. Irradiation was performed at the Metrological Laboratory at the Institute for Nuclear Sciences, Vinča, Serbia, using Co-60 radiation source. Samples were irradiated with the dose of 30 Gy, with the dose rate of 0.5 Gy/min. NBTS was performed at the laboratories of the Department of Microelectronics of the Faculty of Electronic Engineering, University of Niš, Serbia. During NBTS (T = 175 °C, V_G = -50 V) , that lasted 168 h in the prespecified time intervals, transfer I-V characteristics in the saturation region were measured. Threshold voltage is determined from the I-V characteristics using the second derivative method. Absolute value of ΔV_T is exponentially increased during the irradiation and exponentially decreased during the NBTS.

Since ΔV_T changes exponentially, the central element of the CCE is capacitor. Increase of the ΔV_T is modeled as charging of the capacitor through condition determined resistance, while the decrease of the is modeled as discharging of the capacitor through NBTS conditions determined resistance. For the series of the experimental results values of EEC elements are calculated using Lagrange's theorem. Modeled results show correspondence with the experimental results, where relative error of modeling in all of the experimental phases is less than 18 %.

Keywords: modeling, VDMOSFET, irradiation, NBTS

Acknowledgment: This work has been supported by the Ministry of Science, Technological Development and Innovation of the Republic of Serbia [Grant Number: 451-03-137/2025-03/ 200102] The authors would like to thank the staff of the Laboratory of Radiation and Environmental Protection, Institute "Vinča", for support. Part of this work has been supported by the Horizon Europe Twinning project AIDA4Edge (Grant Agreement No. 101160293).

Influence of Pre-Stress Conditions on the Self-Heating Behavior of Power MOSFETs

Sandra Veljković*[1], Nikola Mitrović[1], Miloš Marjanović[1], Emilija Živanović[1], Vojkan Davidović[1], Srboljub Stanković[2], Goran Ristić[1], Danijel Danković[1]

[1] University of Niš, Faculty of Electronic Engineering, Niš, Serbia
[2] University of Belgrade, Institute of Nuclear Sciences Vinča, Belgrade, Serbia

https://doi.org/10.21175/rad.abstr.book.2025.9.4

In this study, VDMOS power transistors manufactured by International Rectifier, identified under the codes IRF9520 and IRF510, were investigated. These devices, representing p-channel and n-channel variants respectively, have been widely utilized across various application domains due to their beneficial electrical and thermal characteristics. Although it might be assumed that these components have already been systematically characterized, recent advancements in electronic systems and evolving application requirements have renewed interest in exploring additional aspects of their behavior. As technology progresses and these devices remain in use, it becomes increasingly important to assess the factors influencing their performance and the extent to which their parameters may drift over time. Such analyses are critical for accurately estimating their reliable operational lifetime.

To this end, the selected devices were subjected to individual and combined exposure to ionizing radiation and negative bias temperature (NBT) stress conditions. One group was irradiated with gamma rays at the Institute of Nuclear Sciences Vinča in Belgrade using a Co-60 source, with a dose rate of 30 Gy/h. Devices were exposed to different radiation dose levels to examine how their characteristics change. Another group was exposed to NBT stress at the Laboratory for Microelectronics and Electronic Components, Faculty of Electronic Engineering in Niš, using a test setup. Devices were stressed under high negative gate bias and elevated temperatures for one week, providing a basis for evaluating stress-induced parameter variations. To gain deeper insight into the degradation mechanisms, a third group of devices underwent sequential exposure to both stresses, allowing assessment of cumulative effects and long-term behavior under harsh conditions.

After the completion of all stress procedures, the devices were integrated into a test circuit simulating standard operating conditions, with the aim of evaluating their post-stress behavior. An experimental setup was developed, centered around an infrared thermal imaging system used to monitor the self-heating behavior of the transistors under varying operating conditions. Pulsed signals of different shapes were applied to the gate terminal, with variable rise and fall times, in order to analyze the thermal response under dynamic switching conditions. Additionally, an active load was connected to the drain terminal to control the current flowing through the transistor, thereby emulating realistic circuit operation. A detailed analysis was performed to compare both maximum and minimum temperatures, as well as heating rates, among samples subjected to different stress histories. Furthermore, the investigation included electrochemical processes contributing to parameter degradation and temperature increase during operation. The effectiveness of heatsinks was also examined as a potential thermal management strategy.

Keyword: MOSFET, prior stress, self-heating effects, electrochemical processes

Acknowledgment: This work was supported by the Ministry of Science, Technological Development and Innovation of the Republic of Serbia [grant number 451-03-137/2025-03/200102]. Part of this work was supported by the L'Oréal-UNESCO project "Influence of Multiple Stress Factors on Components Integrated in Systems Intended for Use in Radiation Environments".

Solar energy conversion system into green hydrogen and electric energy for own consumption

Sorin Ioan Deaconu*[1], Marcel Topor[1], Feifei Bu[2]

[1] Politehnica University, Timisoara, Romania
[2] Nanjing University of Aeronautics and Astronautics, Nanjing, China

https://doi.org/10.21175/rad.abstr.book.2025.9.5

In this paper, we propose to design and simulate a system for converting solar energy into electricity for own consumption, into hydrogen used in the heating system, and to store the surplus in a battery system or super capacitors. During the period when heating is not necessary, the hydrogen is used to prepare domestic hot water and the surplus is accumulated in high-pressure containers for use in the cold season. A cost comparison will be made between the classic version of electricity and methane gas supply and the version with the proposed conversion system, where we will evaluate the cost of implementation and the duration of the investment recovery. A technology known for a long time but little used in the energy field is the electrolysis of water for the production of hydrogen. If the electrolysis is done with renewable electricity, the hydrogen obtained is called green hydrogen and has a very low carbon footprint. National economies must reach climate neutrality not only by improving the energy mix, but also by decarbonizing heavy industry and transport, addressing process differences and facilitating the expansion of production and use of green hydrogen and e-methanol. Reducing costs will require a variety of political decisions, with a predictable and reliable investment climate, a clear and transparent regulatory framework that allows for long-term agreements with partners, financial instruments for risk sharing. Thus, e-methanol and green hydrogen could become more competitive in terms of prices compared to the fluctuating quotations of fossil energy, accelerating the transition to the consumption of green fuels in heavy industry and transport, thus contributing to the creation of a sustainable market of green hydrogen and e-methanol in Romania. Hydrogen can also, mixed with methane gas or alone, be used in residential heating systems. The case study will be done for the Hunedoara Engineering Faculty, part of the Timisoara Polytechnic University, which has five buildings, a canteen and a student dormitory. In addition, the command, tracking and control system will be able to be used as a laboratory for students. A number of sockets for powering electric and hybrid vehicles (plug-in type) will also be provided.

Stress-induced degradation and lifetime estimation in commercial power VDMOS transistors

Danijel Danković*, Nikola Mitrović, Sandra Veljković, Miloš Marjanović, Emilija Živanović, Vojkan Davidović

University of Niš, Faculty of Electronic Engineering, Niš, Serbia

https://doi.org/10.21175/rad.abstr.book.2025.9.6

In this study commercial power VDMOS (Vertical Double Diffused MOS) transistors subjected to different stress conditions were investigated. Power VDMOS transistors are a type of power MOSFET designed for high-current and high-voltage applications. As shown in the technical documentation of the manufacturers, p-channel devices are usually designed to withstand currents of up to 6.8 A and drain-source voltages of – 100 V. Similar situation is for the n-channel devices, they exhibit comparable characteristics, with maximum current ratings of about 5.6 A and drain-source voltages of +100 V. These transistors are realized in standard polycrystalline silicon gate technology with hexagonal unit cell structure and approximately 100 nm thick gate oxide. Despite most of modern MOS transistors are realized with very thin gate oxide, expansion of power devices in various industrial, automotive applications, nuclear power plants, medical equipment and similar, has led to increased interest for investigations of reliability of power VDMOS transistors. For example, in specific situations they can be used for switching power supplies, DC\DC converters, voltage regulator modules, motor drive applications and so on. In most of these applications devices could be exposed to different stress conditions and, as a result, a shift in the threshold voltage is observed. So the degradation phenomena in these devices under different stress conditions (irradiation, high electric field, hot carriers injection, unclamped inductive switching, negative bias temperature instability (NBTI), NBTI under magnetic field, NBTI and irradiation, self-heating and so on) has been the subject of extensive research.

A large number of researchers investigated the behavior of threshold voltage and analyzed the underlying changes of gate oxide-trapped charge and interface trap densities in power VDMOS devices subjected to different types of static and pulsed bias temperature stresses. Namely, this investigation is of great importance, bearing in mind that the electric fields and temperatures applied in NBT stressing can be approached to those achieved during the routine operation of power VDMOS devices in automotive and industrial applications. The responsible mechanisms that explain experimental data have not yet been fully explained. On the other hand, from the aspect of practical applications, it is necessary to know how the parameters of these devices change during the stress in order to be able to determine the lifetime. This is the main reason why several voltage and temperature lifetime models have been developed in the previous period.

In order to investigate device lifetime of commercial p- and n-channel power VDMOS devices IRF9520 and IRF510, respectively, devices were stressed up to 168 hours by applying negative or positive gate voltages in the range 30 – 55 V, with drain and source terminals grounded, at temperatures ranging from 125 to 175 °C. The threshold voltage was used as a degradation monitor, which is widely accepted as a well-suited parameter in the literature. The use of different voltage and temperature models for extrapolation to typical operation voltage and temperature, respectively, were demonstrated. A new approach in estimating the device lifetime for arbitrary operating conditions that assumes multiple extrapolation along both voltage and temperature axes was demonstrated. A detailed analysis was performed to compare both chosen model and selected failure criterion.

Keywords: VDMOS, degradation, NBTI, lifetime

Acknowledgment: This work was supported by the Ministry of Science, Technological Development and Innovation of the Republic of Serbia [grant number 451-03-137/2025-03/200102]. Part of this work was supported by the L'Oréal-UNESCO project "Influence of Multiple Stress Factors on Components Integrated in Systems Intended for Use in Radiation Environments" and by the Horizon Europe Twinning project AIDA4Edge (Grant Agreement No. 101160293).

Automation of control of the complex of superconducting magnet support equipment

Altynov Alexey*, Alexander Chernikov

JINR, Dubna Moscow reg., Russia

https://doi.org/10.21175/rad.abstr.book.2025.9.7

The magnet control complex was developed for a superconducting magnet with a shaft cryostat. The superconducting magnet is used on the DN-12 diffractometer of the IBR-2 reactor (JINR, Dubna). The complex of equipment for the operation of the magnet includes closed-cycle cryocoolers, a 300 A current source, a vacuum station, and instrumentation. Supply and disconnection of power supply to the complex equipment is united in the control cabinet. The logic of sequential switching on of the complex elements is realized. It is impossible to switch on the equipment outside the operating parameters. The connection of supply circuits also provides automatic power cutoff when the superconducting magnet parameters are out of the normal operating range. Switching of control modes “manual” and “automatic” can be performed without disconnecting the power supply of the complex. Information output to the user's computer is carried out via RS485 interface.

A Helmholtz coil-like superconducting magnet using a material with hightemperature superconductivity (HTSC) has been produced for the DN-12 diffractometer of the IBR-2 reactor in the Department of the Spectrometers Complex of FLNP. The magnet cryostat possesses a horizontal shaft for loading the high-pressure chamber that is introduced into the area of high magnetic field. The temperature of the high-pressure chamber can be varied using an electric heater in the range of (3.6 -150) K and the chamber is cooled using a closed cycle cryocooler as part of the cryostat insert that is introduced into the shaft together with the high-pressure chamber. The temperature of the magnet windings ranges from 20 to 40 K and is maintained using a closed cycle cryocooler.

The equipment bound in the system that controls the magnet, magnet current supply, temperature controllers, cryostat vacuum measurements, the pumping system control – vacuum maintenance and compressor control of both cryocoolers are discussed in the report. The logical scheme of this system operation is considered as well. The equipment of the superconducting magnet environment provides such magnet parameters as magnetic induction, temperature of HTS coils and current leads in the cryostat.

The complex of equipment for the operation of the magnet includes closed-cycle cryocoolers, a 300 A current source, a vacuum station, and instrumentation. Supply and disconnection of power supply to the complex equipment is united in the control cabinet. The logic of sequential switching on of the complex elements is realized. It is impossible to switch on the equipment outside the operating parameters. The connection of supply circuits also provides automatic power cutoff when the superconducting magnet parameters are out of the normal operating range. In this case, emergency current removal from the HTS coil is provided. Switching of control modes “manual” and “automatic” can be performed without disconnecting the power supply of the complex. Information output to the user's computer is carried out via RS485 interface.

Assessment of heavy metals seasonal variation and contamination in sediments of Parches and Babele lakes (Danube delta)

Roba Carmen*, Brisan Nicoleta

Babes-Bolyai University, Faculty of Environmental Science and Engineering, Cluj-Napoca, Romania

https://doi.org/10.21175/rad.abstr.book.2025.9.8

Heavy metals contamination represents a major problem for the aquatic ecosystems because of their toxicity, non-biodegradable nature or biomagnification potential. Some of the heavy metal ions are toxic and potentially carcinogenic and can induce a variety of negative effects on aquatic organisms, even at low concentration. Once entered in the aquatic body, the metallic elements are absorbed into sedimentary deposits and in particular environmental conditions can be released into the water column, causing secondary pollution and serious ecological harm to organisms and aquatic systems.

In this study it was assessed the seasonal variation, the contamination status and the bioavailability of several heavy metals in surface sediments of two lakes (Parches and Babele) located in Somova - Parches aquatic complex lakes from Danube Delta, West of Tulcea (Romania). Starting with the 70s, anthropogenic activities, such as the production of ferroalloys and alumina, were performed in the area and it is possible to have had a negative impact on the aquatic ecosystem quality.

The sampling network consisted of 5 sampling points on Babele lake and 9 sampling points for Parches lake. From each lake, bottom sediments samples were collected during July and November 2023 and 2024. The samples were processed in the laboratory in order to measure the pH and to analyze the heavy metals content by atomic absorption spectrometry.

The results showed that the mean concentration level of metals in the sediment samples followed the order of Mn (445.1 mg/kg) > Zn (97.7 mg/kg) > Cu (46.6 mg/kg) > Ni (42.9 mg/kg) > Cd (0.6 mg/kg), being slightly higher in Parches lake, compared to Babele lake. Seasonal fluctuation in sediments revealed that the heavy metal content was higher in July than in November, for both 2023 and 2024 campaigns.

To assess the possible correlation between the anthropic activities and the heavy metals contend in sediments, the enrichment factor (EF) was calculated based on the metals concentration in sediments and their abundance in the upper crust (background), using Fe as reference metal. The EF values indicated a possible anthropic contribution, especially for Cd and Cu.

The sediment pollution with heavy metals was assessed based on the geo-accumulation index (Igeo), which indicated a moderately polluted status for Cd and low polluted / unpolluted status for the rest of the analyzed heavy metals.

Considering that the bioavailable fraction is more relevant in assessing the ecological risk associated with the presence of heavy metals in aquatic ecosystems, in the present study the speciation analysis of heavy metals from sediments was performed, based on a modified BCR (Community Bureau of Reference) technique. The results indicated that in the case of Cd and Cu, their bioavailability was higher compared to other metals.

This work was financially supported by the Romanian Ministry of Research, Innovation and Digitalization, within the project PNRR-III-C9-2022-I5-18_ResPonSE (contract 760010/2022).

Impact of precipitation on the physico-chemical properties and ecosystem dynamics of Velika Rusanda soda lake

Ivana Mihajlović*, Srđan Kovačević, Dušan Milovanović, Nevena Živančev

University of Novi Sad, Faculty of Technical Sciences, Novi Sad, Serbia

https://doi.org/10.21175/rad.abstr.book.2025.10.1

The seasonal monitoring of Lake Velika Rusanda, the largest saline lake in the Republic of Serbia, is one of several aims of SPArrow project within IPA Hungary Serbia Programme. As part of the "Rusanda" Nature Park, the lake holds high conservation priority within the EU's Natura 2000 network due to its significant salt marsh habitats and rich biodiversity. Sampling campaigns were conducted in the northern part of Lake Velika Rusanda, near the Melenci settlement and the Spa "Rusanda" rehabilitation hospital, where mineral peloid is extracted for medical purposes. Two sampling campaigns were performed, one in autumn after a prolonged dry summer, and one in winter, when increased precipitation raised the lake's water level. Key physico-chemical parameters, including mineral and salt content, pH, nutrients, and organic load, were analyzed to assess the impacts of seasonal variations on the lake's chemical composition.

As an inland shallow saline water body, the composition and structure of Lake Velika Rusanda's communities are primarily governed by salinity. With salinity values ranging from 7 to 9.3 g/L, the lake is classified as brackish, falling within the hyposaline range (3–20 g/L). The analyses confirmed the lake's high alkalinity (pH > 9) and hypertrophic status, with total phosphorus concentrations up to 21.2 mg/L. Velika Rusanda is categorized as a saline type of water with chloride as the dominant ion, followed by sulphate, which characterizes it as a non-permanent alkaline brine. Previous studies have shown that the classification of Velika Rusanda is significantly influenced by its seasonally variable water levels, which fluctuate throughout the year. Increased rainfall and water level during the winter period contributed to the dilution of certain solutes, such as sulphates and phosphorus. However, precipitation also led to higher concentrations of nitrogen compounds, such as nitrates and ammonium, possibly due to runoff from surrounding areas.

This study highlights the significant influence of precipitation on the chemical properties of Lake Velika Rusanda. The lake's sensitivity to seasonal and environmental changes emphasizes the importance of ongoing restoration efforts, particularly in the context of climate change and altered hydrological regimes.

Keywords: soda lake, precipitation, water chemistry, seasonal variations

Acknowledgement: This paper has been produced with the financial assistance of the European Union through the Interreg VI-A IPA Hungary-Serbia programme. The content of the presentation is the sole responsibility of FTS and can under no circumstances be regarded as reflecting the position of the European Union and/or the Managing Authority of the Programme.

Scales as an indicator of mercury biomagnification in consumption fishes

Bartosz Skibniewski[1], Michał Skibniewski[2], Izabela Dębska[3], Ewa Skibniewska[3], Iwona Lasocka*[3]

[1] One Health Section, The Scientific Society of Veterinary Medicine Students, Faculty of Veterinary Medicine, Warsaw University of Life Sciences, Warsaw, Poland
[2] Department of Morphological Sciences, Institute of Veterinary Medicine, Warsaw University of Life Sciences, Warsaw, Poland
[3] Department of Biology of Animal Environment, Institute of Animal Sciences, Warsaw University of Life Sciences, Warsaw, Poland

https://doi.org/10.21175/rad.abstr.book.2025.10.2

Humans are exposed to absorption of mercury, especially the highly toxic methylmercury, by consuming fish and crustaceans. Mercury is absorbed by fish through food, gills and body surfaces. Methylmercury has a very long biological half-life. Therefore, it is important to know the concentration levels of this element in fish organisms in order to estimate the level of contamination of water bodies and the risk of human exposure. The aim of the study was to determine the total mercury (THg) content in selected tissues of freshwater fish species: common perch (*Perca fluviatilis*) and common crucian carp (*Carassius carassius*) which are commonly consumed in Poland. The reservoirs from which the fishes for the study were obtained are breeding ponds in Knyszyn, Ełk-Knyszyn fish farm (Podlaskie Voivodeship). Perch is a predatory fish that feeds on invertebrates, smaller fish and roe of other species. Crucian carps feed on benthic fauna and aquatic plants. The average weight of perches studied was 161±21 g and their length was 24±1 cm, while crucian carps measured 223±61 g and 23±2 cm. THg analysis was performed in the following tissues: skeletal muscle from the dorsal part, liver, and scales. The results were expressed as average mean ± standard deviation (SD) in ppm of fresh weight (FW). An AMA 254 mercury analyzer was used. THg content in the muscle tissue was 0.07731±0.03235 ppm in perches and 0.03515±0.007 ppm (FW) in crucian carps. Moreover, perches (0.03655±0.02354) were characterized by a significantly higher mean mercury content in the liver compared to crucian carps (0.00684±0.00182). The mean mercury content in scales was significantly higher in perches (0.00575±0.00606) compared to crucian carps (0.00012± 0.00009). The obtained results confirm the phenomenon of mercury biomagnification in the tissues of the studied fish species and emphasize that even small concentrations of Hg in the natural environment can accumulate in living organisms. The highest mercury contents were found in the meat of fish occupying higher links in the trophic chain (common perch), but it did not exceed the mercury content limits specified in the law (Commission Regulation (EU) 2023/915), i.e. 0.5 mgŸkg^{-1}. Fish tissues are a good indicator of environmental pollution, including Hg, whose distribution in the fish body varies depending on the level of contamination of the reservoir: in reservoirs with a low or zero level of contamination, mercury will accumulate to a greater extent in the muscles, while in reservoirs with a high level of contamination, the liver is the main organ of mercury accumulation [Havelková et al. 2008]. Based on this statement, it can be concluded that the reservoirs from which the fish were obtained for the study were characterized by a low level of contamination. The mercury content was the highest in skeletal muscles, then in the liver, and the lowest content was noted in scales. Scales can be an interesting indicator of environmental pollution with heavy metals. Moreover, obtaining scales is a less invasive method than obtaining other tissues. However, it should be remembered to thoroughly clean them from other tissues before analysis.

Havelková M., Dušek L., Némethová D., Poleszczuk G., Svobodová Z. 2008: Comparison of Mercury Distribution Between Liver and Muscle – a Biomonitoring of Fish from Lightly and Heavily Contaminated Localities. Sensors, 8, 4095–4109.

Studies on the sorption of Cr^{3+}, Co^{2+}, Ni^{2+}, Cu^{2+} and Eu^{3+} ions on chitosan coated with Fe_3O_4 nanoparticles in different aquatic environments

Sergej Šemčuk*[1,2], Galina Lujanienė[1], Danguolė Montvydienė[2], Algirdas Selskis[3], Vidas Pakštas[3], Martynas Talaikis[4], Virginijus Bukauskas[5], Kęstutis Mažeika[6], Jonas Mažeika[7], Kęstutis Jokšas[8], Živilė Jurgelėnė[2]

[1] Department of Environmental Research, SRI Center for Physical Sciences and Technology, Vilnius, Lithuania
[2] Laboratory of Ecotoxicology, SRI Nature Research Centre, Vilnius, Lithuania
[3] Department of Characterisation of Materials Structure, SRI Center for Physical Sciences and Technology, Vilnius, Lithuania
[4] Department of Organic Chemistry, SRI Center for Physical Sciences and Technology, Vilnius, Lithuania
[5] Department of Physical Technologies, SRI Center for Physical Sciences and Technology, Vilnius, Lithuania
[6] Department of Nuclear Research, SRI Center for Physical Sciences and Technology, Vilnius, Lithuania
[7] Laboratory of Nuclear Geophysics and Radioecology, SRI Nature Research Centre, Vilnius, Lithuania
[8] Laboratory of Geoenvironmental Research, SRI Nature Research Centre, Vilnius, Lithuania

https://doi.org/10.21175/rad.abstr.book.2025.10.3

The industrial development of the past century, in conjunction with the escalating demands of the population, has precipitated substantial environmental contamination, most notably water pollution. Wastewater usually contains organic and inorganic pollutants, including large amounts of heavy metals such as copper (Cu), nickel (Ni), lead (Pb), arsenic (As), chromium (Cr), and others. Some radionuclides such as caesium (Cs), americium (Am), plutonium (Pu), europium (Eu), etc. have also been released into the environment as a result of nuclear tests and accidents in nuclear reactors. These pollutants are among the most toxic due to their longevity, their ability to accumulate and migrate in aquatic ecosystems, etc. Moreover, even low concentrations have been demonstrated to have impact on the habitat, and their bioaccumulation in organisms leads to migration along the food chain and affects human well-being. In order to prevent and restore, it is necessary to purify the water. Sorption is one of the most suitable methods for this purpose. Various sorbents are being investigated, including innovative nanosorbents, but as it turns out, some of them can negatively affect the processes in the polluted environment and the organisms living there [1-3]. Therefore, options for the use of environmentally friendly and biodegradable sorbents are increasingly being considered. The aim of this study is to investigate the sorption capacity of chitosan coated with Fe3O4 nanoparticles in different ratios to facilitate its separation from the medium. Different amounts (10 %; 20 % and 30 % w/w) of synthesised magnetite were slowly introduced into chitosan solutions and mixed with 1 % w/w glutaraldehyde as a cross-linking agent. A neodymium magnet was used to separate the resulting magnetic chitosan nanocomposites (MCN). They were then washed, dried and characterised using XRD, SEM, TEM, FTIR, AFM and Mössbauer methods. The target ions Cr3+, Co2+, Ni2+, Cu2+ and Eu3+ were utilised in the sorption experiments in which the dependence of adsorption on their concentrations, pH values and contact times was investigated. In addition, trace radionuclides (152Eu and 60Co) and water samples (from lakes, rivers and the sea) were used to analyse the sorption parameters of MCN as a function of salinity. ICP-OES was used to determine the concentration of target ions, and a gamma spectrometer was used for samples containing trace radionuclides. The removal efficiency and kinetic parameters of sorption of MCN were calculated from the sorption data obtained and the sorption capacity of MCN was determined by isothermal studies. The results obtained indicate that MCN is quite effective in aquatic medium with varying salinity and can be easily and quickly removed from the environment with the help of a magnetic field. Due to its natural origin and biodegradability, MCN can be considered an environmentally friendly and green adsorbent. In addition, the possibility of modifying MCN with various additives that could improve its properties offers the prospect of pre-concentrating or selectively removing certain pollutants and thus expanding the range of applications.

Keywords: magnetic chitosan, adsorption parameters, heavy metals, radionuclides, remediation

Acknowledgement: This study has received funding from the Research Council of Lithuania (LMTLT), agreement No. S-PD-24-44.

References:

1. Camilo Zamora-Ledezma et al., 2021, Environmental Technology & Innovation Vol. 22, 101504.
2. Juliana A. Galhardi et al. 2022, Emerging Freshwater Pollutants P. 309-329.
3. Xiao Zhang et al., 2024, Separation and Purification Technology Vol. 330 (Part C), 125521.

Diet of nocturnal raptors in El Goléa (Northern Sahara, Algeria)

Leila Kebbab*[1,2], Djillali Ghobrini [3], Ali Ahmed Djamila[2]

[1] Facultés des Sciences de la Nature et de la Vie et des Sciences de la Terre, Université de Ghardaia, Ghardaia, Algeria
[2] Département de Biologie, Université Mouloud Mammeri Tizi Ouzou, Tizi Ouzou, Algeria
[3] Unité de Recherche Appliquée en Energies Renouvelables, URAER, Centre de Développement des Energies Renouvelables, CDER, Ghardaia, Algeria

https://doi.org/10.21175/rad.abstr.book.2025.11.1

This study, conducted from October 2016 to March 2017 in El Goléa, Northern Sahara, Algeria, investigates the diet of two nocturnal raptors, Bubo ascalaphus and Tyto alba. The primary objective was to identify rodent prey species through the analysis of regurgitation pellets, complemented by live trapping.

Pellet analysis revealed that rodents from the Muridae and Dipodidae families dominate the raptors' diet, with identified species including Gerbillus gerbillus, Rattus rattus, Jaculus jaculus, and Meriones shawi. Trapping, conducted over 565 trap-nights, captured 56 individuals but did not detect some species found in pellets, highlighting the complementary nature of both methods.

Our findings show that pellet analysis is essential for understanding nocturnal raptor diets, while trapping provides additional data on species presence. This combined approach enhances our understanding of nocturnal raptor ecology and their role in regulating rodent populations in desert ecosystems.

Keywords: Nocturnal raptors, diet, rodents, pellet analysis, trapping, El Goléa

Ground-level ozone as a factor of increase in community-acquired pneumonia rate in Moscow in warm seasons

Nina Dudorova*[1], Boris Belan[1], Sergey Kotelnikov[2]

[1] IAO SB RAS, Tomsk, Russia
[2] GPI RAS, Moscow, Russia

https://doi.org/10.21175/rad.abstr.book.2025.11.2

Community-acquired pneumonia is among the most common acute infectious diseases. According to official statistics, the worldwide incidence of community-acquired pneumonia ranges from 150–1400 cases per 100 thousand adults per year and depends on geography, season, and population characteristics. In the structure of morbidity, the share of pneumonia in all respiratory diseases is small. However, pneumonia accounted for up to 50% in the structure of mortality from respiratory diseases in the Russian Federation in the period 2005–2017. The literature describes many community-acquired pneumonia risk factors, but studies of the effect of air pollution, in particular with ozone, on the community-acquired pneumonia incidence are very few. According to World Health Organization recommendations, the standard daily maximum 8-hr average (MDA8) ozone is 100 μg/m^3.

The aim of this work was to estimate the impact of ground-level ozone on the community-acquired pneumonia rate in different groups of Moscow residents, divided by gender and age, over a long time (2006–2009 and 2011).

Ground-level ozone concentrations were measured every 20 min at four Mosecomonitoring stations. Based on the data from each station, 8-hr average ozone concentrations were calculated by the moving average method and the daily maximum (O_3_MDA8) was selected from them. The calculated values were averaged over the four stations providing the Moscow average daily maximum 8-hr average ground-level ozone concentrations. The number of cases of community-acquired pneumonia was derived based on data from A.S. Puchkov Emergency and Urgent Medical Care Station of the Moscow Healthcare Department.

The study results have enabled us to conclude that ground-level ozone contributes to an increase in the community-acquired pneumonia rate among Moscow residents in summer. The elderly are most susceptible to the negative impact of air pollution; elderly women worse tolerate ozone air pollution than elderly men. As the ground-level ozone concentration rises above 100 μg/m^3, the community-acquired pneumonia rate increases by an average of 22% among women over 60 years old and an average of 14% among men of this age group as compared to periods with low ozone concentrations. It can be noted that ozone levels lower than those accepted by WHO can result in adverse health outcome for elderly women. In the age group of 31–60 years, an increase in the community-acquired pneumonia rate with the ground-level ozone concentrations was found only in men, but less noticeable than in elderly people. In the age group of 15–30 years, no dependence was found between ground-level ozone and community-acquired pneumonia rate.

Acknowledgments: This research was supported by the Ministry of Science and Higher Education of the Russian Federation

Innovative utilization of agro-industrial by-products: Brewers' spent grains in aquaculture feed

Liga Proskina*[1], Agnese Eizenberga[2]

[1] Latvia University of Life Sciences and Technologies, Jelgava, Latvia
[2] Institute of Agricultural Resources and Economics, Riga, Latvia

https://doi.org/10.21175/rad.abstr.book.2025.11.3

The use of fishmeal has become a limiting factor in the expansion of the aquaculture sector due to its reduced availability and increasing costs. Utilizing wild fish for fishmeal and fish oil production is inconsistent with sustainable development principles, necessitating alternative protein sources. One promising solution is the efficient use of agro-industrial by-products, such as brewers' spent grains (BSG). BSG, generated during beer production, is an inexpensive and readily available by-product, accounting for approximately 30% of the barley grains used. This by-product contains significant amounts of valuable compounds, including fiber, protein, essential amino acids, lipids, minerals, polyphenols, and vitamins, which are crucial for both human nutrition and animal feed. The chemical composition of BSG depends on the barley variety, malting and mashing conditions, and the materials added during the production process. Research indicates that incorporating these bioactive compounds into diets can reduce the risk of various diseases, including cancer, diabetes, and cardiovascular diseases. Given the need to reduce the aquaculture sector's dependence on fishmeal, BSG represents a promising alternative protein source for fish feed. Utilizing this by-product not only promotes sustainable resource management but also creates economic value. To fully harness this potential, detailed research and development are necessary to facilitate the integration of BSG into various industries and to develop new, sustainable products. This study aimed to explore the potential of BSG as an alternative protein source in aquaculture feed by evaluating its chemical composition, nutritional value, and application possibilities for sustainable aquaculture development. The use of BSG in freshwater pond aquaculture offers an integrated solution to both economic and environmental challenges while demonstrating how the recycling of industrial by-products can become a significant component of sustainable resource management. From an economic perspective, BSG is a low-cost and accessible by-product that can significantly reduce overall feed costs by replacing traditionally used but considerably more expensive protein sources like fishmeal. Additionally, integrating this by-product supports circular economy principles by reducing production waste and creating added value from otherwise unused resources. From an environmental standpoint, utilizing BSG contributes to the sustainable management of resources. Replacing fishmeal with this by-product reduces anthropogenic pressure on wild fish populations, which is vital for preserving global biodiversity and ensuring the sustainability of fisheries. Furthermore, recycling BSG into fish feed helps decrease the amount of organic waste entering the environment, thus reducing pollution and fostering the preservation of cleaner ecosystems.

Isotopic characterization of the sources of uranium, decay products and artificial actinides in the terrestrial environment of a uranium conversion facility

Laurent Pourcelot*[1], Olivier Masson[1], Anne Meyer[2], Béatrice Boulet[2]

[1] Autorité de sureté nucléaire et de radioprocetion (ASNR), Saint Paul lez Durance, France
[2] Autorité de sureté nucléaire et de radioprocetion (ASNR), Orsay, France

https://doi.org/10.21175/rad.abstr.book.2025.11.4

At the front end of the nuclear fuel cycle, a specific nuclear facility is involved in the purification and the conversion of yellowcake into UF_4. Although efforts have been made by the nuclear operator along years to reduce the atmospheric releases of uranium occurring in the course of the industrial process, the reduction of the U-releases fingerprint in the surrounding environment of the facility still needs to be proved.

After the purification of uranium, residual radionuclides i.e. ^{230}Th and ^{226}Ra, remaining decay daughters of ^{238}U, are send to industrial basins as solid or liquid residus. Thus, those industrial basins are potential sources of radionuclides-bearing microparticules or liquid-spray during strong wind events (typically > 8 $m.s^{-1}$).

In addition, former industrial processes involving the conversion of reprocessed uranium to UF_4 (1960-1982) have induced the release of artificial actinides (mainly plutonium isotopes and ^{236}U) in the atmosphere. Several decades after the releases, those artificial actinides are still present in the soils surrounding the nuclear facility. Thus the uplift of radionuclides-bearing microparticles from the industrial basins and from the soils under the influence of wind would potentially contaminated the atmosphere and the terrestrial environment surrounding the facility.

The relative contribution of the different sources of uranium and other natural or artificial radionuclides in the environment needs to be clarified, especially compared to the decrease of the atmospheric releases of uranium with time. The aim of the current study is to assess the relative importance of the different sources of radionuclides in the terrestrial environment of the studied nuclear facility, namely the release of uranium in the atmosphere, the emission in the atmosphere of decay daughters from the industrial basins and that of artificial actinides from the soils surrounding the facility. To this aim, a deep radiological characterization of a bioindicator, tree leaves sampled in the close proximity to the conversion facility has been carried out. This study involves the determination of several isotopic ratios ($^{238}U/^{232}Th$, $^{230}Th/^{232}Th$, $^{226}Ra/^{232}Th$, $^{236}U/^{238}U$ and $^{240}Pu/^{239}Pu$) to characterize each of the sources of radionuclides in the environment.

Morphological characteristics of fine air particulate matter collected in the suburban area

Mirjana Radenkovic*[1], Inga Zinicovscaia[2,3], Mikhail Kapralov[2], Dusan Topalovic[1], Mirjana Cujic[1], Ljiljana Matovic[1]

[1] Vinca Institute of Nuclear Sciences, National Institute of the Republic of Serbia, University of Belgrade, Belgrade, Serbia
[2] Joint Institute for Nuclear Research, Dubna, Russia
[3] Horia Hulubei National Institute for R&D in Physics and Nuclear Engineering, Magurele, Romania

https://doi.org/10.21175/rad.abstr.book.2025.11.5

The air quality monitoring in both urban and rural areas has revealed the ambient particulate matter as the most harmful airborne pollutant for human health while in addition to the particle composition, their size and shape are crucial for the behavior in the body. Here are presented results of the physical-chemical characterization of the submicron particles collected at the Belgrade suburban monitoring site Zeleno Brdo. Daily (24h) samples were collected by Leckel reference samplers on the polytetrafluoroethylene (PTFE) 47 mm filters in four seasons 2018/19. Particulate matter with submicron aerodynamic dimeters were analyzed for mass concentration with 0.001mg resolution and for content of about 20 elements by EDXRF technique. Additionally, selected loaded filters were dried and coated with a thin layer of gold to prevent charging and analyzed by SEM imaging in high vacuum conditions with varying magnifications (e.g., 1,000-50,000) enabling observation of fine details. Results have shown occasionally smooth or rough image of the surface with individual fine particles and their associations exhibiting a wide range of shapes. The most could be characterized as irregular and agglomerated with porous flakes, such as crustal material with well recognized spherical and rectangular shapes. Soot particles are highly aggregated mostly into chain-like structure, while the mineral dust was observed in irregular shapes with jagged edges. The secondary aerosols such as sulphates and nitrates formed in mutual interactions of smaller air particles with emitted gas pollutants appeared in the form of small spherical droplets. Typical size range of observed structures was between 100 nm to 2.5 μm, with aggregation forming larger clusters. Described results are illustrated with SEM images. Several groups of particles such as soot or carbon-based compounds (C, O, S and N), metal-rich particles (Fe, Pb, Zn, Cu, Ni, Cd) and crustal elements (Si, Al, Mg, Ca, K, Na) are recognized as the most abundant. Obtained results indicate a high degree of the secondary aerosols formation due to a long half-life of small particles in the ambient air exposed to solar radiation and available for physico-chemical interactions with present gaseous compounds and local or transboundary transported pollutants.

Novel composite/sorbents containing carbonaceous nanomaterials carbon nanotubes and magnetic oxide for the purification of aquatic environment from toxic metal and radionuclide ions

Gunta Kizane*[1], Ingars Reinholds[1,2], Larisa Baumane[1,3], Ugis Eismonts[2], Rihards Alps[1,4], Armands Egleskalns[1], Maris Bertins[1]

[1] University of Latvia, Faculty of Science and Technology, Institute of Chemical Physics, Riga, Latvia
[2] University of Latvia, Faculty of Medicine and and Life Science, Riga, Latvia
[3] Latvian Institute of Organic Chemistry, Riga, Latvia
[4] Riga Technical university, Faculty of Civil and Mechanical Engineering, Institute of Mechanical and Biomedical engineering, Riga, Latvia

https://doi.org/10.21175/rad.abstr.book.2025.11.6

Human activity, such as metal mining or nuclear power generation, contributes to environmental pollution with Cs137, Co-60, Sr-90 and other radionuclides. A certain amount of caesium, cobalt and strontium enters the waters because of geological processes. The water in the surrounding environment remains polluted, and entire ecosystems are irreversibly disrupted. Radioactive pollution of environment has received considerable attention due to the accelerated growth of nuclear power stations, nuclear accidents. The radioactive elements in environment are often considered indicators of anthropogenic influence
The commonly occurring isotopes in the environment are caesium (137Cs), strontium (90Sr), cobalt (60Co), tritium (3H) etc. Radiation exposure is a severe health hazard, causing genetic mutation, metabolic impairment, formation of a cancer.
The properties of the prepared sorbents were confirmed by Fourier transform infrared (FTIR), thermal analysis (TGA and DTA), X-ray powder diffraction (XRD), scanning electron microscopy (SEM), ion concentration was studied using inductively coupled plasma mass spectrometry (ICP-MS), free radicals investigated using electron paramagnetic resonance spectrometry (EPR) Specific surface area was determined using Brunauer–Emmett–Teller (BET) sorption tests with nitrogen sorption.
Pre-tests were carried out for carbonaceous nanomaterials carbon nanotube and materials containing magnetic oxide for in a 24 h time (1 day) in order to choose the most suitable carbon nano sorbent materials for further research. 4 different selected sorbents to sorb cations separately and from a mixture were chosen. Graphene nanoplates GNPL1, GNPL2 with different specific surface, its modified form - GNPL3 as well as two different carbon nanotube materials modified with iron oxide.
Studies relevant to adsorption of Cs-137, Co-60 and Sr-90 from the former Salaspils nuclear reactor (SNR) cooling water samples by using the sorbents were performed as a function of contact time, solution pH, metal ion concentration, and temperature in simulation studies using solutions containing stable isotopes of caesium (Cs), strontium (Sr) and cobalt (Co) separate and as mix of all 3 ions together.
Isotopes Cs-133, Co-59 and Sr 88 are representatives of Cs-137, Co-60 and Sr-90, respectively. Those studies were used to find out the best conditions for removing of Cs-137, Co-60 and Sr-90 from SNR cooling water waste.
As a result of model tests, the ability of 4 different selected sorbents to sorb cations separately and from a mixture was determined. Comparing the sorbents with each other, GNPL 1, which has a high specific surface area, showed the best sorption for all ions (Co2+, Sr2+ and Cs+), regardless of the dilution used. The worst was the binding of caesium ions, which did not exceed 70% even for this sorbent. Sorption efficiency of the mentioned ions is at least 83% in the first 15 minutes and increases with time - in some cases it reaches almost 100%.

A GC-MS analysis of amino acids in legumes: Method for discrimination of bens and faba beans

Marijana Ačanski*[1], Marko Ilić[1], Kristian Pastor[1], Đura Vujić[1], Aleksandra Ilić[2], Mirjana Vasić[2]

[1] Faculty of Technology Novi Sad, University of Novi Sad, Novi Sad, Serbia
[2] Institute of field and vegetables crops, Novi Sad, Serbia

https://doi.org/10.21175/rad.abstr.book.2025.12.1

Functionality of legumes is reflected in their richness in proteins, but also in the quality of their proteins. There is a lot of examples of the legume utility, such as substitute for meat in everyday human diet and especially in vegan diet. Nowadays, legumes are often used in bakery industry to enrich a cheaper cereal flours with proteins and starch. Legumes do not contain gluten, so they have been growing in popularity among consumers in recent years. The aim of this work was to develop a method to differentiate beans and faba beans based on free amino acid composition. Free amino acids were extracted from the legume samples and derivatized using ethyl chloroformate (ECF). A GC-MS analysis (gas chromatography coupled to mass spectrometry) of the prepared extracts was performed and the obtained chromatograms were processed in terms to identify eluting amino acids. Peak surface areas of the identified compounds were collected into a data matrix. The data matrix was created for further data processing. Both hierarchical cluster analysis (HCA) and principal component analysis (PCA), as a multivariate statistic tools, were applied to the data matrix to differentiate the legume samples. A similarity dendrogram was created by hierarchical cluster analysis, discriminating bean and faba bean samples into two clusters. The similarity level of both beans and faba beans cluster was about 0.6. Employing principal component analysis, a 3D PCA score plot was created. Samples of beans and faba beans were also discriminated into two separated clusters. Considering the obtained results, proposed method for discrimination of beans and faba beans shows a great potential in legume authentication based on GS-MS analysis of free amino acids.

Measurement of tritium concentration and internal dose assessment from the consumption of bottled drinking water in Korea

Yoonhee Jung*, Jiyeon Ryoo, Min-Ju Lee, Sang-Han Lee

Korea Research Institute of Standards and Science (KRISS), Daejeon, South Korea

https://doi.org/10.21175/rad.abstr.book.2025.12.2

The Fukushima nuclear disaster in March 2011 released significant radioactive materials, raising concerns about contamination in the environment, food, and drinking water. Due to South Korea's proximity to Japan, there is interest in potential radioactive impacts. Tritium (^3H), a beta-emitting radionuclide with a 12.3-year half-life, behaves like water and can be absorbed through drinking, inhalation, or skin contact. It equilibrates within two hours and has a biological half-life of 10 days, making internal exposure a key concern.

This study assessed tritium in South Korea's drinking water using direct distillation and electrolysis concentration. Direct distillation results were below the minimum detectable activity (MDA), while electrolysis reduced the MDA over tenfold, detecting tritium at 0.33–0.79 Bq/L, far below the WHO guideline of 10,000 Bq/L.

These findings indicate that tritium levels in South Korea’s drinking water are safe, with no significant radiation risk, despite its proximity to Japan.

Cyto-genotoxicity studies on green carbon dots developed from biomass for biosensing applications

Ahmed Dawood[1,2], Laura Micheli[2], Clara Piccirillo[3], Alessandra Minchella[4], Bianca Gustavino*[4]

[1] Aquatic Biotechnology, Animal Biotechnology Deptartment, Genetic Engineering and Biotechnology Research Institute (GEBRI) University of Sadat City, Sadat City, Egypt
[2] Department of Chemical Science and Technologies, University of Rome Tor Vergata, Rome, Italy
[3] Institute of Nanotechnology, National Research Council (CNR NANOTEC), Lecce, Italy
[4] Department of Biology, University of Rome Tor Vergata, Rome, Italy

https://doi.org/10.21175/rad.abstr.book.2025.13.1

I**NTRODUCTION:** The production of an increasing amount of biomass/biowaste is an environmental challenge that our society urgently needs to address. Many residues from industrial processes contain valuable biocompounds, either as such or that can be transformed into such by simple and sustainable transformation processes. Biomasses can be converted into graphite-based carbon (carbon dots, CD) by a hydrothermal process, using only water as a green solvent, i.e. without toxic solvents and with minimal impact on the environment.

OBJECTIVE: The purpose of this study is to assess the safety of two green CDs compounds made from waste biomaterials, i.e. Cork powder and Fish scales, on biotechnologists who produce disposable biosensing devices. Cork powder is a residue of the cork stopper production and Fish scales are a residue of the fish processing industry. We performed both a cytotoxicity and a genotoxicity test (the Trypan Blue Staining Assay and the Alkaline Comet Assay, respectively) to investigate the effects of these bio-nanomaterials in Jurkat cells, a human tumor-derived lymphoblastoid cell line defective for P53 activity, exposed to the compounds. The two assays complement each other since the former informs about induction of cell death, while the latter provides a quantitative estimate of DNA damage induction in (surviving) cells. Scaling concentrations (up to 100 ug/ml) were selected for both compounds and prolonged exposure times, up to 72h, were studied.

MATERIALS AND METHODS: Green carbon dots from Fish Scale and Gill (FSG-CDs) and Cork (C-CDs) were prepared from the Nile tilapia (*Oreochromis niloticus*) and cork powder, respectively, by the hydrothermal treatment (described in poster by Dawood *et al.*, 'Green carbon dots developed from biomass for sensing Marine Biotoxins'). Jurkat cells were cultured in RPMI supplemented with RPMI 1640 supplemented with 10% FBS, 100 U/ml penicillin, and 100 µg/ml and maintained in a humidified incubator at 37 °C and 5% CO_2/air. FSG-CDs and C-CDs water solutions (2mg/ml) were sterilized (0,22um filters) and diluted in complete culture medium (1mg/ml) before cell administration. Appropriate volumes were then added to the cell suspensions to obtain the final concentrations of 0, 5, 25, 50, 100 ug/ml, also analysing three times of prolonged exposure (24h, 48h, 72h). In addition to negative control (no treatment), hydrogen dioxide (H_2O_2) was used as positive control (150uM, 30 mins at 37°C). Trypan Blue Staining Assay was carried out before and immediately after the end of treatments by counting viable and nonviable cells in a hemocytometer. Slide preparation for alkaline Comet Assay was performed at the end of exposure, at +4°C, in the dark. One single electrophoretic run was carried out per each test compound, where all concentrations and incubation times were inserted in the basin and run together. The software "Comet IV" (Instem) was used for comet image analysis, and a minimum of 50 comets / experimental point were measured.

RESULTS: No significant induction of cell death was induced by FSG-CDs and C-CDs at the different concentrations and times of exposure. No genotoxic effect was detected for FSG-CDs at all concentrations and exposure times, while a slight but significant increase of DNA damage was induced by C-CDs. An extremely significant increase of DNA damage was recorded in the positive control (H_2O_2), as expected.

Application of solar devices for enhancing human safety and quality of life

Rostyslav Musiy*[1], Iryna Yaremak[2]

[1] Department of PhChFF InPOCC NAS of Ukraine, Lviv, Ukraine
[2] Ivano-Frankivsk National Technical University of Oil and Gas, Ivano-Frankivsk, Ukraine

https://doi.org/10.21175/rad.abstr.book.2025.14.1

Significant energy consumption and environmental pollution have led to a change in the trends of energy development worldwide. In this context, developments and programs aimed at reducing energy consumption for centralized heating, hot water supply, additional heating, ventilation and air conditioning systems, building lighting, etc., are of particular relevance. In the near future, a shift towards the construction of zero-energy buildings is expected. This approach necessitates the implementation of renewable energy sources, particularly solar energy. New efficient solar thermal and electric systems are being developed and created, and methods for simplifying their integration and use as elements of building roofs and facades are being actively researched. For the efficient use of solar energy, this study proposes the development, manufacturing, and installation of solar thermal air collectors and solar dryers. The main element of these systems is a thermally absorbing coating that converts solar energy into heat. Spectrally selective composite coatings are obtained using the sol-gel method. The coatings contain carbon nanoparticles dispersed in dielectric matrices of SiO_2 or NiO. Comparative studies of the synthesized coatings were conducted with a sample from SunSelect (Germany). SunSelect coatings are widely used in the production of solar collectors, but they are manufactured using an expensive technology - vacuum deposition. Based on our selective coatings various types of solar thermal air collectors (STAC) and solar dryers have been created. These systems, which operate solely on solar energy, are used for:

- ventilation and partial heating of various premises;
- heating water and cooling air when using additional equipment;
- providing electricity to premises and charging various devices;
- environmentally friendly drying of products, materials, and foodstuffs.

The developed systems are manufactured in various shapes and sizes. They can be used for facades, roofs of buildings, and other structures. STAC can operate around the clock without human presence, require no additional costs after commissioning, and use solar energy. Thus, the use of the developed solar devices allows: creating a comfortable microclimate to ensure the safe livelihood of humans, especially in areas most affected by natural disasters such as droughts, floods, earthquakes, wars, etc.; contributing to the preservation of human health by protecting them from environmental pollution, including air and water pollution, as well as hazardous waste; providing access to modern and reliable healthcare and care for people living in conditions where traditional energy sources are insufficient or absent.

References:

1. Concerted Action | Energy Performance of Buildings Directive. Available at: http://www.epbd-ca.eu/.
2. Yaremak, I., & Yaremak, R. (2021). State and perspectives of renewable energy development in Ukraine. In: Proceedings of the V International Scientific-Technical Conference “Actual Problems of Renewable Energy, Construction and Environmental Engineering”, Kielce University of Technology, Poland, 3-5 June 2021, pp. 144-146. Available at: https://jntes.tu.kielce.pl/wp-content/uploads/2021/06/Book-of-abstracts.pdf.
3. Batsala, Ya. V., Hlad, I. V., Yaremak, I. I., & Kiianiuk, O. I. (2021). Mathematical model for forecasting the process of electric power generation by photoelectric stations. Naukovyi Visnyk Natsionalnoho Hirnychoho Universytetu, (1), 111–116. https://doi.org/10.33271/nvngu/2021-1/111.
4. Zaidi, S. J., & Matsuura, T. (Eds.). (2019). Polymer Membranes for Fuel Cells. Springer Science + Business Media, LLC, New York.
5. Khairnasov, S., Rassamakin, B., Rassamakin, A., & Musiy, R. (2013). "Analysis of the effect of energy-saving technologies on the building heating systems." Journal of Civil Engineering and Architecture, 7(4), 403-409.

Chromium Content in drinking water in the Pleven region, Bulgaria – Sources and health control

Emilia Bankova*[1], Vanya Birdanova[1], Tsvetelina Vitkova[1], Dima Tsanova[1], Suzana Nikolova[1], Ivan Traykov[2]

[1] Medical University-Pleven, Pleven, Bulgaria
[2] Sofia University, Sofia, Bulgaria

https://doi.org/10.21175/rad.abstr.book.2025.14.2

Ensuring the provision of high-quality drinking water in Bulgaria faces significant challenges, including an outdated and deteriorating water distribution network, anthropogenic pollution of water sources, and the natural migration of chemical elements from rock and soil substrates into groundwater. These factors contribute to water contamination, particularly the presence of harmful substances such as heavy metals, pesticides, and fertilizers, which pose risks to human health. Contamination of drinking water with chromium, especially in areas with naturally high levels, is of serious concern. Chromium in its hexavalent form (Cr^{6+}) is toxic and carcinogenic, while trivalent chromium (Cr^{3+}) is an essential trace element. Data on chromium content in drinking water in the Pleven region were studied over an eight-year period according to the monitoring program of the Regional Health Inspectorate – Pleven. The results indicate that approximately 26% of the total samples tested during this period (1,242 samples) exceeded the maximum allowable chromium concentration of 50 µg/L, with the highest recorded value reaching 138.82 µg/L. According to national and European legislation, the maximum limit applies to total chromium, meaning that hexavalent and trivalent chromium are not regulated separately. These findings highlight the urgent need for improved monitoring and the implementation of water purification technologies to reduce chromium concentrations and ensure safe drinking water for the affected areas. The study further investigates methods for reducing chromium contamination and proposes strategies for meeting national and European water quality standards, with the ultimate goal of protecting public health and enhancing the sustainability of water resources in the region.

Influence of heavy metals on metabolism. Oxidative stress

Vanya Birdanova, Tsvetelina Vitkova, Ivelina Ruseva, Manoela Bogdanova*, Iveta Petrova, Emilia Bankova

Medical University, Pleven, Bulgaria

https://doi.org/10.21175/rad.abstr.book.2025.14.3

Environmental pollution from heavy metals (such as lead, cadmium, mercury, and copper) and other toxic chemical elements poses a serious threat to public health, as these substances enter the environment through dust, smoke, and fumes. People are exposed to heavy metals via air, water, soil, and food, and the disposal of untreated solid waste is also a risk factor. Exposure to these toxic elements can lead to severe metabolic disorders, including insulin resistance and other metabolic issues. In Bulgaria, a significant source of such pollutants includes metal mining enterprises.

The impact of heavy metals on metabolic processes and oxidative stress was examined through a systematic medical review and meta-analysis of available data and experimental studies. The results indicate that the accumulation of heavy metals in the body leads to dysfunction in organs and metabolic processes. Chronic exposure can cause hepatotoxicity, neurotoxicity, and cardiotoxicity. During their biotransformation in the body, heavy metals interact with enzyme systems and promote the accumulation of free radicals, which disrupt cell functions and trigger oxidative stress. Cells under oxidative stress exhibit various dysfunctions due to the damage caused by free radicals to lipids, proteins, and DNA. The study also found that certain metals (such as cadmium and iron) reduce insulin production and may induce type 2 diabetes. Individuals exposed to lead (Pb) and mercury (Hg) are at a higher risk of obesity.

Prevention of the impact of toxic elements requires the hygienic standardization of pollutants and the identification of pollution sources in the environment. To reduce exposure in the workplace, it is essential not only to implement hygienic standardization but also to adopt preventive measures, including dietary adjustments and the use of appropriate hydrating and detoxifying products, such as antioxidants and nutritional supplements that support liver health and the excretory system. The implementation of dietary changes, balneotherapy, and temporary employment can help reverse the development of metabolic issues.

Laboratory synthesis methods of ferromagnetic greigite for its application in cancer hyperthermia

Klaudia Tetfejer, Anna Czarnecka-Skwarek*, Agnieszka Rożek

University of Warsaw, Faculty of Geology, Warsaw, Poland

https://doi.org/10.21175/rad.abstr.book.2025.14.4

Greigite ($Fe^{2+}Fe^{3+}_2S_4$), along with pyrite (FeS_2) and mackinawite (FeS), are part of a group of iron sulfide minerals commonly found in euxenic environments. This ferromagnetic mineral is described in the environmental research literature as the main precursor in the action of pyrite by the polysulfide pathway. However, it is not always an intermediate phase in this process. Recently, greigite has been described as rare, metastable, and could easily be transformed into pyrite. However, thermodynamic modeling shows that it is not subject to further equilibrium reactions under certain physical and chemical conditions and may be preserved in the geological record. In the natural environment, this mineral can be formed in both biotic and abiotic conditions, including: occurring inside the cells of magnetotactic bacteria (MTB) or crystallizing in a purely chemical way as a result of the thermochemical reduction of sulfates process. Due to its magnetic properties, it is used in geological research (paleomagnetic and paleoenvironmental analyses), and recently also in medicine, where it may have a potential importance in cancer treatment. For several years, there have been literature reports regarding the possibility of using nanocrystalline greigite, which can be a source of heat in hyperthermia processes (i.e. heating body tissues to a temperature of 41-45°C). This method may lead to the creation of a mechanism in which heat shock proteins (present in large amounts in cancer cells) will not be able to retain their full activity, which is associated with sensitization of cancer cells to other pharmacological factors, e.g. concurrent chemotherapy. The tissues are heated by these sulfide nanoparticles affected by an external variable magnetic field. It should be emphasized that the results of research conducted on the antioxidant and cytotoxic properties of Fe_3S_4 indicate that its action is effective in destroying cancer cells while having a neutral effect on healthy ones. Therefore, research leading to the production of greigite nanoparticles under optimal synthesis conditions may contribute to the development of cancer treatment methods.

This study aimed to review the methods and mechanisms of laboratory synthesis of greigite under various physical and chemical conditions. Selecting optimal conditions for obtaining the right mineral material is a key aspect affecting the possibilities of subsequent medical applications. The satisfactory product of such synthesis is a pure material with nanometric dimensions, which increases the probability of the occurrence of crystals with one magnetic domain and is used in the hyperthermia process. Abiotic synthesis of greigite carried out in laboratory conditions confirms the possibility of obtaining monomineral phases with the participation of organic compounds such as hexamethylenetetramine. It should be noted that these processes usually require an inert gas atmosphere, the addition of ethylene glycol, and a capping agent as crystal growth inhibitors. The disadvantage of this method is the need to use a temperature in the range of 140-230°C, while it is possible to obtain greigite using the co-precipitation method at a temperature below 100°C while extending the synthesis time to several days. Despite these difficulties, synthesis in abiotic conditions using an autoclave allows to quickly obtain greigite with an ordered crystal structure and application potential in oncological therapies.

Monitoring of *Aedes albopictus (Skuse)* in Southwestern part of Republic of Kosovo

Nesade Muja-Bajraktari*[1], Ferdije Zhushi-Etemi[1], Përparim Kadriaj[2], Kurtesh Sherifi[3]

[1] Department of Biology, Faculty of Mathematics and Natural Sciences, University, Prishtina, Kosovo
[2] Department of Epidemiology and Control of Infectious Diseases, Institute of Public Health, Tirana, Albania, Tirana, Albania
[3] Department of Veterinary Medicine, Faculty of Agriculture and Veterinary, University, Prishtina, Albania

https://doi.org/10.21175/rad.abstr.book.2025.14.5

The tiger mosquito *Aedes albopictus*, widespread throughout tropical and subtropical regions of the world, is one of the most invasive mosquito species in Europe. Since its introduction, it has raised significant public health concerns due to its ability to transmit various pathogens that cause several diseases. The first detection of *Aedes (Stegomyia) albopictus* (Skuse, 1894) in Kosovo is reported in 2020. This study presents the first data on the spatial and seasonal distribution of *Ae. albopictus* in the southwestern part of the country. Monitoring was carried out during 2020–2021 using ovitraps and BG-Sentinel traps for adult mosquitoes, deployed at 35 sampling stations across 7 localities. Inspections were conducted every two weeks. The highest egg abundance was recorded in 2020, with a total of 2,711. The aim of this monitoring was to provide an analysis of the distribution patterns, seasonal dynamics, and intensity of egg-laying by adult female mosquitoes, as well as the development of adult mosquito populations. The findings suggest an established and potentially expanding population in the monitored areas. Given the vector potential of *Ae. albopictus* for arboviruses such as dengue, chikungunya, and Zika, these results highlight the importance of continued surveillance and the implementation of early warning systems to guide public health interventions.

Keywords: *Aedes albopictus*, tiger mosquito, monitoring, ovitraps, vector surveillance.

The MAGIC project - Guaranteeing access to ancient books

Guido Russo*, Stefania Conte, Lorenza Laccetti, Yahya Momtaz

Department of Physics, Napoli, Italy

https://doi.org/10.21175/rad.abstr.book.2025.15.1

The Magic project, initiated in 2023, aims to accurately digitally replicate the essence of antique books while ensuring their accessibility to everybody. The University of Naples Federico II, in collaboration with three prominent ICT companies, initiated this ambitious alliance to honor our cultural heritage. We started with the domain of incunabula, defined as books produced during the nascent period of printing with movable type. These are not mere dusty artifacts; they serve as portals to the past, encapsulating knowledge of ancient literature, astronomy, and medicine.

A group of dedicated specialists is meticulously loading each page of these 500-year-old books onto a designated planetary scanner. They are chronicling history and capturing photographs. Every detail is significant, from the minuscule inscriptions to the aged parchment. High-resolution detail at 600 dpi is obtained by sophisticated scanning technology. Each sheet is managed with meticulous care, like priceless artwork, supported by moveable planes to prevent damage. The long-term archive uses the FITS format, a NASA standard. What is the rationale for utilizing the FITS format? Consider the scenario in which you wish to retrieve a file dated 1990 at the present time. FITS preserves digital information for future generations, akin to a time capsule. Each digitized volume contains its own narrative-historical insights, paleographic studies, and microbiological information. It is not merely the act of reading antiquated texts; it involves comprehending the authors and the societal context in which they existed. The Magic Project seeks to establish a link between the past and present by preserving ancient texts and fostering a society where individuals from many backgrounds can access these treasures. Our web site (www.magic.unina.it) provides immediate access to a private library. The presentation will focus on the informatics aspect of the project, from the web site to the AI tools.

Advanced data processing of ATF claddings

Ondřej Pašta*

Research Centre Řež s.r.o., Husinec-Řež, Czech Republic

https://doi.org/10.21175/rad.abstr.book.2025.16.1

Digital image processing (DIP), neural networks, and artificial intelligence (AI) are revolutionizing materials science, enabling precise and efficient analysis of microscopic features. From nuclear fuel inspections to advanced microscopy studies, DIP has become a cornerstone of material analysis to obtain relevant data quality. At CVR, integrating DIP and AI has streamlined processes, enhanced data reliability, and provided valuable insights in areas such as various microscopy studies (SEM, TEM), reactor shielding evaluations and nuclear fuel inspections based on image data processing with different resolution

A critical application of DIP is the detection of precipitates—microscopic features that affect material properties. We can recognize the nature of precipitates, e.g. the secondary phase particles (SPP)-precipitates which are specifically present in the microstructure from the manufacturing processes/heat treatment, or the radiation-induced precipitates (RIP) formed in the microstructure by diffusion processes caused by fast neutron irradiation. Size, shape, type and distribution of both types of precipitates influence material behaviour under stress, precipitates increase hardness, make the material more brittle and can create a stress field. By controlling of SPPs formation through alloy composition and heat treatment, researchers can optimize material properties. The RIPs distribution is very important part of Post Irradiation Examination (PIE).

In SEM/TEM, DIP is essential for segmenting precipitates in construction materials of nuclear power plants and conducting statistical analysis before and after irradiation. DIP minimizes repetitive tasks, reduces human error, and ensures consistent results, making SEM data more reliable and reproducible.

DIP also plays a crucial role in analysing biological shielding concrete, which endures thermal, gamma, and neutron flux in nuclear reactors. Over time, these exposures cause cracking, especially at the interface between coarse aggregate and hardened cement paste, compromising properties like strength and stiffness. Monitoring crack formation is key to understanding degradation mechanisms. At CVR, DIP provides precise crack tracking and volumetric damage analysis, which can validate other methods as ultrasonic testing (UT), offering a non-invasive way to assess structural integrity.

In nuclear fuel inspections, DIP processes video data to reconstruct high-resolution images of fuel assemblies, verifying key parameters such as bow, twist, and growth with 0.2 mm accuracy. These measurements ensure nuclear safety and operational reliability. Long-term inspections using DIP enable core behaviour verification across different fuel designs, with terabytes of data generated annually. DIP optimizes workload and ensures consistency in results over time.

Nuclear cladding materials, structural components, shielding concrete, and nuclear fuel are vital for the long-term operation (LTO) of nuclear power plants. DIP technologies developed at CVR support LTO policies by enhancing material analysis and quality assurance.

Beyond nuclear research, DIP has broad applications in non-nuclear fields. Industries requiring microscopic analysis, such as crack tracking in concrete or defect detection in alloys, can benefit from DIP's precision and efficiency. DIP provides versatile solutions for challenges across a wide range of materials.

At CVR, advancing DIP technologies remains a priority in the nuclear research and development, where DIP is transforming material science, optimizing workflows, improving data quality, and driving innovation in both nuclear and non-nuclear industries.

We acknowledge the state support of the Technology Agency of the Czech Republic within the National Competence Centre Programme II, project TN02000012 „Center of Advanced Nuclear Technology II“.

Brief overview on the potential possibility of integrating nanotechnology for corrosion control and material enhancement in nuclear industry applications

Amin Shahrokhi*, Lordford Tettey-Larbi, Esther Osei Akuo-ko, Tibor Kovács

University of Pannonia, Veszprém, Hungary

https://doi.org/10.21175/rad.abstr.book.2025.16.2

The integration of nanotechnology, materials science, and nuclear engineering could be a potantial solutiom for one of the most pressing issues in the nuclear industry, namely as corrosion. Despite the widespread application of nanoscience across various fields, the nuclear sector has yet to fully harness its potential, particularly in corrosion control under ionizing radiation. Corrosion remains a significant challenge in nuclear environments due to unique operational conditions, posing threats to safety, cost-efficiency, and material durability. This preliminary overview proposes a multidisciplinary research direction to bridge the current gap and examine the potential of nanotechnology to contribute to safer, more efficient, and longer-lasting nuclear systems., which would be a exprimental research of using nanotechnology as a novel pathway for corrosion mitigation and material enhancement in nuclear settings. The nuclear industry, as an advanced and leading industry, is not immune from the effects and costs of corrosion. In this industry, in addition to corrosion in other industries, due to special environmental conditions (presence of ionizing radiation), the phenomenon of corrosion has a special importance and place. So that the presence of radiation creates a distinct and different aspect for corrosion studies in this industry. In other words, some cases of corrosion are common to all structures and facilities (nuclear and non-nuclear) and some cases of corrosion, due to special materials and conditions, are specific to the nuclear reactor (especially in the heart of the reactor) and other facilities related to the nuclear industry. Additionally, the risks of leaking radioactive material out of the system highlight the importance of controlling the corrosion in nuclear facilities. There have been many studies on reducing the effect of corrosion on different alloys, and even in recent years scientists have tried to use Nano-technology to reduce the effects of corrosion, the results of which are surprisingly different in each industry and depending on the environment, so that in some cases the corrosion is controlled and in some cases the effect is intensified. Therefore, the results cannot be extended to from one to other industry. Meanwhile, the lack of a comprehensive study on the use of Nano-materials and their behavior in the nuclear industry when alloys are exposed to ionizing radiation is felt. This overview highlights the gap in current research regarding the behavior of nanomaterials under nuclear-specific conditions and introduces the need for a focused exploration of nanotechnology as a novel pathway for corrosion mitigation and material enhancement in the nuclear field.

Comparison of physical and mechanical properties of carbide coatings based on TiZrNbC and TiZrMoC: Microstructure, elemental composition and tribological characteristics

Alexander Pogrebnjak*[1], Svitlana Borba-Pohrebniak[2], Volodymyr Ivashchenko[3], Martin Sahul[4], Richard Webster[5]

[1] Slovak University of Technology in Bratislava, Faculty of Material Science and Technology in Trnava, Institute of Materials, Trnava, Slovakia
[2] Sumy state University, Kharkivskaya 116, Sumy, Ukraine
[3] Institute for Problems of Materials Science, National Academy of Sciences in Ukraine, Kiev, Ukraine
[4] Slovak University of Technology in Bratislava, Faculty of Material Science and Technology in Trnava, Trnava, Slovakia
[5] Electron Microscope Unit, Mark Wainwright Analytical Centre, University of New South Wales, Sydney, Australia

https://doi.org/10.21175/rad.abstr.book.2025.16.3

One of the ways to increase the protection of parts and tools made of alloys and metals from wear and temperature are coatings deposited on metal based on nitrides, carbides or carbonitrides. In this work, we focus on the ternary coatings TiZrNbC and TiZrMoC, deposited at high potential on a target made of C (480-520 Volts), with the same residual gas pressure in the installation chamber and a substrate temperature of 400 °C.In the initial state the stoichiometry was Ti50Zr25Nb25 and Ti50Zr25Mo25. The coatings with a thickness of 1.79-1.81 mkm were obtained with a uniform carbon concentration across the thickness and a small oxygen concentration near the surface. Silicon (Si) samples were used as a substrate. RBS, PIXE, ToF ERDA, XPS, STEM, HRTEM analysis methods were used to analyze elements by coating depth and element maps by sample cross-sections and analyze microstructure and chemical bonds. Formation of the TiZrMoC FCC phase with a strictly textured 111 and columnar structure with a lattice parameter of 0.427-+-0.006 nm was detected. At the same time, coatings from also had a TiZrNbC- c FCC lattice with a lattice parameter of 0.426-+ 0.002 nm. An amorphous layer with a thickness of only 2.5 nm was formed near the boundary with the substrate.

Acknowledgements: It was also funded by the NextGeneration EU through the Recovery and Resilience Plan for Slovakia under the project (grant numbers 09I03-03-V01-00026)

Determination of water uptake and diffusion coefficient of polymer/lignin composites

Marija Prosheva*, Andrea Petanova, Jadranka Blazhevska Gilev

Ss. Cyril and Methodius University in Skopje, Faculty of Technology and Metallurgy, Skopje, North Macedonia

https://doi.org/10.21175/rad.abstr.book.2025.16.4

Despite being one of the most abounded natural polymers, with a wide set of properties, majority quantities of lignin are disregarded as a waste. The use of lignin as a filler for synthesis of composites based on polymer matrix is a step towards more sustainable production of polymer-based products. In this research lignin/polymer composites were synthesized via in-situ miniemulsion. Poly(methyl metacrylate-butylacrylate- acryl amide) was used as polymer matrix in which 0.5 wt% and 1 wt% of lignin aqueous dispersion was added by continuous.

The successful incorporation of lignin was confirmed using Fourier transform infrared spectroscopy, while the morphology of the composites was investigated using scanning electron microscopy. The UV-Vis spectroscopy results demonstrated an enhanced absorption ability of the polymer/lignin composites in the UV-B, UV-A, and visible light regions. According to the water uptake test, the composite with 1 wt% lignin did not exhibit a significantly higher affinity for water absorption compared to the neat polymer. This finding corresponds with the calculated diffusion coefficient, which showed a reduction of nearly 40% with the incorporation of 1 wt% lignin within the polymer matrix.

Keywords: lignin, polymer-composites, water uptake, diffusion

Effects of disorder in materials for X-ray Detectors

Sergei Baranovskii*[1,2]

[1] Philipps-Universität Marburg, Marburg, Germany
[2] Universität zu Köln, Cologne, Germany

https://doi.org/10.21175/rad.abstr.book.2025.16.5

Interest to optoelectronic properties of amorphous semiconductors and of crystalline semiconductor alloys has been steeply growing in the last decades. This is caused by successful current applications of such materials in various devices and by their promise for future applications, particularly for large-area flat-panel x-ray detectors.

Structural disorder in amorphous semiconductors and statistical disorder in the distribution of chemically different components in semiconductor alloys drastically affect optoelectronic properties of such materials.

Theoretical models for description of disorder effects in materials used for applications in direct and indirect x-ray detectors will be reviewed in the presentation. Particular attention will be given to material parameters responsible for the effects of structural disorder on charge transport in the direct detectors and on the optical absorption in the indirect devices.

1. S. Baranovski, ed., Charge Transport in Disordered Solids with Applications in Electronics (John Wiley & Sons, Ltd, Chichester, 2006).
2. F. Mousavi, M. Ansari-Rad, and S. D. Baranovskii, “Variational encoder-decoder architecture for charge and energy transport in disordered materials”, Phys. Rev. B 111, 024208 (2025).
3. V. Nenashev, F. Gebhard, K. Meerholz, S. D. Baranovskii, “Computation of the spatial distribution of charge-carrier density in disordered media”, Entropy 26, 356 (2024).
4. V. Nenashev, J. O. Oelerich, S. H. M. Greiner, A. V. Dvurechenskii, F. Gebhard, and S. D. Baranovskii, “Percolation description of charge transport in amorphous oxide semiconductors” Phys. Rev. B 100, 125202 (2019).
5. V. Nenashev, S. D. Baranovskii, K. Meerholz, and F. Gebhard, “Quantum states in disordered media. II. Spatial charge carrier distribution”, Phys. Rev. B 107, 064207 (2023).

Electrochemical impedance spectroscopy of a boron-doped microcrystalline diamond electrode in $NaNO_3$ aqueous electrolytes

Oksana Gutsul*[1], Rene Pfeifer[2], Ondrej Szabo[3], Dhananjay K. Sharma[3], Jaroslav Kuliček[2], Nirmal Kumar[2], Alexander Kromka[3], Bohuslav Rezek[2]

[1] Bukovinian State Medical University, Chernivtsi, Ukraine
[2] Czech Technical University in Prague, Prague, Czech Republic
[3] Institute of Physics of the Czech Academy of Sciences, Prague, Czech Republic

https://doi.org/10.21175/rad.abstr.book.2025.16.6

The unique electrochemical interaction in two- and three-electrode configurations of the aqueous-salt electrolyte sodium nitrate ($NaNO_3$) in a wide range of concentrations (1 - 12 m) with an electrode made of boron-doped microcrystalline diamond (B-MCDE) deposited in a microwave plasma by chemical vapour deposition is demonstrated. Compared to a commercial glassy carbon electrode (C-GCE), the electrochemical stability window reached ~ 3 V. In the frequency range of 10 mHz - 100 kHz, the B-MCDE also demonstrated better conductive (up to R_{ct} 50 Ohm) and capacitive (up to C_{dl} 3.2 µF) properties compared to C-GCE for all electrolyte concentrations. The best performance was obtained for the 8 m concentration at neutral pH and room temperature, while the 12 m concentration was unstable, as confirmed by Raman spectroscopy. The extended ESW and better performance of B-MCDE is attributed to its high-quality material properties and nanostructured surface (size < 100 nm) formed in the WiS $NaNO_3$ electrolyte. The results show that, with well-controlled quality, boron-doped diamond electrodes can provide advantages for water-in-salt supercapacitors.

Electroless deposition of copper-indium coatings for CO_2 reduction

Eugenijus Norkus, Loreta Tamašauskaitė-Tamašiūnaitė*, Ina Stankevičienė, Aldona Jagminienė, Aldona Balčiūnaitė

Center for Physical Sciences and Technology (FTMC), Vilnius, Lithuania

https://doi.org/10.21175/rad.abstr.book.2025.16.7

Carbon dioxide (CO_2) is one of the primary greenhouse gases contributing to global warming, and reducing its emissions is a significant environmental challenge. The conversion of CO_2 into useful materials not only helps mitigate its impact on the environment but also creates potential for new, sustainable resources. Electrocatalysis is an exciting approach for CO_2 reduction because it provides a controlled, energy-efficient means of converting CO_2 into valuable products. Cu-based composites have been widely studied due to their promising performance in CO_2 reduction reactions (CO_2RR). In this study, the copper-indium (CuIn) coatings deposited on the copper surface by the electroless plating method were investigated as electrocatalysts for CO_2RR. The dependence of the electroless plating kinetics on the CuIn coatings on the solution pH, electrode potential, and hydrodynamic conditions was investigated using the electrochemical quartz crystal microgravimetry (EQCM). The morphology and composition of the materials were examined by field emission scanning electron microscopy (FESEM) and inductively coupled plasma optical emission spectroscopy (ICP-OES). The electrochemical behavior of the CuIn/Cu catalysts for CO_2RR was studied by linear sweep voltammetry in the most common electrolyte, CO_2-saturated 0.1 M $KHCO_3$ (pH = 6.8) solution. In addition, constant-potential electrolysis experiments were carried out on CuIn in the same solution to characterize the CO_2RR product distribution as a function of potential. The CO_2RR data on the CuIn and Cu coatings are compared and discussed on the basis of the electrochemical data.

Acknowledgements: This research was funded by a grant (No. P-MIP-24-653) from the Research Council of Lithuania (LMTLT).

Electroless metal and metal alloys deposition using multivalent metal ions as reducing agents

Eugenijus Norkus*

Center for Physical Sciences and Technology, Vilnius, Lithuania

https://doi.org/10.21175/rad.abstr.book.2025.16.8

The possibility and conditions to use lower oxidation state metal ions as reducing agents for autocatalytic electroless metal deposition are discussed. The theoretical background of such kind reactions is presented in the view of thermodynamics. Kinetic data on electroless silver, copper, palladium, platinum and possible alloys deposition using Co(II)/Co(III) redox systems with different ligands are presented and discussed. Ti(III)/Ti(IV) redox systems with different ligands were shown also to be suitable reducing agents for reducing of Pt(IV), Pd(II), Ni(II) and Co(II) to metallic state and formation of continuous metal and metal alloys layer on the surface to be plated. The morphology of metal layers deposited using above-mentioned reducing agents was characterized by means of Field Emission Scanning Electron Microscopy (FESEM). Kinetics of metal deposition rate was investigated by means of the gravimetry or Electrochemical Quartz Crystal Microgravimetry (EQCM).

Acknowgelement: This project has received funding from the Research Council of Lithuania (LMTLT), agreement No S-MIP-24-13.

Growth and characterization of TmF_3 doped fluorite crystals

Marius Stef*, Carla Schornig, Gabriel Buse, Philippe Veber, Maria Poienar, Daniel Vizman

West University of Timisoara, Timisoara, Romania

https://doi.org/10.21175/rad.abstr.book.2025.16.9

Rare-earth-doped fluorite crystals are of significant interest due to their optical properties and wide-ranging applications, particularly in laser technology and scintilators. Among these materials, CaF_2 and BaF_2 crystals doped with TmF_3 stand out for their versatile luminescent characteristics, positioning them as promising candidates for advanced optical applications.

This study explores the luminescence of Tm^{3+} and Tm^{2+} ions in fluorite crystals grown in our Crystal Growth Laboratory using the vertical Bridgman method. A detailed Judd–Ofelt analysis was conducted on Tm^{3+}-doped crystals to assess their spectroscopic properties and application potential. The Judd–Ofelt theory provides a framework for analyzing optical transitions and calculating spectroscopic parameters of rare-earth ions within crystalline hosts. For the investigated Tm^{3+}-doped crystals, the intensity parameters (Ω_2, Ω_4, and Ω_6) were determined, offering critical insights into radiative properties such as emission cross-sections, branching ratios, and quantum efficiencies, essential for the development of advanced laser and optical systems. Advances in spectroscopic techniques and theoretical models have greatly improved the understanding of complex energy transfer processes and relaxation dynamics in Tm^{3+}-doped fluorite hosts. Incorporating these advancements into the Judd–Ofelt analysis, this research provides a deeper understanding of the luminescence mechanisms and spectral characteristics of Tm^{3+} ions, facilitating their optimization for laser applications. The influence of x-ray irradiation on the spectroscopic properties of as-grown crystals will be also investigated.

Acknowledgments: This work was supported by ESCARGOT project founded by the Romania's recovery and resilience plan, PNRR/2022/C9/MCID/I8.

References:

1. Doroshenko, M.E., Alimov, O.K., Papashvili, A.G., Martynova, K.A., Konyushkin, V.A., Nakladov, A.N.; Osiko, V.V. Laser Phys. Lett. 12 (2015) 125701.
2. Taikar, D.R., Taikar, R.N., Nagde, K.R., Sarve, S.R., Macromol. Symp. 400 (2021) 2100019
3. Liu, J., Zhang, C., Zu, Y., Fan, X., Liu, J., Guo, X., Qian, X., Su, L,., Laser Phys. Lett. 15 (2018) 045803.
4. Schornig C., Stef, M., Buse, G., Poienar, M., Veber, P., Vizman, D., Materials 17 (2024) 4965

Luminescence and energy transfer processes in $Ca_3Ga_2Ge_3O_{12}$:Bi,Eu

Assemgul Kissabekova*[1,2], Aleksei Krasnikov[3], Volodymyr Tsiumra[4]

[1] L.N. Gumilyov Eurasian National University, Astana, Kazakhstan
[2] Pavlodar Pedagogical University, Pavlodar, Kazakhstan
[3] Institute of Physics, University of Tartu, Tartu, Estonia
[4] Institute of Physics, Polish AS, Warsaw, Poland

https://doi.org/10.21175/rad.abstr.book.2025.16.10

The interest in Bi^{3+}-doped compounds increased drastically in recent years due to their possible applications as scintillator and phosphor materials suitable for X-ray screens, white light-emitting diodes, solar cells, dosimeters, etc. The compounds co-doped with Bi^{3+} and different trivalent rare-earth (RE^{3+}) ions were found to be potentially applicable as spectral converters for solar cells and solid-state light sources of new generation, so-called white light-emitting diodes (WLED), owing to strong absorption in the ultraviolet spectral region, intense broad visible Bi^{3+}-related emission bands, and effective $Bi^{3+} \rightarrow RE^{3+}$ energy transfer, resulting in the appearance of the luminescence covering a wide spectral range from blue to red.

Detailed and systematic investigation of the Bi^{3+}-related luminescence in $Ca_3Ga_2Ge_3O_{12}$:Bi with different Bi^{3+} contents was carried out by us in. Under excitation in the Bi^{3+} - related absorption band, the ultraviolet and visible emissions were observed in $Ca_3Ga_2Ge_3O_{12}$:Bi. The ultraviolet emission bands were ascribed to the radiative decay of the triplet relaxed excited state of Bi^{3+} ions having different nearest surroundings. A visible emission is found to arise from an exciton localized around a Bi^{3+} ion.

In this work, set of few samples of the $Ca_3Ga_2Ge_3O_{12}$:Bi,Eu microcrystalline powders with the same Bi^{3+} content (2%) and different Eu^{3+} concentrations (varying from 0.5 to 5%) are synthesized by the solid-state reaction method and analyzed by the XRD method. The luminescence characteristics of the $Ca_3Ga_2Ge_3O_{12}$:Bi,Eu powders are investigated by the steady-state and time-resolved spectroscopy methods in a wide temperature range (4.2–500 K) and compared with the characteristics of the undoped and Bi^{3+}-doped $Ca_3Ga_2Ge_3O_{12}$. It is found that owing to the complete overlap of the intrinsic and Bi^{3+}-related emission bands with the absorption bands of Eu^{3+} ions, an effective energy transfer from the host and Bi^{3+}-related states to Eu^{3+} takes place in $Ca_3Ga_2Ge_3O_{12}$:Bi,Eu resulting in the appearance of the luminescence in the 1.7–3.5 eV energy range. The shortening of the Bi^{3+}-related luminescence decay time with the increasing Eu^{3+} concentration allows us to conclude the nonradiative (resonance) energy transfer mechanism in $Ca_3Ga_2Ge_3O_{12}$:Bi,Eu. The luminescence quantum yield values and the CIE color coordinates are determined. Possible application of the $Ca_3Ga_2Ge_3O_{12}$:Bi,Eu phosphor in WLED is discussed.

The work was partially supported by the Science Committee of the Ministry of Education and Science of the Republic of Kazakhstan (Grant No. AP19177651)

1. Baran, M.; Belikov, K.N.; Kissabekova, A.; Krasnikov, A.; Lushchik, A.; Suchocki, A.; Tsiumra, V.; Vasylechko, L.; Zazubovich, S.; Zhydachevskyy, Ya. (2022). Luminescence and energy transfer processes in LuNbO4:Bi, Eu. *Optical Materials*, 123, 111948.
2. Krasnikov, A.; Suchocki, A.; Tsiumra, V.; Vasylechko, L.; Wachnicki, L.; Zazubovich, S.; Zhydachevskyy, Ya (2021). Photoluminescence of the undoped and Bi^{3+} - doped $Ca_3Ga_2Ge_3O_{12}$ garnets. *Journal of Luminescence*, 235, 118065.

Luminescence of the isoelectronic impurities in garnet compounds under X-ray and synchrotron radiation excitations

Yu. Zorenko*[1,2], V. Gorbenko[1], S. Witkiewicz-Lukaszek[1], Y. Syrotych[1], T. Zorenko[1], J. Winiecki[2], Sh. Sagimbayeva[3], A. Kenzhebayeva[3], K. Shunkeyev[3]

[1] Kazimierz Wielki University in Bydgoszcz, Bydgoszcz, Poland
[2] Medical Physics Department, Prof. F. Lukaszuk Oncology Center, Bydgoszcz, Poland
[3] K. Zhubanov Aktobe Regional University, 34 A. Moldagulova Ave., Aktobe, Kazakhstan

https://doi.org/10.21175/rad.abstr.book.2025.16.11

The regularities of the luminescence centers formation by the La^{3+} and Sc^{3+} isoelectronic impurities (IsIm) in oxides with garnet structure $A_3B_5O_{12}$ (A=Y, Lu, Gd; B =Al, Ga) have been investigated. Such regularities have been revealed also for the antisite defects (AD) (Y_{Al} in YAG and Lu_{Al} in LuAG) as special kinds of IsIm. Creation of such type of ADs in the 0.05-0.25 at.% concentration is an irrevocable consequence of the single crystal (SC) growth of garnets at 1900-2000°C from high-temperature melt. At the same time, the single crystalline films (SC) of these garnets grown by the liquid phase epitaxy (LPE) method are free of ADs due to low (~1000°C) temperature of their crystallization. Therefore, both SCFs and SCFs are convenient objects for the investigation of radiative relaxation of low-energy excitations in garnet compounds, in particular, the exciton luminescence, connected with IsIm and AD centers.
Recently was found that the ability of IsIm for the formation of emission centers is defined by the value of none-coulomb potential (NCP) which appears due to the substitution of the core ions by the IsIm in the dodecahedral and octahedral positions of the garnet lattice. The value and sign of this potential depends on: i) the ability of IsIm for the substitution of core cations in their regular positions of garnet host; ii) the difference ΔR of ionic radiuses for IsIm and core cation and iii) the variance between the core and electronic shells of IsIm and host cations. Namely, at reaching the critical value of NCP at ΔR≤0.12 Å, the IsIm and ADs such as La_Y or La_{Lu}, Y_{Al}, or Lu_{Al}, Sc_{Al}, and Sc_Y or Sc_{Lu} cause the formation of separated levels in the forbidden gap of garnets as centers for localization of host excitons and localization of the electrons or holes. The recombination of the free carriers from the conductive and valence bands with the electrons or holes, localized on the mentioned centers leads to radiative annihilation localized and bound with IsIm and ADs excitons and the appearance of the additional emission bands in the UV range as well as the trapping centers responsible for thermostimulated luminescence (TSL) and tunnelling luminescence (TL) of these materials in the 80-600 K range. Peculiarities of the luminescence and excitation energy transfer from the garnet host to the emission centers formed by IsIm and ADs have been studied in this work on the base of conventional spectral methods like cathodoluminescence (CL) at 300 K, as well as X-ray excited luminescence, TL and TSL spectra and TSL glow curves in the 80-600 K range. Furthermore, the time-resolved luminescent investigations of the SCs and SCFs of undoped and La^{3+} and Sc^{3+} doped YAG and LuAG garnets at 300 and 8K were performed at the Superlumi station at PETRA III storage rings at DESY, Germany under excitation by the pulsed synchrotron radiation (SR) in the 3.7-25 eV range. The mentioned energy range of SR covers the part of transmittance range, exciton range and onset of interband transitions of the respective garnet hosts. The obtained results are disscused in the light of creation of an effective UV emitting scintillation materials.

Acknowledgement: The investigations at UKW was performed in the frameworks of Polish NCN OPUS 24 LAP No 2022/47/I/ST8/02600 project and also supported by the Ministry of Science and High Education of Poland in frame of Regional Excellence Initiative nr RID/SP/ 0048/2024/01 project. The investigations at ARU were funded by Science Committee of the Ministry of Science and Higher Education of the Republic of Kazakhstan (Grant No. AP26100001). The investigations at DESY were performed in the frame of I-20240974 EC project.

References

1. Y. Zorenko, Phys. Stat. Sol. (c), 2 (2005) 375-379.

Modified urea-formaldehyde resins as dye adsorbents

Milena Marinović-Cincović*[1], Marija Krstić[2], Suzana Samaržija-Jovanović[3], Katarina Stepić[4], Slobodan Ćirić[4], Vojislav Jovanović[3], Tijana Jovanović[4]

[1] University of Belgrade, Vinča Institute of Nuclear Sciences - National Institute of the Republic of Serbia, Belgrade, Serbia
[2] University of Novi Sad, Faculty of Technology, Novi Sad, Serbia
[3] University of Priština in Kosovska Mitrovica, Faculty of Sciences and Mathematics, Kosovska Mitrovica, Serbia
[4] University of Niš, Faculty of Sciences and Mathematics, Niš, Serbia

https://doi.org/10.21175/rad.abstr.book.2025.16.12

One of the biggest environmental challenges worldwide that needs to be addressed is improving water quality, as water resources are becoming increasingly scarce due to population growth, climate change, and increased demand for water in industrial and agricultural activities. In addition, people's careless attitude when disposing of organic and inorganic pollutants can lead to irreversible damage to the aquatic environment and, consequently, to people. Dyes, phenolic compounds, metal ions, and micropollutants, such as pesticides, pharmaceuticals, and, more recently, plastics, are found in wastewater, surface water and even drinking water, indicating that conventional methods used in treatment plants are no longer sufficient for their removal. Consequently, the attention of the scientific community is focused on removing these highly toxic pollutants, even when they are present in low concentrations, by finding new ways and, above all, new materials. Aluminosilicates, such as clays, zeolites, bentonite, and montmorillonite, are commonly used as inexpensive adsorbents for environmental applications. All of them are used to improve various properties of polymer composites due to their high aspect ratios, which promote efficient interaction with the polymer at low concentrations, e.g. reduction of free formaldehyde in the polymer matrix. In addition, a significant number of research centers are focusing on their use for the reduction of pollutants in various systems, e.g. removal of various dyes from aqueous media. Chitosan, a cationic natural biopolymer derived from the deacetylation of chitin, has been extensively utilized for the adsorption of many dyes. The biopolymer chitosan is attracting considerable interest as a matrix for adsorbent material development, since this biopolymer has a high density of hydroxyl groups (–OH) and primary amines ($–NH_2$) that act as active adsorption sites, making it an efficient adsorbent. In this work, urea-formaldehyde (UF) resins modified with bentonite (BUF) and chitosan (CUF) were synthesized *in situ*. The synthesized materials were characterized using X-ray diffraction (XRD), Fourier transform infrared spectroscopy (FTIR), non-isothermal thermogravimetric (TG) analysis, differential thermal gravimetry (DTG), and scanning electron microscopy (SEM). We also investigated the adsorption characteristics of the new adsorbent materials: CUF and BUF on the anionic dye Acid Red 183 (AR183) and the cationic dye methylene blue (MB). The results show that CUF has no affinity for the adsorption of cationic dyes but adsorbs anionic dyes, while BUF exhibited good adsorption capacity for adsorbing cationic dyes. The effect of initial dye concentration and contact time were investigated. In the case of CUF, the adsorbent dose was 100 mg, and the initial concentrations of AR183 were 10, 20, 30, 40, and 50 mg/dm^3. The results showed that the percentage of dye removal (R%) increased from 94.92 % to 97.03 % with the increase of the initial concentration of AR183. R% also increased with contact time: from 35.07 % at 10 minutes to 97.03 % at 150 minutes. The calculations show that the maximum adsorption capacity (q_{max}) is 24.2571 mg/g (at pH 6.27 and temperature of 25^{o}C). In the case of BUF (adsorbent dose 50 mg, and same initial concentrations as for CUF), R% decreased from 100 % to 67 % with the increase in the initial concentration of MB. Of course, R% increases with contact time: from 30.43 % at 10 minutes to 98.10 % at 120 minutes. The maximum adsorption capacity is 33.4766 mg/g (at pH 7 and temperature of 25^{o}C). CUF effectively removes AR183, while BUF successfully removes MB.

Keywords: Urea-formaldehyde Resin, Chitosan, Bentonite, Adsorption

New antiviral composites based on self-assembled silver(I) coordination polymers

Sabina Weronika Jaros*[1], Julia Fiszer[1], Chris H. J. Franco[2], Barbara Bażanów[3], Alexander M. Kirillov[2], Piotr Smoleński[1]

[1] University of Wrocław, Faculty of Chemistry, Wrocław, Poland
[2] MINDlab: Molecular Design & Innovation Laboratory, Centro de Química Estrutural, Institute of Molecular Sciences, Departamento de Engenharia Química Instituto Superior Tecnico, Universidade de Lisboa, Lisbon, Portugal
[3] University of Environmental and Life Sciences, Wrocław, Poland

https://doi.org/10.21175/rad.abstr.book.2025.16.13

Coordination polymers (CPs) and metal-organic frameworks (MOFs) are important compounds known for their diverse and valuable properties, which make them increasingly relevant in drug delivery, medicinal chemistry, and antimicrobial materials. Microorganism contamination, especially of viral origin, has a significant impact on daily life and public health. For instance, the herpes simplex virus type 1 (HSV-1) affects nearly three-quarters of the population, either directly or indirectly. In another context, adenovirus 36 (Adv-36) has been identified as a potential factor to the development of obesity. These challenges underscore the need to invest in advanced materials capable of enhancing therapeutic strategies and preventing the persistence of pathogenic microorganisms on surfaces.

Here, we present novel blended biopolymer composites based on flax seed hydrogel and starch (FSH/ST), doped with silver(I)-based coordination polymers (abbreviated as Ag@FSH/ST). The self-assembly of silver coordination polymers (Ag-CPs) used as dopants, as well as the dimensionality of their structures (2D or 3D), can be tuned by adjusting the reaction temperature.These Ag@FSH/ST composites contribute to the expanding family of hybrid bioactive materials, offering promising potential for topical antimicrobial applications.

Funding acknowledgment: SWJ gratefully acknowledge the financial support from the National Science Center, Poland (Grant No. 2019/35/D/ST5/01155). AMK acknowledges the FCT (UIDB/00100/2020, LA/P/0056/2020, UID/00100/2023).

References

1. The Chemistry of Metal–Organic Frameworks: Synthesis, Characterization, and Applications (Ed. S. Kaskel), Wiley, 2016.
2. https://www.who.int/news-room/fact-sheets/detail/herpes-simplex-virus.
3. Jaros, S. W.; Krogul-Sobczak, A.; Bażanów, B.; Florek, M.; Poradowski, D.; Nesterov, D. S.; Śliwińska-Hill, U.; Kirillov, A. M.; Smoleński, P. Inorg. Chem. 2021, 60, 15435–15444.
4. Jaros, S. W.; Florek, M.; Bażanów, B.; Panek, J.; Krogul-Sobczak, A.; Conceição Oliveira, M.; Król, J.; Śliwińska-Hill, U.; Nesterov, D. S.; Kirillov, A. M.; Smoleński, P. ACS Appl. Mater. Interfaces 2024, 16, 13411–13421.

Peculiarities of luminescent oxyfluoride sol-gel nano-glass-ceramics doped with Ho^{3+}, Tm^{3+}, and Pr^{3+} ions

Natalia Pawlik*[1], Joanna Śmiarowska[1], Marta Kuwik[1], Maciej Zubko[2,3], Tomasz Goryczka[2], Wojciech Pisarski[1]

[1] University of Silesia, Institute of Chemistry, Katowice, Poland
[2] University of Silesia, Institute of Materials Engineering, Chorzów, Poland
[3] University of Hradec Králové, Department of Physics, Hradec Králové, Czech Republic

https://doi.org/10.21175/rad.abstr.book.2025.16.14

Lanthanide ions are promising optical dopants whose energy levels enable the generation of luminescence across broad spectral ranges from ultraviolet, through visible light up to infrared irradiation. Thus, such a tremendous spectrum of emitted wavelengths opens vast application possibilities for optical materials doped with Ln^{3+}, which could be successfully utilized, e.g., in optoelectronics for color screens or amplifiers operating in the telecommunication windows, for documents' anti-counterfeiting, optical thermometry, and bioimaging.

Among the various classes of optical materials doped with Ln^{3+} ions, many researches are devoted to the oxyfluoride glass-ceramics (OxGCs). Indeed, OxGCs are very attractive host materials because Ln^{3+} ions could be effectively incorporated inside the low-phonon energy fluoride crystals, significantly promoting the generated luminescence. Regarding OxGCs preparation, the unquestionable ascendancy falls for the sol-gel technique because the individual chemical reactions (i.e., hydrolysis of the metal/semi-metal alkoxide and (poly)condensation) are usually performed at relatively low temperatures, reducing the risk of fluorides evaporation, which makes the possibility to obtain particularly enhanced emission of Ln^{3+}. Thus, the crystal size and amount of precipitated fluoride phase within the sol-gel host, as well as effectiveness in the densification of the host matrix, play a decisive role in overall luminescence originating from optically active Ln^{3+} ions.

The main concept of this research was to prepare the series of sol-gel OxGCs doped with selected rare-earth ions, i.e., Ho^{3+}, Tm^{3+}, and Pr^{3+}, containing LaF_3 nanocrystals. The ATR-IR spectroscopy, XRD technique as well as TEM microscopy were used to determine the structural changes within the silicate sol-gel host and the crystallization of LaF_3 phase. The luminescence properties of the synthesized OxGCs were evaluated based on the excitation and emission spectra. Resultantly, the characteristic luminescence within red (Tm^{3+}: $^1G_4 \rightarrow {}^3F_4$), blue ($Tm^{3+}$: $^1D_2 \rightarrow {}^3F_4$), and green ($Ho^{3+}$: $(^5S_2,{}^5F_4) \rightarrow {}^5I_8$) light. The OxGCs doped with Pr^{3+} ions are able for simultaneous generation of multi-color emission at greenish-blue ($^3P_{0,1} \rightarrow {}^3H_4$, $^3P_{0,1} \rightarrow {}^3H_5$) and reddish-orange light regions ($^3P_{0,1} \rightarrow {}^3H_6$, $^1D_2 \rightarrow {}^3H_4$, $^3P_0 \rightarrow {}^3F_{2,3}$). Based on the obtained results, the chromaticity coordinates (x|y) were calculated and presented on CIE 1931 diagram. It was verified that appropriate combination of individual luminescence bands originated from Pr^{3+} ions makes an opportunity for emitting neutral or warm-toned white light. The quality of emitted light was examined by the correlated color temperatures (CCT) and color purity (CP). The obtained results suggest that fabricated sol-gel OxGCs doped with Ho^{3+}, Tm^{3+}, and Pr^{3+} ions could be predisposed for using as integral optical elements in RGB devices or white light emitters.

References

1. P.C. Ricci et al., *Crystals* **10** (2020) 559.
2. G. Tessitore et al., *RSC Adv.* **13** (2023) 17787-17811.
3. C. Zhang et al., *Dalton Trans.* **51** (2022) 3180-3187.
4. A. Puccini et al., *Nanoscale* **16** (2024) 10975-10993.
5. D. Li et al., *Adv. Sci.* **6** (2019) 1902042.
6. P.P. Fedorov et al., *J. Fluor. Chem.* **172** (2015) 22-50.

Production and study of thin films based on refractory metals WNbTa, WMoRe, TiWV(Mo, Zr, Nb), deposited on a substrate of Si

Alexander Pogrebnjak*[1], Arcadie Sobetkii[2], Yaroslav Babitski[3], Martin Kusy[4], Igor Gorlachev[5]

[1] Slovak University of Technology in Bratislava, Faculty of Material Science and Technology in Trnava, Institute of Materials, Trnava, Slovakia
[2] MGM Star Construct SRL., Bukharest, Romania
[3] Institute for Problems of Materials Science National Academy of Sciences in Ukraine, Lviv, Ukraine
[4] Slovak University of Technology in Bratislava, Faculty of Material Science and Technologyin Trnava, Trnava, Slovakia
[5] Institute of Nuclear Physics, Almaty, Kazakhstan

https://doi.org/10.21175/rad.abstr.book.2025.16.15

Metals with a high melting point are used in many applications, for example, alloying steels, to improve their properties, to protect against high temperatures during operation. That is, today they are in demand for various applications. In this work, films were obtained from refractory metals of 3 compositions (9 described in the title) using a magnetron at high power and a very low deposition rate. That is, today they are in demand for various applications. In this work, films were obtained from refractory metals of 3 compositions described in the title) using a magnetron at high power and a very low deposition rate. The films were deposited in a vacuum on three different substrates, a Si single crystal, glass and a titanium alloy (TiVAl), with a thickness of 200 to 300 nm. To analyze the films obtained by magnetron sputtering, the following methods were used: RBS, PIXE analysis to obtain profiles of elements along the film depth, AFM to analyze the surface morphology, micromechanical studies (analysis of nanohardness and modulus as well as ball wear along the film surface, XRD analysis of microstructure and phase composition, corrosion and microbiology.The highest hardness was found in the WNbTa film (13 Gpa), the lowest hardness was obtained in the WMoRe film, at the same time this film has the best antibacterial properties.

Acknowledgements: It was also funded by the NextGeneration EU through the Recovery and Resilience Plan for Slovakia under the project (grant numbers 09I03-03-V01-00026)

Pulsed laser fabrication technique: A sustainable solution for the production of carbon-based nanomaterials

Andrea Petanova, Marija Prosheva*, Jadranka Blazhevska Gilev

Ss. Cyril and Methodius University in Skopje, Faculty of Technology and Metallurgy, Skopje, North Macedonia

https://doi.org/10.21175/rad.abstr.book.2025.16.16

This investigation includes a direct and eco-friendly approach for fabrication of carbon-based nanostructures via pulsed laser deposition (PLD), a novel and cost-efficient technique[1]. The subsequent products exhibit significant potential for applications in multiple branches, such as electronics, sensor manufacturing and many other fields[2].

Two types of precursors, perylene tetracarboxylic dianhydride (PTCDA) and multi-walled carbon nanotubes (MWCNTs) combined with polyvinyl alcohol (PVA) as a binding agent, were utilized in the synthesis process. Thin films were deposited on different substrates in a vacuum environment, by optimizing the number of IR-ray pulses and were subsequently subjected to annealing in order to enhance their properties. The quality and structural properties of the deposited films were analysed using infrared (IR), ultraviolet-visible (UV-Vis) spectroscopy and Energy Dispersive X-Ray Spectroscopy Analysis (SEM-EDX) analyses, while their electrical properties were evaluated using the four-point probe method. Interestingly enough, the films obtained from both of the selected precursors revealed similar results from the characterizations, with MWCNT/PVA precursor's films demonstrating improved electrical performance post-annealing.

This study presents pulsed laser ablation as a promising, efficient, and sustainable method for carbon nanostructure fabrication, combining cost-effectiveness with material efficiency.

Keywords: Carbon nanostructures, pulsed laser deposition, eco-friendly, cost-efficient

Rate coefficients for H_2^+ ions in Ar gas

Željka Nikitović*, Zoran Raspopović

Institute of Physics, University of Belgrade, Belgrade, Serbia

https://doi.org/10.21175/rad.abstr.book.2025.16.17

Cold plasmas are often exploited in new technologies where they favorably offer non-intrusive production or modification of various substances. Understanding the plasma distribution, characteristics and phenomena is important for the development and optimization of plasma equipment for the production of semiconductor devices, such as etching and deposition tools. For this reason, plasma simulation is currently used in every phase of equipment design, development and improvement.

It was found that the sets of cross sections obtained by applying the Denpoh-Nanbu theory to H_2^+ ions during Ar collisions are in general qualitative and partially quantitative agreement with the data from the literature. The Monte Carlo technique was used to calculate the transport parameters. The calculated cross-sections can be used to obtain transport coefficients, drift velocity, mean energy, reduced mobility and specially rate coefficients for low and moderately reduced electric fields *E/N* (E-electric field strength; N-gas density) and to calculate non-conservative collisions.

Acknowledgments: The authors acknowledge funding provided by the Institute of Physics University Belgrade, through the grant by the Ministry of Science, Technological Development and Innovation of the Republic of Serbia.

Self-assembly silver nanoparticles for localized surface plasmon resonance in organic optoelectronics

Tetiana Bulavinets*[1], Oleksandr Bezvikonnyi[2], Bohdan Bulavinets[1], Khrystyna Ivaniuk[1], Dmytro Volyniuk[2], Pavlo Stakhira[1], Iryna Yaremchuk[1]

[1] Lviv Polytechnic National University, Lviv, Ukraine
[2] Kaunas University of Technology, Kaunas, Lithuania

https://doi.org/10.21175/rad.abstr.book.2025.16.18

Organic optoelectronic devices, such as organic light-emitting diodes (OLEDs), are attracting attention as new generation optoelectronic devices due to their advantages, including low cost, mechanical flexibility, and suitability for large-area fabrication. Although nearly 100% of OLEDs internal quantum efficiency has been achieved through the selection of emitter material and optimization of device architecture, the external quantum efficiency is still not high enough. The localized surface plasmon resonance effect of metal nanoparticles can be an effective way to enhance the light extraction generated by decaying excitons in the emitting layer and the absorption of incident light energy in the active layer. In this context, silver nanoparticles are a promising plasmonic material due to it strong plasmonic peak and light scattering effect. The main mechanism of increasing OLED efficiency with plasmonic nanoparticles is the use of localized surface plasmons, which arise in metal nanoparticles under the influence of light. In this case, efficiency improvements can be achieved by enhancing light-emitting processes, improving energy harvesting, or reducing non-monochromatic losses. The spectral characteristics can be controlled by tuning the plasmon resonance to wavelengths corresponding to the OLED spectrum, which provides better matching of the emission of the OLED active layer with the plasmon gain.

In this work, plasmonic silver nanoparticles were synthesized using a laser assisted wet chemical approach. The resulting nanoparticles were subsequently integrated into a classical OLED structure. In the study, silver nanoparticles were deposited directly onto an ITO substrate and covered with a thin film of MoO_3 (approximately 6 nm). The application of a hole-transport layer made it possible to prevent the degradation of organic materials due to contact with metal, as well as to minimize radiation losses by ensuring the optimal distance between the active organic layer and nanoparticles. The results obtained demonstrate the effectiveness of using plasmonic silver nanoparticles to enhance the optical properties of OLED structures by optimizing the interaction between localized surface plasmons and excitons. Further research will focus on a detailed analysis of the effects of nanoparticle size, shape, and concentration on the electroluminescent characteristics of the device, as well as studying the optimal architecture to improve the stability and efficiency of OLEDs.

We acknowledge the support of the European Union under Horizon Europe for the HELIOS project (Grant Agreement 101155017).

Silver nanoparticles for surface-enhanced Raman applications

Tetiana Bulavinets, Mariana Shepida, Khrystyna Ivaniuk, Ihor Helzhynskyy, Pavlo Stakhira, Iryna Yaremchuk*

Lviv Polytechnic National University, Lviv, Ukraine

https://doi.org/10.21175/rad.abstr.book.2025.16.19

Nowadays, plasmonic nanoparticles have attracted attention due to the significant improvement in the detection of Raman scattering signals from molecules adsorbed on rough metal surfaces. In the field of surface-enhanced Raman scattering (SERS), it is possible to record spectral signatures of even individual molecules. This phenomenon is partly explained by the significant enhancement of the electromagnetic field at the surface of metal nanoparticles, which actively interacts with the energy levels of adsorbed molecules. The shape, geometry of nanostructures, as well as the size and state of aggregation of the nanomaterial play a key role in the creation of the regions of local enhancement of the electromagnetic field. The localized surface plasmon resonance contributes to a significant enhancement of the electromagnetic field. Due to this, the intensity of the Raman signal of molecules located in these zones increases significantly. There are various approaches to improving the Raman signal of the studied substances.

In this work, the extinction cross-sectional spectra of silver nanoparticles under surface plasmon resonance conditions have been calculated using the quasi-dipole approximation, taking into account the influence of the substrate on which the nanoparticles are deposited. The calculations consider the nanoparticle size and the distance between the nanoparticles and the substrate surface. Numerical experiments have demonstrated that the substrate material's permittivity, on which silver nanoparticles are deposited, plays a key role in the design and fabrication of optical structures based on them. It was revealed that a substantial shift of the extinction cross-section peak and an increase in its magnitude at the operating wavelength are primarily driven by surfaces with a high dielectric constant. Based on theoretical research findings, SERS substrates were produced using galvanic replacing and wet chemical methods. Silicon and ITO served as the base materials. Experimental data confirmed that the fabricated SERS substrates are comparable in performance to commercial counterparts.

The work was carried out within the SERS project (state registration number 0124U000823).

1. Wang, X., Huang, S. C., Hu, S., Yan, S., & Ren, B. (2020). Fundamental understanding and applications of plasmon-enhanced Raman spectroscopy. Nature Reviews Physics, 2(5), 253-271
2. Schmidt, M. M., Brolo, A. G., & Lindquist, N. C. (2024). Single-molecule surface-enhanced raman spectroscopy: challenges, opportunities, and future directions. ACS nano, 18(38), 25930-25938.
3. William, R. V., Das, G. M., Dantham, V. R., & Laha, R. (2019). Enhancement of single molecule Raman scattering using sprouted potato shaped bimetallic nanoparticles. Scientific Reports, 9(1), 1077.

Artificial memory activated by neural network infrared transmission – An electronic model

Mihai Costache*

Alexandru Ioan Cuza University, Iași, Romania, Physics Faculty, 11 Carol I Blvd, Iasi, Romania

https://doi.org/10.21175/rad.abstr.book.2025.17.1

The brain is one of the most important organs in the body, playing an active role in virtually any reaction in the body, controlling memory, thinking, emotions, vision, hearing, motor skills, hunger, sleep, temperature of the body, etc. As part of the brain, the memory – whether long or short term – is very important, since not only reflects our ability to retain information and recall it later, but also can bring together with it the emotions associated with that information recalled from memory (the associative memory).

Unfortunately, around 25million people worldwide are affected by dementia (a syndrome associated with an ongoing decline of brain functioning – the most important decline being the short time memory), most of them suffering of Alzheimer's disease, with around 5 million new cases occurring every year, and the prognosis for the future is not encouraging: the number of people with dementia are expected to double every 20 years. That's why it is important, as a first step, to understand how the memory is working. For this reason I constructed a binary memory by using integrated circuits CDB 493 as a classroom demonstration, providing a better understanding of how the brain memory works.

In this paper I present the construction of this artificial binary 8 bits memory, being activated by an artificial neural network composed by 2 monostable transistor circuits by means of infrared electromagnetic transmission which emulates the synaptic transmission of the action potential of the biological neurons.

It is my hope that in the future, by using electronic circuits or certain materials with magnetic "memory" to bypass the damaged areas of brain/memory in order to restore the lost functions.

The first year experience of X-ray cabins for veterinary clinics

Sergii Miroshnychenko*[1], Oleksandra Miroshnychenko[2], Yurii Khobta[3]

[1] Teleoptika SPA, LLC, Kyiv, Ukraine
[2] State University „Kyiv Aviation Institute“, Kyiv, Ukraine
[3] Teleoptic PRC, LTD, Kyiv, Ukraine

https://doi.org/10.21175/rad.abstr.book.2025.17.2

A year ago, at the RAD 2024 conference, we drew the attention to the presence of overexposure of veterinary clinic personnel who manually fix the animal during X-ray examinations. Over the past year, we have clarified the reasons why clinic personnel do not pay attention to this problem. We have accumulated experience using the first two cabins in clinics. We modernized the cabins based on the recommendations of veterinarians.

X-ray digital technology has increased significantly the dose pressure in the clinic. Everything has become more humane: the animal is fixed on the X-ray table by the hands. There is a myth that the hands belong to the owner of animal and one X-ray examination cannot harm a person. In fact, according to legislative acts, a person who supports to fix cannot be lover 18 years of age and cannot be a woman lover 45 years of age. Until then, the fixation must be confirmed professionaly. That is why in most veterinary clinics animals are fixed by veterinary specialists, for which they charge an additional fee. Based on information on the Internet, this service costs $2.5...5 per X-ray photo. Up to 20 digital photos or more can be taken in one day. Then you can earn an additional $100 per day, and an additional $2000 per month. In order not to spoil this controversial discussion, let us return to the basic principle of ALARA: if it is possible to reduce the rate of exposer for a person, that needs to be implemented.

There is another myth: tighten up your individual equipment - an apron, eyepieces, a cap and gloves - and everything will be fine. Unfortunately, it’s not like that. The individual needs of the operator are very important; however, they are subject to the fact that the operator stands at a distance of 2...3 m from the X-ray tube. For this purpose, is extension of buttons whish swish on high voltage. For the personal, which fixes the animal, this is not at all. They are located under the influence of direct and diffuse X-ray.

The procedure for putting the cabin into operation consists of calculation protection of the cabinet. When reasonable completely concentrate all the protection on the cabin. It is possible to decrease the cost of installing elements in the cabinet. Then comes the experimental confirmation of the protection of workers. All stages exactly comply with the standards. It is particularly relevant during the expansion of health care during for veterinary clinics in high-rise residential buildings. This is allowed in some countries with the use of dental x-rays.

Experience in operating the cabins over the course of 1 year indicated the need to use high-quality gloves with double-sided protection. The cabins themselves do not significantly complicate the work, but provide reliable protection for the staff and visitors of the veterinary clinic.

An analysis of ionizing radiation medical examinations frequencies in the period 2017-2023

Olga Irina Girjoaba*

National Institute of Public Health, Bucharest, Romania

https://doi.org/10.21175/rad.abstr.book.2025.18.1

The study follows the evolution of the number of medical exposures to ionizing radiation, depending on the type of examination, in the period 2017-2023, corresponding to the new system for recording and reporting medical exposures implemented at national level in 2017, following the transposition into national legislation of the norms for recording, centralizing and reporting information on the medical exposure of the population to ionizing radiation, as part of the implementation program in Romania of the European Directive 2013/59/EURATOM.

The methodology, developed based on the above-mentioned norms, establishes the annual collection of the number of medical exposures performed depending on the type of diagnostic and interventional radiology procedure and diagnostic nuclear medicine procedure. For each radiological facility, data are collected by age and gender groups for each type of examination/procedure with ionizing radiation in accordance with the specific codings established at national level. The centralization of the collected data is initially carried out at the level of the hospital and subsequently at the county level, respecting the same specific codings, and the results at national level are centralized and managed by the National Institute of Public Health.

The results obtained based on data reported and centralized at the national level during the period 2017-2023 indicate a constant increase in the number of procedures performed, except for the period 2020-2021 in which a strong decrease in all examinations performed was noted, the cause being obviously the Covid 19 pandemic.

Analyzing the entire study period, the results from 2019 stand out, noting an increase of almost 20%, compared to the previous year, in the number of all types of diagnostic and interventional radiology procedures. The exception for 2019 is fluoroscopy procedures, which maintain the strongly decreasing trend observed in 2018 and which is otherwise maintained throughout the entire period analyzed, with a decrease of approximately 75% in 2023 compared to 2017.

In general, the number of conventional radiological examinations remains relatively constant, except for the period of the Covid 19 pandemic when it decreased sharply, but it far exceeds the number of computed tomography procedures and dental radiology examinations, although the latter two have a strong upward trend. In the case of mammography, the increasing trend observed in the period 2017-2019 is mirrored in the period 2021-2023, reaching in 2023 the values recorded before the Covid 19 pandemic period. Osteodensitometry and interventional radiology also maintain in 2022-2023 the trend observed in the period 2017-2019, with a slight but constant increase in the number of procedures.

The number of nuclear medicine procedures shows a 60% increase in 2019 compared to the previous year, this being due to the strong increase in the number of PET CT scans. During the Covid19 pandemic period, the number of conventional nuclear medicine procedures decreased, following the general trend, but the number of hybrid PET CT procedures continued to increase, a situation that was maintained after the pandemic period.

Assessment of the diagnostic value of the fine-needle aspiration and core needle ultrasound-guided biopsy of malignant tumors of the breast

Sharmazanova O.P.*, Fedulenkova Y.Ya., Shapovalova V.V.

National Technical University "KhPI", Kharkiv, Ukraine

https://doi.org/10.21175/rad.abstr.book.2025.18.2

The incidence and mortality from breast cancer (BC) in women over the past decade has continued to grow steadily in all countries of the world, reaching high numbers in recent years, and therefore the problem of breast cancer is acquiring social significance. Fine needle aspiration (FNA) and core needle biopsy (CNB) are the most common methods for obtaining morphological material from pathological formations and areas of the mammary gland. Verification of cancer using cytological and/or histological methods for examining punctate from a tumor is a necessary measure for any suspicion of a malignant process in the mammary gland. To predict the clinical course of the tumor process, response to treatment and outcome of breast cancer, great importance is attached to markers determined by immunohistochemical (IHC) methods. The need for preoperative morphological verification of the diagnosis is directly related to the introduction of neoadjuvant therapy methods into oncological practice, which has improved the five-year survival rates of cancer patients.

CNB was performed using an automatic biopsy system BARD (Germany) with a 16G needle. FNB was performed with a regular 20 ml syringe and 25G needle. Ultrasound examinations were carried out on an expert-class scanner Xario SSA-660A Toshiba (Japan) on the basis of the Expert-Kharkiv Medical Center.

125 case histories of patients with breast cancer were analyzed. All patients underwent FNB and CNB under ultrasound control, and cytological, histological and immunohistochemical examination of the material was performed. It was found that in 44 patients in whom atypical cells were not found in the biopsy specimen during FNB, a positive result was obtained during CNB. It was also noted that tumor size did not correlate with false-negative FNB results. An immunohistochemical study of the material revealed that 86 patients had tumor sensitivity to estrogen, 65 to progesterone, the estrogen-progesterone combination was also detected in 65 patients, and sensitivity to Herceptin was detected in 79 patients.

Conclusions: comparative assessments of FNB and CNB were carried out for the diagnosis and prognosis of treatment of breast cancer according to the following criteria: information content, the presence of complications, economic accessibility, the ability to predict the clinical course of the tumor process. It was found that in 99.2% of cases, a positive result was obtained with CNA, and despite the higher cost of this type of biopsy, it makes it possible to determine the receptor status of the tumor using IHC, which makes it possible to prescribe effective neoadjuvant chemotherapy, thus increasing the effectiveness of treatment and survival of patients with breast cancer.

Comparison of the average glandular doses displayed and measured in mammography systems: A phantom study

Wojciech Ciszek*, Aleksandra Woźnica, Marek Kijonka, Lukasz Kapek, Joanna Prazmowska, Beata Niewiadomska, Aneta Wajda, Bozena Wozniak, Adam Bekman, Jacek Wendykier, Andrzej Orlef, Maria Sokol

Maria Sklodowska-Curie National Research Institute of Oncology, Gliwice Branch, Poland, Gliwice, Poland

https://doi.org/10.21175/rad.abstr.book.2025.18.3

Introduction:

Mammography remains a cornerstone in early breast cancer detection, employing X-ray imaging for diagnostic and screening purposes. Average glandular dose (AGD) is the primary metric for quantifying ionizing radiation exposure during these procedures. Console-displayed AGD values are routinely used for dose comparison against diagnostic reference levels and European screening guidelines. This study critically evaluates the accuracy of these displayed AGD values by comparing them with the independently measured and calculated values, employing a phantom-based approach.

Materials and Methods:

Four mammography systems—Siemens Inspiration, Siemens Inspiration Prime, Hologic Selenia Dimensions, and GE Pristina—were evaluated. A poly(methyl methacrylate) (PMMA) slab phantom with spacer leaves was used to test the automatic exposure control system and the AGD values reported by the mammography units. The study covered equivalent breast thicknesses ranging from 2 to 9 cm. The displayed AGD values were compared with the independent measurements obtained using a calibrated RTI Piranha Black multimeter. The AGD values were calculated using the Dance formalism.

Results:

The discrepancies between displayed and measured AGD values were observed, with deviations not exceeding 25%. The largest deviations were observed for the smallest equivalent breast thicknesses among all mammography providers. The highest values of the differences were found in both Siemens systems.

Conclusions:

AGD values displayed on mammography consoles should be interpreted with caution. For an accurate and reliable dose evaluation, these values should be independently verified at least annually using a calibrated multimeter. Significant deviations in the displayed AGD values may require service intervention to ensure compliance with established radiation dose standards.

Effects of dose on OARs in ICRP pediatric phantoms in CT scan

Hande Unal*[1,2,3], Ismail Hakki Sarpun[1,2,4], Merve Arslan[1], Nigora Nizomova[1]

[1] Akdeniz University, Physics Department, Antalya, Turkey
[2] Akdeniz University, Faculty of Medicine, Radiation Oncology Dept., Antalya, Turkey
[3] Akdeniz University, Vocational School of Health Sciences, Radiaotherapy, Antalya, Turkey
[4] Akdeniz University, Nuclear Research and Application Centre, Antalya, Turkey

https://doi.org/10.21175/rad.abstr.book.2025.18.4

Computed Tomography (CT) use is increasing in radiotherapy clinics, despite the specific stochastic risks of low-dose ionizing radiation cannot be certainly determined. The most important quantity for estimating the risk from imaging procedures in pediatric patients is the radiation dose absorbed by OARs, which can be calculated by classical methods or by computer codes. The dose of OARs can be calculated in pediatric phantoms via National Cancer Institute Dosimetry System (NCICT). The NCICT code combines predefined ICRP reference pediatric phantoms with a Monte Carlo simulation of a reference CT scanner. In this way, it enables the calculation of OARs' doses by using pediatric phantoms of the desired ages for different predefined CT brands and models. In this study, a pediatric phantom whose age is 0, 1, 5, 10 and 15 years was used. The changes in organ doses for this phantom were investigated by NCICT. For this purpose, the x-ray tube current value was selected as 300 mAs and the tube voltage was 120 kV. It has been observed that the doses to selected organs and the effective dose change with phantom's age.

Investigation of the Effect of photon energy and number on dose in CT scan

Hande Unal*[1,2,3], Ismail Hakki Sarpun[1,2,4], Busra Yilmazer[1], Senanur Kutlu[1]

[1] Akdeniz University, Physics Department, Antalya, Turkey
[2] Akdeniz University, Faculty of Medicine, Radiation Oncology Dept., Antalya, Turkey
[3] Akdeniz University, Vocational School of Health Sciences, Radiaotherapy, Antalya, Turkey
[4] Akdeniz University, Nuclear Research and Application Centre, Antalya, Turkey

https://doi.org/10.21175/rad.abstr.book.2025.18.5

With the development of Computed Tomography (CT) technology, its use is increasing in other departments such as radiotherapy clinics, despite the risk of low-dose radiation. However, the specific stochastic risks of low-dose ionizing radiation cannot be certainly determined. Therefore, it may be necessary to estimate the radiation dose that patients are exposed to during a CT scan.

The most important quantity for estimating the risk from imaging procedures is the radiation dose absorbed by each organ, which can be calculated by classical methods or by computer codes. Various computer codes can be used to calculate patient organ doses. One of these codes is the National Cancer Institute Dosimetry System (NCICT), developed specifically for CT by Lee and colleagues. The NCICT code combines predefined ICRP reference pediatric and adult voxel phantoms with a Monte Carlo simulation of a reference CT scanner. In this way, it enables the calculation of organ doses by using adult phantoms of the desired height and weight or pediatric phantoms of different ages for different predefined CT brands and models according to gender. NCICT is a user-friendly code that also allows the tube voltage and current to be changed using an interface screen.

In this study, a male phantom with a height of 170 cm and a mass of 60 kg was used. The effects of changing both the photon energy and the photon number on organ doses for this phantom were investigated by NCICT. For this purpose, the x-ray tube current value was selected as 300 mAs and the tube voltage was changed between 90-150 kV in 10 kV steps to investigate the effect of photon energy. Similarly, the effect of the photon number was investigated by selecting the x-ray tube voltage as 120 kV and changing the tube current between 150-450 mAs in 50 mAs steps.

It has been observed that the doses to selected organs and the effective dose increase with both photon energy and photon number. As a result of the calculations, it was seen from the graphs drawn that the effect of photon energy on the dose is greater than the number of photons.

Possibilities of assessing the morphological and functional state of the liver using ultrasonography and computed tomography in patients with breast cancer during complex treatment

Fedulenkova Y.Ya.*, Sharmazanova O.P., Volkovskaya O.V.

National Technical University "KhPI"

https://doi.org/10.21175/rad.abstr.book.2025.18.6

Chronic diffuse liver disease remains a very serious socioeconomic, clinical and epidemiological health problem today. The viral hepatitis, alcohol, and the effect of various drugs on the liver are responsible for the majority of their development.

Due to the fact that chemotherapy used in the complex treatment of breast cancer has a pronounced toxic effect on the liver, the question of the leading method of assessing its morphofunctional state for timely correction of pathological changes is very acute, since interruption of the course of chemotherapy significantly reduces its effectiveness. In order to compare the informativeness of computed tomography (CT) and ultrasonography (US) in detecting early signs of diffuse liver pathology caused by cytotoxic effect of drugs, 120 case histories of women aged 24 to 75 years who underwent complex treatment were analyzed.

All patients were examined clinically, as well as by CT with contrast and US in duplex and triplex modes before and after the course of chemotherapy. The control group included 30 patients without liver pathology.

Detailed analysis of the data showed that CT with contrast showed pathologic changes only in 36 (30%) patients in the form of diffuse decrease in the density of the parenchyma, which is not a specific indicator. At US in 88 (73 %) patients decrease of linear and volumetric velocity of portal blood flow by 20-30 % was determined, as well as increase of resistance index and pulsatility index in splenic artery by 1.5-2 times, which indicates toxic effect on liver and deterioration of its functional state.

Conclusions: Both CT and US provide an opportunity to assess the macrostructure of the liver under pathological conditions, but only ultrasonography with the use of pulsed Doppler ultrasonography makes it possible to determine changes in linear and volumetric velocity of portal blood flow, which is crucial in the diagnosis of early manifestations of diffuse liver pathology. Ultrasonography is not accompanied by radiation exposure, which makes it possible to regularly monitor and correct the course of chemotherapy.

Ultrasonic and morphological comparisons in gunshot injuries to peripheral nerves

Svetlana N. Dubrovskikh*[1], Alexander V. Chursin[1], Alena V. Tatarina[1], Elmira Anvarovna Gumerova[1], Yulia A. Stepanova[2]

[1] National Medical Research Center of High Medical Technologies - Central Military Clinical Hospital named after A.A. Vishnevsky, Moscow region, Krasnogorsk, Russia
[2] A.V. Vishnevsky National Medical Research Center of Surgery, Moscow, Russia

https://doi.org/10.21175/rad.abstr.book.2025.18.7

To determine the echographic criterias that allow to establish the degree of nerve damage after a gunshot injury without neurotomy.
Material and methods. The results of a comprehensive study of 30 peripheral nerves after reconstructive surgeries were analyzed. The cause of nerve damage was a gunshot injury. The condition of the peripheral nerves was assessed using ultrasound (US) at the preoperative stage and intraoperatively. The postoperative material was microscopically examined. The US results were compared with the results of the histology. Of the 30 nerve trunks, 12 (40%) had signs of complete disruption of the anatomical integrity with the formation of terminal neuromas. In 18 (60%) nerves, there were signs of partial rupture of fibers. At the preoperative US the echostructure of the nerves changed from a slight disruption of the nerve fascicular structure to a complete loss of differentiation into fascicles with the formation of neuromas. Neuromas made up from 10 to 100% of the cross-sectional area (CSA). Histology of neuromas revealed areas of substitution perineural fibrosis with dystrophic changes in regenerating axons of varying severity. The following surgeries were performed to restore the nerves integrity: neurorrhaphy – 6 (20%), neurotransplantation – 15 (50%), intra-trunk neurolysis – 9 (30%). Depending on the depth and extent of the nerve trunk damage, we identified 3 groups of patients. Group 1: 12 (40%) nerve trunks with mild or moderate dystrophic changes. Intraoperatively, the external characteristics of the damaged area of the nerve didn't differ significantly from the healthy one. Neuromas involved up to 25% of the CSA of nerves, no more than 1.5 cm in length at intraoperative US. Neurolysis was performed in 9 cases, neurorrhaphy in 3 cases. Group 2: 7 (23%) nerves with pronounced degenerative changes. During the operation, the external characteristics of the nerve damaged area were different and stood out against the background of the healthy area of the nerve. Neuromas involved up 25 to 50% of the PPS of the nerve, length from 1.5 to 5.0 cm at intraoperative US, were operated on: 4 nerves – neurorrhaphy; 3 nerves - neurotransplantation. Group 3: 11 (37%) nerves with subtotal or total nerve damage. Such changes highlighted the nerve injured area, leaving no doubt about its damage during the operation. Neuromas replaced 50-100% of the PPS of the nerve, length of 5.0 cm or more: neurotransplantation was performed in 11 cases. With the intact nerve fascicular structure, most of its fascicles are morphologically unchanged or have moderately pronounced degenerative changes, not always noticeable macroscopically, which requires intraoperative US to exclude neuroma. Neuromas that make up to 25% of the entire PPS of the nerve, with a length of no more than 1.5 cm, are often subject to endoneurolysis. Thickening of individual or most of the fascicles, morphologically manifests itself as pronounced degenerative changes in the fascicles with substitution perineural fibrosis. The changes are not always noticeable macroscopically, which may require intraoperative US. With neuromas that make up from 25 to 50% of the entire PPS of the nerve with a pathological lesion length of up to 2.0 cm, neurorrhaphy will be required, more than 2.0 cm - neurotransplantation. The absence of the nerve fascicular structure is morphologically manifested by subtotal replacement of the nerve by perineural fibrosis with the formation of a neuroma, which is always manifested macroscopically and doesn't require additional intraoperative US. In the presence of a neuroma, performing from 50 to 100% of the entire PPS of the nerve and the length of the pathological focus up to 5.0 cm, neurorrhaphy is more often performed, more than 5.0 cm - neurotransplantation.

Using a mobile radiology team to improve the efficiency of medical care for the rural population

Yuliia Mykhaliuk[1], Andrii Pavlusenko[2], Oleh Lesyk[2], Yuliia Muravska[2]

[1] Primary Health Care Center, Dubrivka village, Zhytomyr region, Ukraine
[2] Baranivka Hospital, Baranivka city, Zhytomyr region, Ukraine

https://doi.org/10.21175/rad.abstr.book.2025.18.8

Primary care doctors working in rural areas are often unable to effectively use radiological diagnostic methods due to the remoteness of urban hospitals where such examinations are conducted. As a result, radiological diagnostics are unavailable or barely accessible for a significant portion of the population, which reduces the quality and effectiveness of medical care.

The aim of this work was to bring radiological diagnostics closer to patients by utilizing a mobile radiological team.

The Primary Health Care Center of the Dubrivka Village Council, in cooperation with the Baranivka Hospital of the Baranivka Village Council, organized the work of a mobile radiological team consisting of ultrasound diagnostics physicians and a digital X-ray system operator. The team was equipped with a lightweight digital X-ray diagnostic complex (KRDC-04-Alpha) and a portable ultrasound scanner (ORCHEO LITE). X-ray images were processed remotely by a radiologist.

Two field visits by the mobile radiology team were conducted, during which 148 X-ray and 22 ultrasound examinations were performed. Pathological findings were identified in 92 patients (62%) during X-ray examinations and in 9 patients (40%) during ultrasound examinations.

The results obtained from the mobile radiological team's work allow the following conclusions to be drawn:

- Performing radiological examinations on patients with medical indications and those in risk groups who have limited ability to travel to urban hospitals enabled the detection of a significant number of pathologies, including first-time diagnoses, and the provision of timely medical care.
- The use of a mobile radiological team equipped with modern portable digital X-ray and ultrasound equipment made it possible to provide high-quality and effective medical care to patients living in remote areas.
- Conducting radiological examinations at the primary care level allows for on-site diagnosis without referring patients to higher-level medical institutions, thereby improving the quality and efficiency of medical care for the population that most frequently accesses primary healthcare facilities.

Comparison of thoracic spine images of digital radiography and tomosynthesis mode

Oleksandra Miroshnychenko*[1], Sergii Miroshnychenko[2], Yurii Khobta[3], Andrii Nevgasymyi[3]

[1] Kyiv Aviation Institute, Kyiv, Ukraine
[2] Teleoptika SPA, LLC, Kyiv, Ukraine
[3] Teleoptic PRC, LTD, Kyiv, Ukraine

https://doi.org/10.21175/rad.abstr.book.2025.18.9

The war in Ukraine significantly changed the profile of the spread of diseases and injuries. There is a long list of diseases and injuries accompanying military operations, ranging from mental disorders to shrapnel wounds. Both the civilian population and the military suffer from them. Standard military equipment on the front line includes body armor and other accessories. Depending on the level of protection, the weight of the protection worn by a serviceman may exceed 20 kg. This leads to the development of various diseases of the spine, which must be diagnosed during routine or emergency medical examinations. According to information from the Ministry of Defense of Ukraine, the average age of a combatants is more than 40 years. Because of this, most military personnel have chronic diseases, which must be taken into account when assigning positions. The most common diseases of the spine are: osteochondrosis, scoliosis, hernia, protrusion and compression fractures of the vertebrae.

X-ray diagnostics is the most widespread method. The simplicity and relatively low price of the examination procedure has led to the fact that most hospitals have basic X-ray machines. Resolution of the digital radiography reaches 5 lp/mm. However, the disadvantage of this method is the low diagnostic sensitivity of 0.4 - 0.7, depending on the object of research. Radiography does not allow creating cross-sectional visualization. Thus, the patient should be referred to a further study with higher diagnostic sensitivity and cost: computed tomography or magnetic resonance imaging. Given the large flow of patients at the military medical commission, many patients remain underexamined.

Resolution of digital tomosynthesis has an intermediate value of 2 lpl/mm and allows visualization of most pathology. At the same time, dose load for digital tomosynthesis does not exceed 0.4 mSv and thus corresponds to the principle ALARA. The sensitivity of digital tomosynthesis is more than two times better than that of digital radiography (0.92), but it is about 8% worse than that of computed tomography (0.98)

34 cases of frontal radiographs and series of tomosynthesis sections of the same patients were studied. It was noticed that, depending on the location of the vertebra, the effectiveness of the use of tomosynthesis images compared to radiography varies. When using tomosynthesis, the average contrast of the vertebra to surrounding tissues on the slices in the focus ranges from 0,14 to 0,38. Thus, the contrast of tomosynthesis is to 1,26 - 4,86 times bigger than for radiography. The digital tomosynthesis module can be installed on a standard basic x-ray system and thus the equipment has 2 research methods, so if there is doubt about the diagnosis, the patient can be examined right there on the spot.

A mechanistic approach to predict the probability of complication in the rat spinal cord following particle irradiation

Alice Casali*[1,2], Aurora Madonnini[1], Ricardo Luis Ramos[2], Francesca Ballarini[1,2], Mario Pietro Carante[1,2]

[1] Università degli Studi di Pavia, Pavia, Italy
[2] INFN, Sezione di Pavia, Pavia, Italy

https://doi.org/10.21175/rad.abstr.book.2025.19.1

The current hadrontherapy treatment-plans are based on constraints related on physical quantities and on the optimization of the distribution of absorbed dose within the patient. However, incorporating biologically related models of Normal Tissue Complication Probability (NTCP) would help further minimizing adverse tissue reactions, and would allow achieving a more patient-specific strategy. The aim of this study is to develop a mechanistic approach to directly predict clinical outcomes, specifically NTCP for late tissue reactions following ion irradiation [Casali et al., Phys. Med. Biol. 69 245012, 2024].

The considered NTCP model is the Critical Element Model, which is based on the concept of Functional SubUnits (FSUs) and the serial architecture of the organ [Withers et al., Int. J. Rad. Oncol. Biol. Phys., 14:751-759, 1988]. This model involves two tissue-specific parameters, as well as two radiation-dependent parameters: the α and β coefficients of the Linear-Quadratic cell survival model. The model was employed to fit experimental data on rat spinal cord tolerance following photon irradiation with 1, 2, 6 and 18 fractions, with the same set of parameters for every fractionation scheme. The considered endpoint was the onset of paresis of grade II following irradiation. The fit allowed to determine the two parameters that only depend on the tissue features and the α and β coefficients for photon irradiation. Based on the photon α and β parameters, the biophysical model BIANCA [Casali et al., Phys. Med. Biol. 69 245012, 2024], coupled with the GEANT4 transport code, was used to generate a database of α and β values as a function of particle type and LET (Linear Energy Transfer) values. An interface between BIANCA and GEANT4 was developed to obtain the α and β values for mixed fields. Thus, the irradiation conditions of the experimental SOBP (Spread Out Bragg Peak) were reproduced with GEANT4 (in collaboration with the GEANT4-INFN project).

Subsequently, the model was applied to NTCP curves of spinal cord tolerance following irradiation with ions of different LET values: carbon ions (13 - 125 keV/µm), helium ions (2.9 – 20.7 keV/µm) and protons (1.4 – 5.5 keV/µm). The tissue-dependent parameters were kept fixed as determined by the photon fit, while the α and β values were predicted by BIANCA. Importantly, the model no longer required free parameters to be adjusted, thus the simulations were full predictions. Therefore, the predicted NTCP curves for ion irradiation were tested against the ion experimental data, by performing a statistical analysis. The model showed a good predictive power, as assessed by a Chi-Square test. Indeed, the model passed a significance test at 5% for most of the datasets.

This study represents a first step towards a novel approach, based directly on the prediction of clinical outcomes, to improve treatments plan optimization and evaluation in hadrontherapy, allowing for more effective and personalized therapies. To this aim, the approach needs to be extended to other endpoints and to be applied to patient's data.

An investigation of the absorption of lead (Pb) through skin with hair using synchrotron x-ray techniques

Helen Melino*[1], Lisa Bhatia[1], Kirstin Davidson[1], Viorica (Ibi) Bondici[2], Sebastian Schoeder[3], Michael Farquharson[1], Fiona McNeill[1]

[1] McMaster University, Hamilton, Canada
[2] Canadian Light Source, Saskatoon, Canada
[3] Synchrotron Soleil, Paris, France

https://doi.org/10.21175/rad.abstr.book.2025.19.2

Recent μXRF (micro-x-ray fluorescence) data from our research group has shown that inorganic lead can be absorbed through the skin more readily than previously recognized. Here, we present the first μXRF images of lead uptake in the sweat glands and hair follicles of skin and show lead binding to hair.

Lead acetate (used historically in hair dyes and cosmetics) was applied to the outermost layer of pig skin (the epidermis) and allowed to diffuse through the skin layers into a receptor solution for various time periods using a traditional Franz cell diffusion set-up. The receptor solution was analyzed by ICP-MS to determine the concentration of lead passing through the skin layers. The skin samples were prepared by flash freezing and microtoming for cross sectional μXRF imaging at the Canadian Light Source (CLS, Canada) and Synchrotron Soleil (France) using the BioXAS Imaging and PUMA beamlines, respectively. At each synchrotron facility, μXRF imaging was performed using a focused monochromatic x-ray beam (13.45-13.5 keV) on the skin samples. Samples were rastered in continuous bidirectional-flyscanning mode at 5 μm or 20 μm step size. XRF images were generated from the x-ray fluorescence spectra collected at each pixel by the silicon drift detector positioned 90 degrees to the incident beam. Elemental distribution maps were deconvoluted from the sum of spectra using the PyMCA softeware and XRF signals corresponding to the lead L-series were further analyzed to determine the path of lead through the skin.

At the CLS, a sample of skin with the underlying fat layer was imaged. The data shows strong evidence of the diffusion of lead through the skin layers into the fat, with specific uptake in cells within the epidermis and in sweat glands.

The observed accumulation of lead in the sweat glands led to addition diffusion experiments using pig skin with hair, since hair follicles are often associated with sweat glands anatomically. These samples were imaged at Synchrotron Soleil, where skin samples with hair showed a different pattern of diffusion compared to hairless pig skin. For skin with hair, a lead diffusion gradient from the skin surface into the deeper skin layers is present in areas where hair is absent and is minimal in areas where hair is present. Lead uptake was also seen in the hair shaft of the pig skin in cases of long diffusion times, but mainly in the hair cuticle. This is supported by μXRF images obtained from lead-treated human hair embedded in resin, which showed little-to-no lead uptake within the hair cortex, with high levels of lead uptake in the cuticle and medulla.

Diffusion data from ICP-MS analysis for samples of skin with hair show a decrease in the concentration of lead in the receptor solution compared to hairless skin. These data combined with the information from the μXRF maps showing binding to hair and less diffusion at hair follicles suggests that the presence of hair reduces the diffusion of lead through the skin and alters the uptake of lead by skin.

Anthropomorphic breast phantom production with 3D printer technique to find more accurate factors for average glandular dose calculation

Aziz Safi*[1], Haluk Yücel[2]

[1] İstanbul Gedik University, İstanbul, Turkey
[2] Ankara University, Ankara, Turkey

https://doi.org/10.21175/rad.abstr.book.2025.19.3

According to World Cancer Research Fund International, breast cancer is the 2nd common cancer type worldwide and 1st type among women. To diagnose breast cancer, mammography (MG) and digital breast tomosynthesis (DBT) are commonly preferred imaging methods. Radiotherapy is one of the treatment methods of breast cancer and in case of radiotherapy is preferred, breast computed tomography (B-CT) is taken for breast contouring which is essential for radiotherapy. Mammography (MG), digital breast tomosynthesis (DBT) and breast computed tomography (B-CT) are medical imaging techniques using ionizing radiation. During the MG, DBT and B-CT scan, the patient is exposure to ionizing radiation and determining the correct radiation dose is crucial for both correct imaging of breast and avoiding side effects of radiation to the patient. Determination of the correct dose for diagnosis is called dose optimization. For dose optimization, medical imaging devices are calibrated via phantoms. Phantom is a device that mimicking real patient tissues on radiosensitivity. Formerly, phantoms were made of water, as the human body mainly consists of water. Then, epoxy or PMMA based phantoms are used due to the water is not perfect material for mimicking human tissue. Epoxy or PMMA based phantoms are better at mimicking soft tissue and bone tissue but not enough for breast due to the breast is formed by heterogeneous distribution of glandular and adipose tissues. Heterogeneity of glandular and adipose tissues, glandular and adipose tissue percentage (%G/A), vary with race and age of women. Due to the radiation dose absorbed by glandular tissue is dependent on the glandular tissue percentage, it is essential to develop breast phantom specific to glandular and adipose tissue percentage (%G/A) for better radiation dose optimization. The aim of this study is to develop anthropomorphic breast phantoms specific to Turkish women at different age intervals. In previous study, %G/A ratios for Turkish women at different age intervals are determined and epoxy-based phantoms were produced for each age interval. Those phantoms assumed the glandular and adipose tissues are distributed homogeneously contrary to real breast. The aimed more realistic, anthropomorphic phantoms will consist of three different materials mimicking three different tissues. A FDM type 3D printer with dual nozzle is going to be used for producing glandular and adipose tissues; an SLA type 3D printer is going to be used for skin. By this way, development of phantom mimicking breast better than epoxy-based one is the goal of the study. At first step, the materials and filling ratios mimicking best each three tissues will be determined. By using PVA, TPU, ABS, PLA and PET type filaments, cubic samples will be produced with filling ratios between %50 and %100. Physical density, HU value, effective atomic number, HVL values for each sample will be determined and the filament types and filling ratios closest to real tissues will be chosen to produce phantom. Anonymous B-CT images of breast with specific %G/A ratios will be base for design of phantoms. The phantoms will have cavities for placing point detectors to measure the glandular dose during the CT scan. After all the phantoms will be produced, the phantoms will undergo CT scan and during the scan, glandular dose and tissue entrance dose will be measured via appropriate detectors. Via finding the relation between skin entrance dose and glandular dose, it is aimed to determine more accurate factors for Dance's equation for calculation of glandular dose.

This study is being supported by TÜBİTAK with project code 224S843 in the scope of 1002-A Fast Support Program.

Comparison of patient specific quality assurance (PSQA) results for trigeminal neuralgia (TN) patients receiving CyberKnife stereotactic radiosurgery

Aleksandra Woznica*, Joanna Prazmowska, Marek Kijonka, Bozena Wozniak, Lukasz Kapek, Beata Niewiadomska, Adam Bekman, Jacek Wendykier, Aneta Wajda, Andrzej Orlef, Maria Sokol

Maria Sklodowska-Curie National Research Institute of Oncology, Gliwice, Poland

https://doi.org/10.21175/rad.abstr.book.2025.19.4

Trigeminal neuralgia (TN) is a chronic condition that causes severe, shock-like pain on one side of the face. In its most severe form, it can be so debilitating that it is often referred to as the "suicide disease." The first-line treatment for TN is medication, but if symptoms persist despite medication, surgical options are considered. CyberKnife (CK) stereotactic radiosurgery (SRS) is an effective treatment that targets and destroys specific trigeminal nerve fibers using multiple precisely-shaped beams of ionizing radiation from a linear accelerator mounted on a robotic arm. Treatment utilizes a fixed 5 mm diameter circular collimator, targeting the nerve root entry zone or cisternal segment. Given the small target volume and the proximity to the brainstem, ensuring geometric and dosimetric precision is critical for the successful delivery of radiation therapy.

Aim: This study compares the PSQA results for patients receiving CK SRS. The measurements of the dose distributions were conducted using two dosimetric systems: Gafchromic EBT3 film dosimetry and an SRS MapCheck diode array inserted into a StereoPhan phantom.

Materials and Methods: The SRS MapCheck was inserted into the StereoPhan, a dedicated PMMA phantom for dose distribution verification. Both relative array calibration (for detector sensitivity) and absolute dose calibration (converting measurement counts to an absolute dose) were conducted according to the manufacturer's protocols. The software functionality allows for implementing temperature, beam angle, field size, and dose rate corrections. The Stereotactic Dose Verification phantom, made up of blue water slabs, allows for precisely positioning a 5 x 5 cm2 EBT3 film in its exact center during the dose distribution measurements. The dose-response curves were fitted in the range from 0 to 5 Gy to the function X(D)= (A + BD) / (D + C), where X(D) represents film response value on the dose D, and A, B, and C are constants. The Epson V850 Perfection scanner, working in a transmission mode, was used to acquire 48-bit RGB images at a resolution of 72 dpi. The so-called “One San” recalibration protocol was followed to convert from PV to the dose. For each dose distribution, three film pieces were used: one applied in the measurement, an unexposed one, and a piece exposed to a known dose. The expected dose distributions in the film and detector array planes were calculated by overlaying the patient specific plan generated in the Precision Treatment Planning System (TPS) onto computed tomography scans of the verification phantoms. Gamma index analysis was conducted using SNC Patient software for the SRS MapCheck and FilmQA Pro for the EBT3 film dosimetry system to assess the agreement between the planned and measured dose distributions.

Results: All treatment plans validated with the SRS MapCheck met the established acceptance criteria, achieving global gamma passing rates exceeding 95% with the 3%/1 mm criterion and a threshold of 10%. For all PSQA measurements verified using the film dosimetry system, the global gamma passing rates also consistently exceeded 95% when applying a 3%/1 mm criterion and a 10% threshold.

Conclusion: Both Gafchromic EBT3 film dosimetry and the SRS MapCheck diode array provide reliable and effective methods for routine pretreatment verification in CyberKnife stereotactic radiosurgery. While the SRS MapCheck dosimetry system demonstrated superior agreement between planned and measured dose distributions, the high spatial resolution, tissue equivalence, and independence from beam angle, energy, and dose rate make the EBT3 Gafchromic film dosimetry system a valuable tool in the dosimetric validation process. The measurements confirmed the dosimetric and geometric correctness of the CK SRS treatment administered to patients suffering from TN.

Composite hydrogels as tissue

Veselina Georgieva*[1,2], Georgi Tankovski[1], Nikoleta Traikova[2], Yordan Marinov[3], Ginka Exner[1], Elizabet Dzhambazova[4]

[1] Faculty of Physics and Technology, Plovdiv University Paisii Hilendarski, 24 Tzar Asen Str., Plovdiv, Bulgaria
[2] UMBAL St. Georgi, 66 Peshtersko Shose Blvd., Plovdiv, Bulgaria
[3] Georgi Nadjakov Institute of Solid State Physics, Bulgarian Academy of Sciences, 72 Tzarigradsko Chaussee Blvd., Sofia, Bulgaria
[4] Faculty of Public Health at Medical University of Plovdiv, Plovdiv, Bulgaria

https://doi.org/10.21175/rad.abstr.book.2025.19.5

Medical phantoms gain considerable attention in last decades when improving the educational process towards better outcomes or testing the possibilities and limits of existing and newly appearing medical diagnostic modalities. On the market there are a number of physical phantoms for equipment calibrations and some anthropomorphic phantoms used for educational purposes and dose measurements. The common feature for all phantoms is to mimic specific physical characteristics of the real biological tissues, chosen depending on the particular application. Commercial phantoms are important and they are well suited for standard tests but they fail when more specific investigations are required. Therefore, the development of materials for case-specific medical phantoms is necessary. This specificity requires easy and eco-friendly design with a simple route to modify and tune the final properties. Such are for instance gelatin-based composite hydrogels.

In the present study we report the design of gelatin hydrogels with several additives (collagen and baking soda, psyllium husk and glass microbubbles). Their potential as tissue mimicking materials in diagnostic imaging is discussed by comparing their Hounsfield units with such for real biological tissues. The results show that such materials cover the range from soft tissues to some bones. The mechanical performance was also monitored, so that the hydrogels can be successfully mechanically manipulated during usage. The observed properties and their differences are discussed with respect to their morphology, as revealed by scanning electron microscopy.

Acknowledgement: This work was supported by the Ministry of Education and Science of Bulgaria (MESB), through the National Research Fund of Bulgaria (research project "Liquid crystal nanocomposites for applications in photonics, sensors and biomedicine", No. KP 06 N58/6/2021).

1. V. Georgieva, N. Traikova, G. Exner (2024) Low-budget gelatine-based hydrogels for computed tomography tissue mimicking phantom materials, Rentgenologiya i radiologiya, LXIII(4), 221-227
2. V. Georgieva, G. Tankovski, N. Traikova, G. Exner (2025) Effect of different fillers on hydrogels for application as tissue-substitute materials in Computed tomography, J. Phys. Conf. Ser., 2952, 012014, doi:10.1088/1742-6596/2952/1/012014
3. G. Tankovski, V. Georgieva, N. Traikova, G. Exner (2025) Engineering the mechanical and X-ray attenuation properties of gelatine composite hydrogels with a potential for tissue mimicking materials, J. Phys. Conf. Ser., 2952, 012015, doi:10.1088/1742-6596/2952/1/012015

Estimation of fetal dose for Tena phantom in abdominal radiography using MCNP code

Dragana Krstic*[1], Dario Faj[2,3], Hrvoje Brkić[2,3], Željko Cimbaljević[1], Milena Živković[1], Marija Jeremić[4], Ana Krstić[5], Nicolas Arbor[6], Paolo Ferrari[7], Christelle Huet[8]

[1] University of Kragujevac, Faculty of Science, Department of Physics, Kragujevac, Serbia
[2] Faculty of Medicine, Osijek, Croatia
[3] Faculty of Dental Medicine and Health, Osijek, Croatia
[4] University Clinical Center, Kragujevac, Serbia
[5] KVARK doo, Kragujevac, Serbia
[6] University of Strassburg, Strassburg, France
[7] ENEA – Radiation Protection Institute, Bologna, Italy
[8] IRSN, The Institute for Radiological Protection and Nuclear Safety, Fontenay-aux-Roses, France

https://doi.org/10.21175/rad.abstr.book.2025.19.6

Pregnant females who have health issues that require abdominal radiography could be exposed to radiation that can affect the fetus's health if the radiography procedure is not well-optimized. Fetuses are highly susceptible to ionizing radiation, and special attention is needed to ensure the maximum safety of the fetus from radiation. Numerical simulations with an appropriate phantom are used to evaluate and optimize radiation doses without risking patients' health.

Purpose: In this study, the Monte Carlo simulation of abdominal radiography was conducted using the pregnant female computational phantom TENA.

Methodology: Numerical simulation was performed using Monte Carlo MCNP6.3 software. The case of abdominal radiography was simulated according to a realistic scenario on a Tena phantom. The field size of abdominal radiography imaging was 42.4 cm x 34.7 cm. The detector was put behind the patients' abdomen. The distance of the source (the X-ray spectra) from the table was 114 cm, while the distance of the source from the detector was 120.1 cm. Calculation was normalized to the air kerma on detector placed 70 cm from the source.

Results: Estimated fetal dose obtained by Monte Carlo simulation, normalized to entrance kerma, was 0.595 mGy with an uncertainty below 1%.

Conclusion: This study showed that the TENA phantom can be used to estimate fetal doses from beams used in diagnostic or interventional radiology. Using the TENA phantom for estimating fetal doses from beams utilized in diagnostic or interventional radiology has direct clinical implications.

Acknowledgments: This study was supported by the Serbian Ministry of Education, Science and Technological Development (Contract No. 451-03-136/2025-03) and PIANOFORTE SONORA project (Réf. IRSN: LW Contrat 2024-0032).

Keywords: Tena pregnant phantom, abdominal radiography, Monte Carlo MCNP code

GAMMA-MRI: Revolutionizing medical imaging with radioactive hyperpolarized xenon

Stavroula Pallada*, Anastasios Kanellakopoulos, Quentin Rogliardo, Ashley Cooper

University of Applied Sciences and Arts Western Switzerland, Geneva, Switzerland

https://doi.org/10.21175/rad.abstr.book.2025.19.7

Introduction: GAMMA-MRI aims to bring innovation in clinical molecular imaging by developing a new imaging modality based on the physical principle of anisotropic gamma emission from hyperpolarized isomers of xenon. To mitigate the low signal detection sensitivity of MRI, a radioactive gamma-emitting isotope is used as a contrast agent, with gamma energy comparable to that of 99mTc (Eγ=140 keV), a widely used medical radioisotope in nuclear medicine imaging techniques.

Methods: The GAMMA-MRI relies on detecting the asymmetric gamma emission from long-lived isomers of a radioactive noble gas nucleus with spin I>1/2. For gamma-ray anisotropy to be observed, the radioactive nuclei must be polarized via Spin Exchange Optical Pumping (SEOP), a hyperpolarization technique already applied in clinical lung perfusion studies [1].

The long-lived xenon isomers studied in this project, 129mXe ($T_{1/2}$=8.88 d, Eγ=236.1 keV) and 131mXe ($T_{1/2}$=11.84 d, Eγ=163.9 keV), were produced via neutron activation in ILL (Grenoble, France) and the MARIA reactor (Warsaw, Poland) [2].

Once purified from potential Rb oxidation contaminants, the radioactive mXe isomers are introduced to a SEOP glass cell containing natural rubidium (Rb). The cell is filled with a mixture of Rb, mXe, N_2, and occasionally He, and then it is placed at the center of a custom built SEOP oven and within a 1- 6 mT B_0 magnetic field generated by Helmholtz coils. Heating the oven above 40 oC (Rb melting point) creates Rb vapors, and laser irradiation (QCP diode laser, 795 nm) initiates optical pumping, inducing atomic polarization in Rb. Spin exchange between Rb atoms and mXe nuclear spins results in hyperpolarized (HP) mXe. During radioactive decay, HP mXe emits gamma photons anisotropically, preferentially perpendicular to the B_0Z axis. Multiple CsI(Tl) gamma detectors (2-8) surrounding the glass cell record gamma count asymmetries between transversal and longitudinal planes.

Results: A fully automated SEOP system has been developed, incorporating temperature control and active oven cooling to precisely regulate SEOP parameters, maximizing gamma asymmetry and, consequently, the polarization of mXe nuclei. A GAMMA-MRI H-shaped prototype magnet has been designed to accommodate a 3 x 3 x 3 cm3 imaging object for in vitro and in vivo applications. To facilitate repeated in vitro experiments, the SEOP system has been integrated into the GAMMA-MRI prototype, enabling continuous polarization before and after the application of RF pulses for GAMMA-NMR or MRI acquisitions. SEOP of 129mXe and 131mXe achieved a maximum polarization of P=30%. The T1 relaxation time of 131mXe was measured under different buffer gas mixtures and B_0 field strengths, with values in the minute range.

We are now one step closer to obtaining the first GAMMA-MRI image using the GAMMA-MRI prototype with radioactive mXe.

References

1. S Khan et al. Angewandte Chemie, 60, 41 (2021), doi:10.1002/anie.202015200
2. M. Jerzy Chojnacki et al, Applied Radiation and Isotopes, 205, (2024), doi:10.2139/ssrn.4575330

Investigation of the effect of different silver concentrations on dose distribution in radiotherapy: A Monte Carlo Study

Osman Vefa Gul*[1], Turan Sahmaran[2]

[1] Selcuk University, Faculty of Medicine, Department of Radiation Oncology, Konya, Turkey
[2] Kırıkhan Vocational School, Hatay Mustafa Kemal University, Hatay, Turkey

https://doi.org/10.21175/rad.abstr.book.2025.19.8

Purpose: Silver nanoparticles (AgNPs) have been intensively investigated in recent years to increase the sensitivity of tumour cells in radiotherapy. These nanoparticles may potentiate therapeutic efficacy by increasing sensitivity to radiation, especially in cancer cells. In this study, the effect of different concentrations of AgNPs in the radiotherapy beam field on the percentage depth dose (PDD) was investigated using Geant4-based GATE Monte Carlo (MC) modelling technique.

Material and Methods: Values were obtained using spectrum photon energies of 6 and 18 MV in the GATE simulation programme. Target volumes containing different concentrations of silver were centred on the target surface to match the source position. These simulations consisted of 5 different silver concentrations (0, 5, 10, 20 and 30 mg/g). A lead collimator block was placed between the source and target to create a radiation field of 5x5, 10 × 10, 15x15 and 30x30 cm2 on the target surface, respectively. The setup was adjusted so that the distance between the beam centre and the target surface was 100 cm. Using 6 and 18 MV photon beams, PDD was obtained from 1 cm depth to 20 cm depth in 5x5, 10 × 10, 15x15 and 30x30 cm2 radiation fields for 5 different silver concentrations.

Results: When the dose distribution at 1 cm depth in tissue equivalent medium exposed to 6 MV photon energy and 5x5 cm2 beam area was compared with 0 mg/g, the % difference was 1.97, 1.88, 1.71 and 2.80 for 5, 10, 20 and 30 mg/g silver concentration, respectively. For similar AgNP concentration for 10x10 cm2 area and 1 cm depth, this difference was 2.06%, 0.33%, 2.08% and 1.76%, respectively. When the dose distribution at 1 cm depth was compared for 0 mg/g and 20 mg/g silver concentration in the environment exposed to 18 MV photon beam, 6.30%, 1.45%, 3.49% and 3.21% were found for 5x5, 10 × 10, 15x15 and 30x30 cm2 areas, respectively. It was observed that there may be changes in the dose distribution depending on the AgNP concentration of the photon beams used in radiotherapy. This indicates that higher doses can be achieved in the target volume by adding AgNP to the tumour.

Conclusions: The combination of AgNPs with radiotherapy has the potential to provide a more effective treatment at lower doses. Since the dose distribution in the target volume depends on the number of particles delivered, more realistic studies are needed in this regard. In the future, this technology is expected to be used more widely in cancer treatment.

Keywords: Radiotherapy, silver nanoparticle (AgNP), percentage depth dose (PDD)

Patient dose analysis in Total Skin Electron Irradiation procedure using Gafchromic films

Bożena Woźniak, Beata Niewiadomska*, Adam Bekman, Marek Kijonka, Joanna Prażmowska, Aleksandra Woźnica, Jacek Wendykier, Łukasz Kapek, Aneta Wajda, Wojciech Ciszek, Maria Sokół, Andrzej Orlef

Medical Physics Department, Maria Sklodowska-Curie National Research Institute of Oncology, Gliwice Branch, Gliwice, Poland

https://doi.org/10.21175/rad.abstr.book.2025.19.9

Introduction

Total Skin Electron Irradiation (TSEI) is one of the most effective treatments for malignant skin diseases, such as mycosis fungoides (MF) and cutaneous lymphomas. Typically, it is performed at considerable source-to-surface distances with the patient positioned on a rotatory platform. The TSEI procedure poses a major challenge in ensuring a uniform dose distribution to the total skin surface. This study aimed to measure the skin dose using Gafchromic films in the patients undergoing TSEI therapy at the Maria Sklodowska-Curie National Research Institute of Oncology, Gliwice Branch, Poland.

Materials and Methods

The TSEI procedure was based on a modified Stanford technique (six dual-field method) and performed on a TrueBeam linear accelerator (Varian, Palo Alto) with a modified 6 MeV electron beam (HDTSe mode). The surface dose on the skin was measured using Gafchromic EBT3 or EBT4 films (Ashland, USA), calibrated with 6 MV photon beam in an RW3 phantom. The calibration films were scanned 24 hours after irradiation using an Epson Perfection V850 Pro scanner. The dose values were obtained with FilmQA Pro software (Ashland, USA). In-vivo dosimetric verification was performed for 20 MF patients treated with TSEI from 2019 to 2025. The surface dose was measured using 2.5cm×2.5cm Gafchromic films strategically placed at various anatomical locations of the patient's body: abdomen (reference point), chest, forehead, hand, elbow, the right and left sides of the body, knee, ankle, lower back, neck. The scanning conditions and analysis were consistent with those used for the calibration curves.

Results

The mean doses, standard deviation, minimum and maximum values were calculated. The mean surface dose at the reference point (abdomen) for all patients was 99.5% of the planned dose (SD = 3.6%, range: 92.6%–107.7%). The torso received an average of 97.0% of the prescribed dose (SD = 5.3%, range: 86.0%–109.0%). The highest deviations were observed in the peripheral body regions (hands, ankles), with a mean dose of 88.6% (SD = 6.2%, range: 75.5%–98.0%).

Conclusions

The doses measured in the TSEI-treated patients using the film dosimetry remained in a good agreement with the planned dose. The observed differences were within the uncertainty range reported in the literature (±10%). A noticeable underdosing was detected primarily in the hands and ankles, which was likely due to the factors related to the patient's physical condition (inability to maintain a stable posture during irradiation), as well as to the field edge inhomogeneity and inaccuracies related to the methodology used. Precise patient positioning, appropriate beam geometry parameters, and non-standard dosimetry dictated by the Stanford technique conditions are crucial for ensuring the effectiveness and safety of TSEI therapy. Thus, an independent in-vivo verification is essential to assess the accuracy and quality of the treatment and to identify potential problems. Gafchromic films may be recommended for such an application.

Quantifying risks in immunotherapy using bayesian modelling of quantitative imaging biomarkers

Marija Delić*[1], Martin Horvat[2], Katja Strašek[2], Daniel Huff[3], Robert Jeraj[3]

[1] Faculty of Technical Sciences, University of Novi Sad, Novi Sad, Serbia
[2] Faculty of Mathematics and Physics, University of Ljubljana, Ljubljana, Slovenia
[3] Department of Medical Physics, School of Medicine and Public Health, University of Wisconsin-Madison, Madison, WI, USA, United States

https://doi.org/10.21175/rad.abstr.book.2025.19.10

Immune Checkpoint Inhibitors (ICIs) have revolutionized cancer treatment by significantly improving patient outcomes. However, they also pose a considerable risk of immune-related adverse events (irAEs), necessitating reliable risk assessment for early intervention and improved clinical management. Our study focuses on developing a predictive model for irAE risk estimation prior to clinical manifestation, leveraging biomarkers extracted from medical imaging.

Our study utilizes quantitative imaging features (Quantitative Imaging Biomarkers) extracted from 18F-FDG PET/CT scans, which provide insights into metabolic activity and potential immune-related toxicity. These biomarker values were identified as independent variables in our risk estimation framework. We analysed imaging data from 58 metastatic melanoma (MM) patients treated with anti-PD-1 and/or anti-CTLA-4 ICIs, focusing on three organs commonly affected by irAEs: bowel, lungs, and thyroid.

To quantify the risk, we employed Bayesian modelling to estimate the probability of irAE occurrence, characterizing transitions between biomarker values associated with adverse events and those without. Bayes' theorem allows for modelling based on past outcomes, providing information about a patient's condition by using conditional probabilities that depend on previous events. Given the limited dataset size, we constrained our probability distribution modelling of normal control (NC) group data and adverse event (AE) cases to Normal (Gauss) and Lognormal functions. Our results demonstrate that the Bayesian models provide meaningful risk quantification, visualized as S-shaped curves. We derived both optimal and median of the model, incorporating 95% confidence intervals to account for uncertainties arising from the limited sample size and modelling. The inflection point in these curves represents the critical threshold distinguishing low from high irAE risk, offering a potential tool for clinical decision-making. However, practical challenges have arisen in modelling probability estimates around zero SUV values, where some cases experience an unexpected reversal back to 1. Addressing these limitations would improve the prediction performance and robustness of the model.

This study highlights the potential of Bayesian modelling in oncology, providing a data-driven framework for quantifying irAE risk in immunotherapy patients and supporting more informed clinical decisions.

Acknowledgements: This research was supported by the Science Fund of the Republic of Serbia, GRANT No 9393, Optimization and prediction in therapy treatments of cancer - OPTIC, and by Slovenian Research Agency ARIS, research program P1-0389 and project N1-0197.

Ring artifacts on Ethos HyperSight kV cone beam CT (kV-CBCT) scans: a comparative study using patient images, QA phantoms and an anthropomorphic phantom supporting on-couch adaptive radiotherapy

Beata Niewiadomska*[1], Bożena Woźniak[1], Łukasz Kapek[1], Marek Kijonka[1], Aleksandra Woźnica[1], Jacek Wendykier[1], Aneta Wajda[1], Barbara Bekman[2], Joanna Prażmowska[1], Adam Bekman[1], Andrzej Orlef[1], Maria Sokół[1]

[1] Medical Physics Department, Maria Sklodowska-Curie National Research Institute of Oncology, Gliwice Branch, Gliwice, Poland
[2] Radiotherapy Planning Department, Maria Sklodowska-Curie National Research Institute of Oncology, Gliwice Branch, Gliwice, Poland

https://doi.org/10.21175/rad.abstr.book.2025.19.11

Introduction: The Varian Ethos v 1.1 system (product version 4.0) is equipped with the new HyperSight flat-panel detector (86 × 43 cm2, cesium iodine scintillator detectors). Improvements in its design and iterative reconstruction algorithm allow for almost CT-like image quality. In the Ethos, the kV-CBCT HyperSight imaging modality plays a crucial role in adaptive radiation therapy. Any kV-CBCT image artifacts can potentially impact the precision of adaptive treatment and must be identified by the QA program. This study investigates the occurrence of ring artifacts in kV-CBCT patient scans and explores their presence using various phantoms for quality assurance (QA) testing.

Materials and Methods: The study involves the following approaches: 1. Review of the kV-CBCT scans to assess the presence of ring artifacts. 2. Analysis of monthly image QA test data for the kV-CBCT modality using the Quart Phantom, evaluating Hounsfield Unit (HU) constancy, homogeneity, noise levels, image scaling and artifact presence. 3. Recalibration kV, kV-CBCT and another activity performed by the service team. 4. Evaluation of artifacts with the additional phantoms (such as Catphan 604 and an anthropomorphic phantom (Alderson-Rando phantom)). The phantoms were imaged using the Varian HyperSight imaging platform (pelvic protocols with different acquisition parameters).

Results: Ring artifacts were observed in the kV-CBCT scans of the patients. However, the routine QA tests with the Quart phantom did not detect them, showing image uniformity, noise levels, scaling, and HU constancy, to be within the acceptable limits. Tests performed using the Catphan phantom also did not show any artifacts. The detection of these artifacts was only possible by using an anthropomorphic phantom that reflects the patient geometry. Recalibration of the flat panel total detector with PVA procedures performed in Service Mode had minimal effect on permanent artifact reduction. Other Varian maintenance procedures also did not produce lasting results. Ultimately, replacing the flat detector significantly improved image quality.

Conclusions: The observed artifacts make the segmentation process and the evaluation of deformation fusion by the physician more difficult during on-site adaptation. At the same time, at this stage the user is not able to determine their impact on dose distribution. Such artifacts should certainly be eliminated from the images as soon as possible. This study underscores the phantom-dependent nature of the ring artifacts in Ethos kV-CBCT imaging. The presence of such artifacts in the patient scans and the scans obtained for the anthropomorphic phantom, and their absence when the standard QA phantoms are applied, suggests that certain material properties or scatter conditions may be of importance in contrast-visible artifact formation. It is worthwhile to include the use of anthropomorphic phantoms in QA protocols to better represent clinical imaging conditions. Furthermore, the study highlights the importance of collaboration and communication between radiation therapists, physicians, medical physicists and manufacturer service to optimize adaptive radiation therapy procedures.

Searching for biomarkers of Parkinson's disease using mass spectrometry methods

Aleksandra Klimkowicz-Mrowiec[1], Renata Franczak[2], Kamil Brudecki*[2]

[1] Jagiellonian University Medical College, Kraków, Poland
[2] Institute of Nuclear Physics Polish Academy of Science, Kraków, Poland

https://doi.org/10.21175/rad.abstr.book.2025.19.12

One of the challenges arising from an aging society is the increasing number of individuals suffering from neurodegenerative diseases, such as Parkinson's disease (PD). PD is characterized by the loss of nerve cells in the substantia nigra of the brain, leading to dopamine deficiency and the onset of clinical symptoms such as tremors, muscle rigidity, bradykinesia, and postural instability. These symptoms significantly impact patients' quality of life, leading to a loss of independence. Despite significant advances in research, the causes and pathogenic mechanisms of PD remain not fully understood, making it difficult to develop effective therapies.

In recent years, there has been growing interest in the role of macro- and microelements as well as trace elements in the development and progression of PD. Preliminary studies suggest that PD patients exhibit abnormal biokinetics and accumulation of elements such as selenium, iron, and zinc in cerebrospinal fluid, serum, and other biological matrices compared to healthy individuals.

One of the advanced analytical techniques enabling precise determination of element concentrations in biological samples is inductively coupled plasma mass spectrometry (ICP-MS). This technique is characterized by high precision, repeatability, and accuracy, making it a key tool in the discovery, development, and validation of neurodegeneration biomarkers.

At the Institute of Nuclear Physics of the Polish Academy of Sciences in Kraków, in collaboration with the Jagiellonian University Medical College, research is being conducted on the application of ICP-MS for determining element concentrations in blood and hair samples of PD patients. The presentation will discuss current research findings, opportunities, and challenges associated with ICP-MS, highlighting the potential of this technique in better understanding the pathogenesis of the disease.

A novel method for simulating the X-ray dose distribution of a digital mammography system with GEANT4

Gizem Şişman*[1], Ayşegül Yurt[2], Hakan Epik[3], Kadir Akgüngör[3]

[1] Izmir University of Economics, Vocational School of Health Services, Medical Imaging Techniques Program, Izmir, Turkey
[2] Dokuz Eylul University, Vocational School of Health Services, Medical Imaging Techniques Program, Izmir, Turkey
[3] Dokuz Eylul University, Faculty of Science, Department of Physics, Izmir, Turkey

https://doi.org/10.21175/rad.abstr.book.2025.19.13

The heterogeneous dose distribution in the X-ray field of mammography systems is a critical factor affecting image quality and patient dose. This heterogeneity arises due to factors such as the heel effect in the anode-cathode direction and off-focus radiation. This study aims to develop a practical and reliable method for simulating the X-ray field of a digital mammography system in GEANT4 without the need for direct modeling of the X-ray tube.

Monte Carlo (MC) simulations were performed using the GEANT4 toolkit to model the Hologic Selenia Dimensions digital mammography system. Dose measurements were conducted on the patient support plate, and the particle distribution function was derived through reverse engineering to represent the heterogeneous dose distribution of the X-ray field. This function was then integrated into the GEANT4 simulation to accurately model the system.

Results indicate that the proposed particle distribution function successfully represents the heterogeneous dose distribution of the X-ray field with high accuracy. When the function was not applied, significant discrepancies were observed in the simulated dose distributions compared to measured data, with differences reaching up to 10%. However, when the function was utilized, the overall discrepancy between measured and simulated dose distributions was reduced to 1.9%. Additionally, the half-value layer (HVL), a key parameter for beam quality assessment, remained consistent with experimental measurements in both cases.

By incorporating this particle distribution function, the simulation process becomes more efficient while maintaining accuracy, eliminating the need for direct X-ray tube modeling. This method provides a valuable tool for future studies evaluating dose distributions in mammography systems and can contribute to dose optimization strategies in digital mammography.

A ^{68}Ga-isotope /Gd-atom labeled PET/MR imaging probe for pH assessment

Tibor Kovacs*[1,2], Noemi Kovacs[3], Domokos Mathe[1,3], Imre Hegedus[3], Kalman Nagy[4], Eliana Gianolio[5], Roberta Napolitano[6], Bengt Långström[7], Krisztian Szigeti[3], Miklos Toth[4], Christer Halldin[3,8], Silvio Aimé[5]

[1] Hungarian Centre of Excellence for Molecular Medicine (HCEMM), Szeged, Hungary
[2] University of Pannonia, Department of Radiochemistry and Radiecology, Veszprem, Hungary
[3] Department of Biophysics and Radiation Biology, HUN-REN TKI-Semmelweis University, Budapest, Hungary
[4] Karolinska Institute PET Centre, Stockholm, Sweden
[5] University of Torino, Torino, Italy
[6] Present address Bracco Imaging SpA, Milan, Italy
[7] Department of Chemistry, Uppsala University, Sweden, Uppsala, Sweden
[8] Karolinska Institute PET Centre, Stockholm, Sweden

https://doi.org/10.21175/rad.abstr.book.2025.20.1

A novel hybrid probe for pH reporting using PET and MRI was prepared that harnesses the complementary properties of both imaging techniques. Here, we utilize PET to quantify the concentration of the probe with very high sensitivity, while simultaneously obtaining pH-related relaxivity information from MRI at higher spatial resolution. Both techniques supply essential information for surgeons, facilitating more precise removal of malignant tissues, because extracellular pH values change on the tumor edge from acidic to neutral are detectable at the submillimetric range. A biotinylated conjugate of a Gd-DO3a – sulphonamide derivative (Gd-DO3A-SA-biotin) and a ^{68}Ga-NOTA-chelator (^{68}Ga-NOTA-biotin) coupled to avidin has been synthesized. The DO3A ligand changes it chelate denticity towards the coordinated Gd^{3+} from heptadentate at acidic pH to octadentate at basic pHs. This yields a change in hydration and causes an increase in the observed relaxivity. It was observed at pH <6 and at a magnetic field of ca. 1 Tesla. The ^{68}Ga-labeled NOTA-ligand can be stably biotinylated, and its concentration is measured by PET. The change of relaxivity was characterized as a function of the magnetic field and pH making MR images at 1T. The chelate construct was radiolabeled with ^{68}Ga using a commercial ^{68}Ge/^{68}Ga generator eluate. Gd-DO3A-SA-biotin and Avidin were mixed in the stoichiometric molar ratio of 3.9:1 to have enough free sites for binding the ^{68}Ga-NOTA-biotin complex. PET/MRI imaging (Mediso nanoScan PET/MRI system) was performed. Previously pH values were validated (using pH electrode) from 4.93 to 7.74. Activity concentrations from 3.2 to 12.6 MBq/mL were imaged in PET with acceptable reproducibility. The complex system was synthesized relatively easily. The chemical exchange saturation transfer rates are of high value at the field strength of 1 Tesla of the PET/MRI instrument. In each phantom well, the calculated pH based on calculated Ga-Gd concentration was in good accordance with the potentiometric measured pH. The kinetics of the local ligand change is influenced by the H^+ and protein concentration. The number of complex agents available for correct detection could be previously calculated well to apply the proper dose. The reported PET/MRI avidin-based platform appears to be an efficient probe in assessing pH in this proof-of-principle study. The good biological compatibility and versatility of the avidin-biotin platform open interesting directions for targeted tissue pH measurements using a 1 T PET/MRI instrument in vivo. In live studies we assume that the false signal caused by the acidic nature of the healthy muscle tissue can also be filtered using volumetric and water diffusion based MRI sequence images.

References

1. Longo et al. Cancer Res. 2016; 76:6463-70.
2. Terreno et al. Chem Rev 2010; 110:3019-42

A biomedical application of robust logistic regression: Effect of outliers

Silvia Vargas Castrillón*, Francisco Cutanda

Universidad Nacional de Educación a Distancia, Madrid, Spain

https://doi.org/10.21175/rad.abstr.book.2025.20.2

Applications of logistic regression methods have been commonly used applications in biomedical fields. There are many references dealing with procedures to be followed and methods to find the estimators for the parameters from the observed values, and they have been implemented to all state-of-the-art statistical packages. These estimators belong to the "maximum likelihood" type, i.e. they are the ones that make the observed values the most likely among all the models that could have been used. Maximum likelihood estimators exhibit very good properties. Nevertheless, there are some practical circumstances that cause the presence of "outliers", i.e. observed values not corresponding to the logistic model used as a hypothesis. Occasionally, these anomalous observations can have a strong effect on the fit, and could lead wrong conclusions. The causes associated with these outliers depend on the particular study, but it is possible to point out classification errors, observations (subjects) with special features which have not been taken into account, uncertainty in the measurement of some parameters, etc. The problem with maximum likelihood estimators is that they are not "robust", i.e. their sensitivity to outliers could be arbitrarily large, and even a reduced number of outliers could lead to an inappropriate logistic model. In this work, we have analysed one dataset regarding Comorbidities in patients coinfected with HIV and HCV that helps illustrate possible consequences, and we have discussed the application of robust methods. The use of robust logistic regression ensures the reliability of the conclusions, despite possible outliers.

Breast cancer awareness, findings from a cross sectional - Study among Albanian women

Albana Shahini[1], Bledi Kreka*[2], Altin Malaj[3]

[1] Catholic Hospital Our Lady of Good Counsel, Tirana, Albania
[2] Mother Teresa University Hospital Center, Tirana, Albania
[3] Freelance, Tirana, Albania

https://doi.org/10.21175/rad.abstr.book.2025.20.3

Background: Breast cancer is the leading cause of death worldwide. Achieving early detection through screening and increasing awareness about risk factors and clinical signs and symptoms is of vital importance. Studies have indicated that often awareness is not adequate, and screening methods are not accessible or affordable in low resource settings.

Methods: A cross-sectional study surveyed Albanian women using an online questionnaire. Information was collected on socio-demographics, personal history and knowledge of breast cancer cases, risk factors, signs and symptoms as well as screening methods, frequency of examinations etc. The data was analyzed with Stata 16, looking at uni and bivariate analysis, for three levels of education. Chi square tests for independence between other characteristics and education were considered significant at p-value of 0.05.

Results: A total of 455 Albanian women completed the online questionnaire. The mean age of respondents was 39.9±12.4 years, 92% lived in urban settings and 67% in capitol Tirana. 70.8% had knowledge of breast cancer in close relatives, and only 9.5% had a history of benign breast disease. Only the number of hours of weekly exercise and age at first breast examination were associated with education levels. Of all the risk factors asked, only giving birth after the age was 30 was associated with education level. None of the lifestyle related risk factors were associated with education level. Of all the clinical signs and symptoms asked, only the breast lump, the armpit mass and abrupt changes of the shape of the breast were associated with education level. The awareness of at what age and when in the menstrual cycle to start/conduct the breast self-examination and its frequency were associated to education level.

Conclusion: The findings are similar to other studies conducted in low resource settings on three continents, suggesting inadequate breast cancer awareness. Breast awareness campaigns should target Albanian women of all educational backgrounds at the primary health care level.

Exploring the potential of magnesium in reducing nickel toxicity in the context of orthopaedic implants

Polina Navrátilová*[1], Martin Štípal[1], Markéta Vejvodová[2], Tomáš Vaculovič[2], Luděk Ryba[3], Monika Pávková Goldbergová[1]

[1] Department of Pathophysiology, Faculty of Medicine, Masaryk University, Brno, Czech Republic
[2] Department of Chemistry, Faculty of Science, Masaryk University, Brno, Czech Republic
[3] Department of Orthopaedic Surgery, University Hospital, Brno, Czech Republic

https://doi.org/10.21175/rad.abstr.book.2025.20.4

The release of metallic ions from orthopaedic implants is a significant concern in medical materials research, particularly in the context of implant longevity and patient health. Cobalt-chromium (CoCr) alloys, commonly used in joint replacements, often contain nickel (Ni), which can be released into surrounding tissues due to tribocorrosion—mechanical wear combined with electrochemical degradation of the implant surface. Continuous exposure of surrounding tissues to Ni^{2+} ions is associated with cytotoxicity, oxidative stress, and alterations in cellular function, potentially leading to adverse tissue responses and implant failure. Despite the well-documented risks, there are currently no effective strategies to mitigate Ni^{2+} toxicity at the cellular level.

This study investigates the potential of active forms of magnesium (Mg) to reduce Ni^{2+} toxicity by affecting its cellular absorption. Given the similar charge of Mg^{2+} and Ni^{2+}, it is hypothesized that magnesium supplementation may reduce Ni^{2+} uptake by potentially competing for the same transport mechanisms, thereby decreasing intracellular Ni^{2+} accumulation and its associated toxicity. To evaluate this, primary chondrocytes isolated from cartilage fragments of osteoarthritic patients undergoing joint replacement will be used. The cytotoxic effects of Ni^{2+}, both alone and in combination with Mg, will be assessed through cell viability assays (MTT), oxidative stress detection (DCFDA assay), and fluorescence-based imaging of intracellular metal accumulation. Additionally, laser ablation ICP-MS (LA-ICP-MS) will be employed to quantify Ni^{2+} distribution within the cells.

By analysing Ni^{2+} absorption and the protective effects of Mg, this research aims to provide new insights into strategies for minimizing implant-related metal toxicity, particularly in the context of long-term implant wear.

This study was supported by MUNI/LF-SUp/1371/2024 and MUNI/A/1790/2024 projects.

Lung function in Covid-19 pneumonia survivors 3 months after the discharge from the hospital

Immanuels Taivans*, Gunta Strazda, Normunds Jurka, Valentina Gordjusina

University of Latvia, Riga, Latvia

https://doi.org/10.21175/rad.abstr.book.2025.20.5

A significant number of covid-19 pneumonia patients continue to complain of cough and shortness of breath long after the acute period has passed. To gain a deeper understanding of the processes that cause these symptoms, we examined 18 patients from 30, who arrived for repeated control three months after the discharge from the hospital. Patients underwent spirography, body plethysmography (BP), CO transfer factor testing (Tco) and oscillometry (FOT indices:R5; R5-20; X5; AX; Fres). Main results: Mean Z-score with confidence intervals for VC was -0,13 (-0.64/+0.37), for TLC -1.28 (-1.89/-0.67), for RV -1.44 (-1.96/-0.92); for Tco -1.07 (-1.51/-0.63); for MMEF –068 (-1.11/-0.24); for R5 0.23 (-0.10/+0.76); for R5-20 0.89 (0.67/1.72); for X5 -1.37 (-3.11/+0.37); for AX 1.06 (0.38/1.75) and for Fres 1.82 (-0.36-1.44);

Six individuals of 18 had Tco below the lower limit of normal (LLN) that corresponded to decreased values of TLC and RV indicating on restrictive character of ventilatory failure. Five of these patients had elevated above ULN FOT values $R_{5\text{-}20}$, X_5, AX indicating on small airways obstruction. We conclude that lung affections in late covid manifest as combined obstructive-to-restrictive ventilatory failure that develop in some individuals, possibly due to fibrosis and closure of small airways.

Nutrition and acne: Exploring the connection

Vanya Birdanova*[1], Preslav Vasilev[2], Ivelina Ruseva[1], Ivelina Jordanova[2], Iveta Petrova[1], Valentina Kozova[3]

[1] Department of Hygiene, Medical Ecology, Occupational Diseases and DM, Faculty of Public Health, Medical University-Pleven, Bulgaria, Pleven, Bulgaria
[2] Department of Dermatology and Venereology, Faculty of Medicine, Medical University Pleven, Bulgaria, Pleven, Bulgaria
[3] Department of Medical-diagnostic activities, Medical College, Medical University-Pleven, Bulgaria, Pleven, Bulgaria

https://doi.org/10.21175/rad.abstr.book.2025.20.6

Acne vulgaris is a persistent inflammatory skin condition affecting the pilosebaceous unit. Its development involves a combination of factors, including increased sebum production, changes in keratinization leading to comedone formation, colonization of hair follicles by Cutibacterium acnes, and the release of inflammatory mediators. Additional factors influencing acne include hormonal fluctuations, genetic predisposition, certain medications, stress, and dietary habits. Foods with a high glycemic index, increased carbohydrate intake, and dairy products have been associated with acne occurrence, particularly among individuals following a Western dietary pattern. The impact of diet on acne severity may also be influenced by sex and ethnicity. This study aimed to investigate the relationship between the severity of acne vulgaris and the eating habits of young Bulgarian women. The study included 46 women with acne vulgaris, aged between 14 and 40 years. The severity of acne was assessed by a dermatologist and classified according to the Global Acne Grading System (GAGS). Dietary intake was evaluated using the Food Frequency Questionnaire (FFQ) method. In the studied group, low daily consumption of foods rich in vitamins, antioxidants, and fiber—such as fresh vegetables and fruits, whole grain bread, and legumes—was observed. Acne severity showed a significant negative correlation with the intake of nuts ($r=0,51$; $p<0.05$), and significant positive correlations with the intake of milk ($r = 0.46$; $p < 0.043$), sugary products, and honey ($r = 0.61$; $p < 0.016$). The frequency of consumption of sunflower oil, processed meats, and beer was higher in severe and very severe acne cases. The intake of energy-dense foods rich in fats and sugars, as well as milk and alcohol, may aggravate acne development in young women.

On the relationship between medicine and philosophy in the context of health, life, and the biological organization of the human being

Dariusz, Adam Szkutnik*, Krzysztof Bochenek

University of Rzeszów, Institute of Philosophy, Rzeszów, Poland

https://doi.org/10.21175/rad.abstr.book.2025.20.7

Philosophy and medicine have been interconnected for centuries, forming an inseparable causal framework that seeks to explain the nature of the human being. Since antiquity, thinkers such as Hippocrates and Aristotle have reflected on fundamental questions concerning life and death, as well as the relationship between body and soul, understood in the context of the human person as a substantial entity. Accordingly, medicine, as an empirical science, has long served humanity by contributing to the protection of health and life. Its foundations lie in scientific inquiry, which began with direct observation of living organisms and gradually evolved into clinical and experimental research. The historical interplay between medicine and philosophy reveals a dynamic mutual influence – both as a driving force of scientific development and as a source of epistemic errors arising from reductionist approaches to the explanation of life processes, including human development. In the 17th century, William Harvey, through his studies on blood circulation, demonstrated that the heart functions as a pump. This mechanistic explanation of the organism as a biological system composed of distinct parts with specific roles represented a scientific breakthrough, yet it also revealed the limitations of such a perspective. While it provided clarity regarding some organic processes, it failed to account for the complexity of life's dynamic nature, which became the subject of further philosophical and scientific debate. A telling example is the 18th-century dispute between embryologist Caspar Friedrich Wolff and physician-physiologist Albrecht von Haller regarding causality in the organization of life. Haller advocated the flawed philosophical concept of preformation, whereas Wolff defended a theoretically and empirically grounded theory of epigenesis. In the 19th century, a similar tension resurfaced in the debate between Wilhelm Roux's mechanistic approach and Hans Driesch's vitalism. Despite their respective shortcomings, both perspectives contributed to the emergence of Ludwig von Bertalanffy's organismalism, later developed into general systems theory. This framework conceives the organism as an irreducible whole composed of complex interactions among its constituent parts. Historical examples show that medicine has always been embedded in diverse research contexts – both empirical and philosophical. The convergence of these domains has led not only to epistemological errors but also to necessary revisions of foundational assumptions and, ultimately, to scientific advancement. Philosophy has played a critical role in correcting medical misconceptions, although when understood as pure metaphysics, it has at times misled science through faulty assumptions. The historical tendency to reduce organisms to simple functional mechanisms – stripped of broader explanatory contexts – often resulted in false conclusions. Thus, a proper understanding of the human being as a complex biological, psychological, and social entity requires the collaborative engagement of philosophy, medicine, and other fields, including technology. Philosophy has not only accompanied major debates in developmental biology and medicine, but it continues to be essential in resolving boundary disputes and ethical dilemmas arising from rapid medical and technological progress. Advances in technology allow for deeper exploration of human nature – not only in its biological and psychological aspects, but also in its social and cultural dimensions – thereby revealing the ontological complexity, dignity, and freedom of the human person. Only by embracing this multidimensionality can medicine remain a complete science, and philosophy retain its relevance in uncovering the foundations of life and the essence of humanity.

Keywords: Philosophy of medicine, Human nature, Biological organization, Reductionism and holism, Epigenesis, Preformation

Surface modifications of titanium: an in vivo biocompatibility study

Lucie Válková*, Jan Štingl, Michaela Krchová, Alessandro De Felice, Konstantinos Chatzichristou, Monika Pávková Goldbergová

Department of Pathophysiology, Faculty of Medicine, Masaryk University, Brno, Czech Republic

https://doi.org/10.21175/rad.abstr.book.2025.20.8

Titanium and its alloys are the most commonly used materials for biomedical devices due to their unique properties. They exhibit high strength, excellent biocompatibility, high corrosion resistance, and are lighter in weight compared to other metals. An exciting advancement is 3D printing, which can be used to make customized titanium implants for each patient. These implants can lead to better treatment outcomes and a lower risk of complications compared to standard implants.

Specific health risks are associated with the presence of metal due to interactions between live tissues and implanted metal components. The degradation of the metal material is unavoidable and can lead to complications. When an implant is damaged (by corrosion or wear), material degradation products (micro- and nanoparticles, ions, inorganic salts, and metal oxides) are released. These products can affect the behavior of surrounding cells and induce loosening and osteolysis as well. Various surface modifications are used to improve metal properties, such as extending implant life, reducing inflammation, reducing ions/nanoparticles, and enhancing biocompatibility. One of the promising improvements of these properties is a surface modification by microstructure or nanostructure (e.g., laser surface engineering).

The main goal of this *in vivo* study is to better understand the processes of healing and inflammation brought on by metal ion release.

The experiment was carried out on female Wistar rats. A titanium disc (with or without surface modification) 10 mm in size and 1 mm thick was placed between the *latissimus dorsi* and *scapula*. The control group underwent an incision without the insertion of a metal implant. After the monitoring period (72 hours, 2 weeks, and 4 weeks), muscle samples from direct contact with the metal were collected. RT-qPCR was used to examine the expression levels of selected genes that play essential roles in the inflammatory response. The $2^{-\Delta\Delta CT}$ method was used to calculate changes in the expression of target genes.

This research was supported by MUNI/LF-ACC/1129/2022 and by the Czech Republic Ministry of Defence - University of Defence project for the Development of the Organization "DZRO Military autonomous and robotic systems". The samples with laser surface modifications were prepared in HiLASE Centre.

The correlation between dental caries prevalence and parents' education of children 12-15 years in Kosovo

Majlinda Jusufi, Mihail Kochubovski*

Faculty of Medicine, Ss. Cyril and Methodius University, Skopje, North Macedonia

https://doi.org/10.21175/rad.abstr.book.2025.20.9

Oral health is a crucial aspect of overall well-being, playing a significant role in not only preventing other diseases but also in promoting a positive physical appearance and emotional state. Good oral health enables individuals to maintain a routine that includes eating, smiling, and effective communication. Dental caries, a widespread non-communicable disease, is particularly prevalent among children and adolescents. Various factors contribute to the incidence of dental caries, including oral hygiene practices, socioeconomic status, and eating habits. Early childhood habits in oral care are heavily influenced by parental guidance, making the role of parents, particularly their educational level, critical in shaping their children's oral health behaviors.

This study investigates the correlation between the prevalence of dental caries and the educational level of parents in adolescents aged 12-15 years in Kosovo. Additionally, it compares oral health practices and caries prevalence between adolescents from urban and rural areas. A total of over 200 teenagers were selected through random sampling from two cities and two villages of Kosovo. The findings of this study indicate that higher parental education is linked to better oral health practices among teens. These disparities highlight the need for targeted interventions to address oral health issues. Promoting preventive dental care and raising awareness about the importance of oral hygiene across all regions of Kosovo are key to improving oral health outcomes.

The results of this study will guide future research and inform the development of preventive oral health programs, ensuring that both urban and rural adolescents benefit from improved oral health education and practices.

Keywords: Dental Caries, Parent's Education, Adolescent Oral Health, Socioeconomic Status, Urban-Rural Disparities

Upper abdominal MRI – From sequences to applications

Claudia Gabriela Chilom*[1], Cazacu Nicoleta[2], Cosmin Adrian[3], Costin Minoiu[3]

[1] Department of Electricity, Solid Physics and Biophysics, Faculty of Physics, University of Bucharest, Magurele, Romania
[2] Smeeni Chronic Disease Hospital, Buzau, Romania
[3] Clinical Emergency Hospital Bucharest, Bucharest, Romania

https://doi.org/10.21175/rad.abstr.book.2025.20.10

Magnetic Resonance Imaging (MRI) is an important non-invasive imaging technology used on the one hand, in the initial detection phase and as a complementary technique for a more complex characterization of pathologies on the other hand. To improve detection sensitivity, eliminate artifacts, and increase patient comfort, state-of-the-art MRI systems have been implemented and applications have been developed to deal with pulse sequences, image reconstruction, and data analysis. Nevertheless, performing an abdominal MRI examination can be challenging, and a thorough understanding of the sequences and the trade-offs between various parameters is essential for acquiring interpretable images without compromising the detection of pathologies. These aspects are important in characterizing hepatic lesions where the appropriate selection of sequences and parameters plays a crucial role in differentiating benign from malignant lesions and establishing an accurate diagnosis. The present study examines the impact of sequence selection and parameters optimization on MRI image quality and highlights how the resulting images using different contrast mechanisms (e.g., T1-weighted, T2-weighted, Water/Fat Separation, In-phase/Out-of-phase) contribute to the differentiation of various pathologies. By analyzing these contrasts, we aim to provide a comprehensive understanding of their distinctive imaging characteristics, to improve diagnostic accuracy. In conclusion, this study provides a deeper understanding of how parameters and sequences influence the quality of acquired images as well as an integrated medical perspective, contributing to the enhancement of diagnostic and clinical management of hepatic lesions.

Application of humanistic existentialism to personalized and precision medicine (PPM)

Masaki Tan*

SEMINE-NO-OKA Geriatric Health and Welfare Facilities, Miyagi, Japan

https://doi.org/10.21175/rad.abstr.book.2025.20.11

Holistic medicine views health as a complex interplay of physical, mental, emotional,and spiritual factors and the whole person is considered. PPM is a unique model of healthcare to integrate medicine, science, education, art, and mentality to secure the individual health, wellness, and biosafety as upgraded entity. Re-shaping tomorrow's healthcare in broader science and targeted scenario. PPM as being the grand challenge to forecast, to predict, and to prevent is rooted in a big and a new science generated by the achievements of system biology. Involvement of philosophy in medicine is considered important. However, it is not easy to understand it. This time Humanistic Existentialism was chosen for the usage of philosophy to medicine. What is humanistic existentialism by Sartre? Existentialism is a doctrine that makes human life possible and also affirms that every truth and every action imply an environment and a human subjectivity. We cannot produce a knife without knowing what purpose it would serve. The essence of the paper-knife –the sum of formula and properties that enable it to be produced and defined—precedes existence. Existence precedes essence" means that man first exist: he materializes in the world, encounter himself, and only afterward defines himself. To begin with he is nothing. He will not anything until later and then he will be what he makes of himself. Man is not only that which he conceives himself to be, but he which he wills to be, and since he conceives of himself only after he exists, just as he wills himself to be after being thrown into existence, man is nothing other than what he makes of himself. This is the first principle of existentialism. If existence truly does precede essence, man is responsible for what he is. He is responsible not only for his own individuality but for all men. There is no determinism –man is free. Man is condemned to be free: condemned, because he did not create himself, yet nonetheless free, because once cast into the world, he is responsible for everything he does. "Man is the future of man"-Francis Ponge. Whatever man may appear to be, there is a future waiting to be created—a virgin future. Quietism is the attitude of people who says "Others can do what I cannot do". Existentialism is the opposite of quietism, since it declares that reality exists only in action. The coward is responsible for his own cowardice. He has made himself a coward through his actions. There is no such thing as a cowardly temperament. There is always the possibility that one day the coward may no longer be cowardly. No doctrine is more optimistic, since it declares that man's destiny lies within himself. Man makes himself: he does not come into the world fully made, he makes himself choosing his own morality and his circumstances are such that he has no option other than choose morality. We can define man only in relation to his commitments. Life has no meaning a priori. Life itself is nothing until it is lived, it is we who give it meaning, and value is nothing more than the meaning that we give it. Existentialism is a humanism, because there is no legislator other than himself and that he must, in his abandoned state, make his own choices and also because we show that it is not turning inward, but by constantly seeking a goal outside of himself in the form of liberation or of some special achievement, that man will realize himself as truly human. What man needs is to rediscover himself and to comprehend that nothing can save him from himself.

In conclusion: Personalized and Precision Medicine (PPM) is a tailored and idealistic future medicine for patients. Humanistic existentialism might be useful for holistic medicine due to its optimism, freedom, no determinism, responsibility for all, importance of acting, support for human growth, and raison d'être.

Alkyl chain-dependent modulation of blood-brain barrier permeability in N-aryl-tetrahydroisoquinolines

Dunja Jovanović*[1], Ana Filipović[2], Bojan Bondžić[2], Aleksandra Bondžić[1]

[1] Institute of Nuclear Sciences, Belgrade, Serbia
[2] Institute of Chemistry, Technology and Metallurgy, University of Belgrade, Belgrade, Serbia

https://doi.org/10.21175/rad.abstr.book.2025.21.1

Alzheimer disease (AD) is an irreversible progressive neurodegenerative disease that causes failure of cerebral neurons and disability of the affected person to practice normal daily life activities. Despite extensive research efforts, no effective drug capable of significantly slowing or halting neurodegenerative processes has been developed. One of the main challenges in AD drug development is ensuring that therapeutic compounds can efficiently cross the blood-brain barrier (BBB) and reach adequate concentrations in the central nervous system (CNS). This ability is largely influenced by a molecule's lipophilicity and its ADME (absorption, distribution, metabolism, and elimination) properties. Additionally, over the years, numerous studies have shown the importance of lipophilicity in individual ADME parameters, highlighting its importance in drug design. Identifying the optimal range of lipophilicity has become a strategy in the optimization of lead compounds. This study deal with experimentally and theoretical evaluation of the impact alkyl chains at the R^1 position of *N*-Aryl-tetrahydroisoquinolines on BBB permeability of these compounds. For theoretical evaluation the ADME properties of three *N*-aryl-tetrahydroisoquinoline (THIQ) derivatives, each differing in the alkyl-substituted ketone at the R1 position were examined using the SwissADME tool, alongside experimental assessments of their lipophilicity and BBB penetration ability. SwissADME predictions indicated that all three compounds (**1a**, **1b**, and **1c**) had the potential to penetrate the BBB. However, according to Lipinski's Rule of Five, compounds **1b** and **1c** did not meet drug-likeness criteria due to their elevated logP values, suggesting higher lipophilicity. To experimentally validate these predictions, logP values were determined using the ultra-performance liquid chromatography (UPLC) method. The results confirmed that the measured logP values were within the range typically suitable for drugs targeting neurodegenerative diseases, in accordance with Lipinski's guidelines. Furthermore, it was observed that lipophilicity increased as the alkyl chain length extended. To further investigate the BBB permeability of the synthesized compounds, a Parallel Artificial Membrane Permeability Assay for the BBB (PAMPA-BBB) was carried out. The results revealed that despite all three compounds possessing logP values within an acceptable range for AD drug candidates, only compound **1a** successfully permeated the artificial BBB model. In contrast, compounds **1b** and **1c**, despite having comparable logP values, exhibited high lipophilicity, which prevented their detection in the assay. These findings confirm the importance of optimizing lipophilicity and that compound **1a** could be potential candidate for drugs in AD disease.

Acknowledgment: This work was supported by the Ministry of Science, Technological Development, and Innovation of the Republic of Serbia (Agreement No. 451-03-136/2025-03/200017 and 451-03-136/2025-03/200026).

Cytotoxic activity of macrocyclic Lu (III) complexes

Branka Dražić*[1], Andreja Leskovac[2], Sandra Petrović[2], Vojislav Stanić[2], Mirjana Antonijević Nikolić[3], Slađana Tanasković[1]

[1] Faculty of Pharmacy, University of Belgrade, Belgrade, Serbia
[2] Vinča Institute of Nuclear Sciences - National Institute of the Republic of Serbia, Belgrade, Serbia
[3] Academy of Applied Studies Šabac, Šabac, Serbia

https://doi.org/10.21175/rad.abstr.book.2025.21.2

Aim: Two newly synthesized complexes [[Lu2tpmcCl2(H2O)2](BF4)4·2NaBF4 and [Lucyc(H2O)2] (BF4)3·NaBF4 were tested against human lung carcinoma cell line A549 and the non-malignant, human lung fibroblast cell line MRC-5. The values of IC50 were calculated.

Material and Methods. Cell Culture. The human lung carcinoma cell line A549 (CCL-185) and the non-malignant human lung fibroblast cell line MRC-5 (CCL-171) were procured from the American Type Culture Collection. The cells were grown in Dulbecco's Modified Eagle Medium (DMEM), supplemented with 10% fetal bovine serum, and a solution of penicillin (10,000 UmL−1) and streptomycin (10 mgmL−1). Cell cultures were maintained at 37 °C in a humidified atmosphere containing 5% CO2.

Cell viability assessment

The cytotoxic effects of investigated complexes on A549 and MRC-5 cell lines were evaluated using the Cell Cytotoxicity Assay Kit (Abcam, Cambridge, UK) to assess cell viability, following the manufacturer's protocol. Absorbance intensity was measured at 570 nm and 605 nm.

IC_{50} values were derived from dose-response curves for each cell line. The selective effect of the compound is represented by the selectivity index (SI), calculated by comparing the cytotoxic activity of the compound on a cancer cell line to its activity on a normal cell line.

Results: According to the results both complexes induced dose-dependent antiproliferative effects in the A549 cell line, which were significant at 100-1000 µgmL−1 concentrations. On the contrary, in the case of the MRC-5 cell line, both complexes significantly enhanced proliferation at 1-10 µgmL−1 concentrations, displaying cytotoxic effects only at the highest applied concentration.

According to results, and [Lucyc(H2O)2] (BF4)3·NaBF4 complex possesses efficacy against tumor cells greater than the toxicity towards normal cells (SI > 1.0).

Keywords: Lutenium(III) complexes, macrocyclic ligand, antiproliferative activity

Acknowledgments: This research was funded by the Ministry of Science, Technological Development and Innovation, Republic of Serbia through two Grant Agreements with University of Belgrade-Faculty of Pharmacy No 451-03-136/2025-03/ 200161 and No 451-03-137/2025-03/ 200161.

Rational design, synthesis and biological evaluation of dual-binding reversible inhibitors of cholinesterase's with mild inhibitory potency toward monoamine oxidase B

Tamara Vujatović-Velimirov*[1], Milan Nikolić[2], Nataša Pajić[1], Maja Vitorović-Todorović[1]

[1] Military Technical Institute, Belgrade, Serbia
[2] Faculty of Chemistry, Belgrade, Serbia

https://doi.org/10.21175/rad.abstr.book.2025.21.3

Alzheimer's disease (AD) is neurodegenerative disease that is the cause of 60-70% of dementia cases. The major symptoms of AD involve progressive decline of cognitive and motor skills, caused by neuropathological changes, including elevation of oxidative stress, shrinkage of neurons, formation of Aβ plaques and neurofibrillary tangles in the central nervous system (CNS) and disruption of glutamatergic and cholinergic neurotransmission systems. In AD, the nerve terminal disruption is observed in immediate vicinity of Aβ plaques. Peripheral ionic site of AChE promotes aggregation of Aβ peptides which leads to formation of Aβ plaques. Dual-binding inhibitors interact both with catalytic site and peripheral site of AChE, elevating the levels of ACh and disabling involvement of AChE in the formation of Aβ plaques. Apart from palliative treatment, this approach can slow down the progression of the disease. Overexpression of monoamine oxidase B (MAO B) in CNS has been linked to the accumulation reactive oxidative species, contributing to the neuronal damage. Therefore, it is considered as an advantage that potential AD therapeutics exert anti-MAO B activity along with anti-AChE activity. It catalyses the amyloidogenic and non- amyloidogenic cleavage of amyloid precursor protein by activating the beta- and gamma-secretase activity which leads to aberrant amyloid plaque formation. Here we presented rational design, synthesis, structural characterisation and biological evaluation of the four new reversible dual-binding inhibitors of ChE with mild inhibitory potency toward MAO B. Synthesized compound were characterised by ^{1}H and ^{13}C NMR spectroscopy and their inhibitory potency was evaluated toward AChE from electrical eel (*Ee*AChE) and BChE from equine serum (*Eq*BChE) using modified Ellman's assay. Structurally compounds are composed of three fragments: tacrine and differently substituted phenylamides of aroylacrylic acids linked *via* polymethylene linker. The major structural difference among compounds **1-4** comprise different substituents at aroylacrylic and the tacrine moiety. Compounds **1** and **2** are substituted with methyl groups in position 2 and 5, and methoxy group in position 4 on aroyl ring. Compounds **3** and **4** are substituted in position 4 with methoxy group on aroyl ring, lacking the methyl substituent. All four compounds have methoxy group substituents in positions 3 and 5 on phenylamide ring. The structural difference is also made by using 9-chloro-1,2,3,4-tetrahydroacridine (THA) as 'tacrine' moiety of compounds **1** and **3**, while 7-chloro-2,3-dimethylquinoline (DMQ) was used as building block of compounds **2** and **4**. Tacrine exhibit adverse hepatotoxic effects and ring opening is expected to improve the efficiency of oxidation by cytochromes in Phase 1 metabolism of the compound, thereby reducing hepatotoxic side effects. Synthesized compounds expressed low nanomolar to low micromolar activity toward ChEs, and all compound exhibited micromolar activity toward MAO B. The compound with greatest potency toward MAO B was **2** with 89% inhibition at 15.64 μM. The least active ones were compounds **1** and **3**, which implies that compounds with DMQ as building block are more potent inhibitors of MAO B than those with THA. Compound **3** has the greatest inhibitory potency toward both AChE and BChE with IC_{50} values 4.12 nM and 17.86 nM respectively. The least active compound toward AChE is 23 (IC_{50}=0.26 μM), and the least active toward BChE is 21 (IC_{50}=0.14 μM) Introduction of methyl group into positions 2 and 5 on aroyl ring reduces the inhibitory potency of compounds toward both ChEs. Tacrine ring opening has a positive impact on inhibitory potency toward MAO B, and negative impact toward ChEs. All compounds exhibited low micromolar to low nanomolar inhibitory activity toward ChEs, which makes this type of structure an adequate lead for future research.

Keywords: Alzheimer's disease, cholinesterase, monamine oxidase B, inhibitory activity.

A relapse of multiple sclerosis classifiable as an acute clinical event with stable magnetic resonance imaging (MRI) (ACES)

Anna Maria Sotgiu*

Sapienza Università di Roma Master, Rome, Italy

https://doi.org/10.21175/rad.abstr.book.2025.22.1

An MS 'Relapse' is defined as a monophasic clinical episode with symptoms reported by the patient and objective findings typical of MS, developing acutely or subacutely, lasting more than 24 hours, and occurring in the absence of fever or infection. ACES are clinical events identified as MS relapses with Stable Magnetic Resonance Imaging (MRI). These are not associated with new T2 lesions or gadolinium-enhanced T1 lesions on MRI of the brain and spinal cord (Gavoille et al., 2024). The clinical case concerns a person with Multiple Sclerosis (MS) and comorbid osteoporosis who likely experienced an MS relapse classifiable as an ACES. This case aims to provide useful information to clinicians dealing with MS relapses and their onset. The clinical event concerned a 54-year-old female patient, affected by MS since the age of 29 and with a comorbidity of osteoporosis since the age of 42. For both conditions, the patient had undergone medical therapies and periodic clinical check-ups over the years. Regarding MS, control MRIs (brain, cervical, and dorsal, with contrast medium) have been performed over the years at an annual frequency, and those conducted in the last six years before the described event, have shown findings indicative of neuroradiological disease stability. Even the most recent of these control MRIs, performed 16 days before the acute clinical event in question, showed unchanged MRI findings compared to the past. The relapse began suddenly, and the main symptoms, reported by the patient, lasted more than 24 hours and were described as leg cramps while lying down, a sensation of numbness in the right foot and leg and altered sensitivity in the sole of the right foot. Following the onset of symptoms, the general practitioner conducted laboratory tests involving hematology, clinical chemistry, and virology, with the most significant results reported later in the text. Additionally, a specialist neurologist, following a medical examination, diagnosed a suspected clinical relapse of MS and prescribed an MRI (brain, cervical, and dorsal, with contrast medium), which was performed 27 days after the onset of symptoms. Laboratory test results indicated an increase in relative and absolute eosinophil levels (9.90%; #0.81 x 10^3/uL) and a decrease in hemoglobin (11.2 g/dL), variations already known in the patient, as well as a decrease in relative neutrophil levels (35.5%). Varicella IgG antibodies were present with a chemiluminescence value of 4.60, and Varicella IgM antibodies were absent. The brain, cervical, and dorsal spine MRI with contrast medium showed no new lesions or pathological enhancements in the brain and spinal cord compared to the aforementioned last control MRI, performed 45 days earlier. The therapies taken by the patient before the onset of symptoms included: folina (5 mg), Tardyfer (80 mg), Prolia (Denosumab), and Tyruko (Natalizumab-sztn). These medications were taken respectively 40, 10, and 2 days before the onset of the relapse, which occurred abruptly during nighttime hours. The patient, who had been on Tysabri (Natalizumab) therapy for 14 years, had been switched from the original drug to the biosimilar Tyruko (Natalizumab-sztn) two days before the onset of symptoms. The patient, affected by osteoporosis and treated with Prolia (Denosumab), had received a subcutaneous injection of the drug 10 days before the onset of the symptoms, while therapy with folina and tardyfer had started 50 days prior. Ninety days after the onset of symptoms, the patient was treated with 3 g/IV of methylprednisolone and underwent a change in immunomodulatory therapy for MS, which consisted of transitioning from Natalizumab-sztn to Mavenclad (Cladribine) tablets, in accordance with the guidelines of a paper prescription form for DMT drugs published in the Official Gazette of the Italian Republic.

Polarized microscopy in genetic hair disorders: case series

Zorana Djaković*

Euromedik, Belgrade, Serbia

https://doi.org/10.21175/rad.abstr.book.2025.22.2

Here we present microscopic features of selected hairs in ten patients with rare genetic disorders during early childhood. Among them there were six patients with Netherton syndrome, two patients with hypotrichosis congenita hereditaria Marie Unna, and two patients with ectodermal dysplasia (Smurf syndrome). We used optical microscopy device with polarized mode. Polarized microscopy in trichology is the technique of examination histological sections of the hair by passing a beam of polarized light. By interposition of the polarizer and the analyzer in the track of a white polychromatic light, that vibrate in all planes, the light started to vibrate in one plane, and if the object of the observation is a crystal structure, the orientation of the light beam is changed. This phenomenon of refraction in the case of the thick hair shaft is symmetrical in relation tp the diameter of the shaft. The colour of the light beam depend on the type and the thickness of the crystal trough which it passes. In the case of disturbed orientation of cortical hair fibers, changes of coloration also appear. In this way, polarized light helps in determining hair thickness, microfibrillar composition, and structural anomalies. It is used to distinguish either acquired or congenital hair shaft irregularities, such as local extensions, twists, invaginations, fractures, changes of medulla or cuticula, and many other specific or less specific changes. This noninvasive diagnostic method in trichology provides valuable clues for fast detecting wide spectrum of the hair shaft pathology. Thus, polarized light microscopy has also the huge importance in our ten cases of alopecia, which is the first and the most persisted clinical sign due to these rare genetic syndromes.

Absorption spectra measurements of riboflavin with a novel dual-line spectrophotometer

Roberto De Angelis*[1], Alessandro Agugliaro[1], Sebastiano Albergo[2,1,3], Ivana Di Bari[4], Rino Persiani[2], Valerio Scimone[3], Antonella Sciuto[4], Alessia Tricomi[2,1,3]

[1] Department of Physics and Astronomy "E.Majorana", University of Catania, Catania, Italy
[2] INFN section of Catania, Catania, Italy
[3] CSFNSM - Centro Siciliano di Fisica Nucleare e di Struttura della Materia, Catania, Italy
[4] CNR-IMM, Catania, Italy

https://doi.org/10.21175/rad.abstr.book.2025.23.1

We present the first data collected during an experimental campaign conducted at DFA "Ettore Majorana" in Catania, with the aim of testing the performance of a recently developed dual-line spectrophotometer for absorbance measurements, based on a innovative sample holder design replacing standard 1 cm quartz cuvettes.
The prototype consists of a 2 cm - radius integrating spherical cavity realized in PTFE, whose walls behave as a lambertian reflector in the UV-Vis spectral region. The high reflectivity of the cavity guarantees a longer photon path length inside the samples (up to a few meters), thus enhancing light absorption by the analytes. Two identical spheres (one containing the analyte, the other filled with ultra-pure water) are connected to two silicon photomultipliers (SiPM) detecting the transmitted intensity of light crossing the samples. A Xenon pulsed lamp, coupled to a motorized monochromator, was employed to irradiate the spheres (through optical fibers) in the spectral range [240, 500] nm. The analyte chosen for this study was riboflavin (vitamin B2) because of its rich and well-known absorption spectrum in the UV-Vis region, its availability and safety in handling. A number of solutions at different concentrations were prepared and tested, showing the expected decrease of transmitted light when increasing the sample concentration. The results have been compared to those obtained with a table-top commercial spectrophotometer, revealing an enhanced sensitivity of our setup to low concentrated solutions in the explored spectral region. The technique endeavours to achieve higher detection sensitivity of low-concentrated pollutants in acqueous media with respect to standard spectrophotometers, having vast applicability in environmental monitoring, particularly in assessing water quality.

How the operating parameters of the Venturi cavitation reactor efects on the quntity of $OH^{\cdot}$ radicals fornation

Jelena Jovanovic*[1], Nebojsa N. Begovic[1], Vesna Panic[2], Borivoj Adnadjevic[3]

[1] Institute for General and Physical Chemistry, Belgrade, Serbia
[2] University of Belgrade, Innovation Center of Faculty of Technology and Metallurgy, Belgrade, Serbia
[3] Faculty of Physical Chemistry, University of Belgrade, Belgrade, Serbia

https://doi.org/10.21175/rad.abstr.book.2025.23.2

Hydrodynamic cavitation is a relatively new, cheap, energy-efficient technology for intensifying a series of chemical reactions and physical-chemical processes. Intensification of chemical reactions using cavitation is a consequence of both physical and chemical cavitation's effects. Physical effects are formation, growth and imployment of bubbles, sudden increase in temperature and pressure, formation of microjets and shock waves, increase in turbulence, increase in mass and heat transport, etc. Chemical effects can be dissociation of small molecules, generation of radicals, thermal degradation of molecules and oxidation of molecules.

In this work, using the method of independent change of the value of one variable, the effect of the operational parameters of the Ventury type cavitation reactor (VTKR) on the quntity of created radicals (NOH) have been thoroghly investigated. Accordingly, the following paramaters were varied: inlet pressure (Pi= 1-50 at), cavitation number (CN=1-0.1), number of passes of the reaction mixture through the cavitator (n=1-200), temperature (T= 293-308K) and pH = 2-12.

Cavitation assisated formation of $OH^{\cdot}$ radicals was performed using VTKR of own construction (1). Determination of the number of formed OH radicals was performed using the KJ dosimeter (1). Based on the obtained results, it was established that: An increase in P1 leads to a concave growth of NOH; the decreases in the value of KB lead to a concave increase in NOH; the increase in the value of n leads to a concave increase in the value of NOH; the increase in the pH value of water does not lead to changes in N_{OH} values, wheras an increase in water temperature leads to a linear increse in NOH values.

The established efects of operational parameters of VTKR on N_{OH} is explained by the effect of operational parameters on the formation, growth and implosion of cavitation bubbles.

Information about the public concern regarding the EMF exposure from base stations for mobile communication

Victoria Zaryabova*

National Center of Public Health and Analyses, Sofia, Bulgaria

https://doi.org/10.21175/rad.abstr.book.2025.23.3

Communication with the public regarding environmental risks caused by the activities of various technologies is extremely important. The National Research Council (USA), explains risk communication as an interactive process for exchanging information and opinions among individuals, groups, and institutions. Therefore, risk communication is not only a presentation of a scientific calculation of risk, but also a forum for discussion on broader issues of a moral and ethical nature. Evaluation of the effectiveness of a programme for risk communication with the population was carried out on the basis of response to requests from citizens concerned about the impact of EMF on their health and for measurements in their homes situated close to base stations for mobile communication. An informal method of "Personal contact" was used, asking the following type of questions:

- What concerns you? Would you describe your EMF-related concerns?
- What are your complaints? Would you describe them?
- Tell us in detail:
  - about your complaints
  - are there any places in your home where you can experience these senses?
- Where did you learn about the risks of EMF exposure to humans?
- Where have you heard about our activities in National Centre of Public health and Analyses (NCPHA)?

A comparison was made between the number of received complaints and the actual measurements in homes, the years of elections in the country, and the years when different telecommunication standards were introduced. We found that the number of requests does not depend on the development of technology and the introduction of different standards, nor are they strictly dependent on the political and economic situation of the country.

The problems with the public can be summarized as follows:

- Uncertainty and fear of diseases and health consequences;
- Possible health consequences for children;
- Financial and economic issues;
- Insufficient information regarding the impact of EMF on humans;
- Disregard for the interests of the public in the areas of installation of base stations;
- Unwillingness to change the landscape after the installation of antennas;
- Presence of people with chronic diseases that may get worsen;
- Last but not least – the legislation in the country regarding the construction and installation of base stations.

Many factors influence a person's decision to accept or reject a certain risk. People perceive the risk as insignificant, acceptable, bearable, or unacceptable, comparing it with the benefits. These perceptions depend on:

- individual factors (age, gender, culture, education, social status);
- external factors (available scientific information; personal and public economic situation, movement of opinions in society; structure of the regulatory process and political decisions made);
- the nature of the risk.

As a result of our research, we have identified a significant problem that we recorded in 2009., which can be explained by the one-sided campaign of the industry (operators) that led to a sharp increase in the concern of the population.

Investigation of cancer cell occurrence due to non-ionizing radiation in high microwave frequency range

Nantakan Wongkasem*

The University of Texas Rio Grande Valley, Edinburg, United States

https://doi.org/10.21175/rad.abstr.book.2025.23.4

The dielectric constant, also known as relative permittivity, measures a material's ability to store electrical energy in an electric field. Insulators or dielectric materials become conductive and allow current to flow through if the materials have absorbed a sufficient electric field intensity or strength, passing their breakdown level, so-called 'dielectric breakdown'. In biological tissues, cell permittivity is related to the tissue's ability to polarize in response to an electric field, which can be influenced by factors like water content, cellular structure, and membrane properties.

Cancer cells often exhibit a higher dielectric constant compared to normal cells, potentially due to changes in membrane properties, cellular contents, and extracellular fluid, which can be used for non-invasive cancer detection. A study on breast cancer cells showed that cancer cell lines exhibit a higher dielectric constant compared to non-tumorigenic cells, especially in the lower part of the measurement spectrum. Another study on lung cancer found that the dielectric properties of lung tumors were significantly higher than those of the surrounding healthy lung tissue. A study on colon cancer found that the dielectric constant of colon cancerous tissue was 8.8% higher than healthy tissues.

Ionizing radiation, ranging from the high-end of the Ultraviolet to the Gamma Ray, based on its high energy, can remove electrons from atoms; hence can change the chemical composition of the material it interacts with. In living tissue, this effect can result in a process that damages DNA and can result in the mutation of the impacted cell.

In this research, we investigate how a non-ionizing frequency radiation in the high microwave range, focusing on the W-band, 75-100GHz, can induce a higher dielectric constant in human cells, which could be the cause of cancer cells or mutation.

Problems of control in the scope of Directive 2006/25/EC on the health and safety of workers using lasers in the work environment

Mihaela Ivanova*[1], Michel Israel[1,2]

[1] National Center of Public Health and Analyses, Sofia, Bulgaria
[2] Medical University, Pleven, Bulgaria

https://doi.org/10.21175/rad.abstr.book.2025.23.5

In Bulgaria, legislation on protection from laser radiation in the work environment existed since 1986. It was developed on the basis of the ANSI laser standard and was a good basis for ensuring health and safety for workers. The requirements of the regulation included the following:

- Safety classification of lasers - based on the technical characteristics of the lasers – wavelength, power/energy, emission duration, pulse characteristics of laser beam, beam diameter/spot size, etc.;
- Assessment of radiation conditions, which includes assessment of compliance with protective measures for the respective class laser system: premise, presence of reflective surfaces, warning labels, protective equipment, additional hazards in the work environment;
- Training of personnel in the field of safe application of lasers - initially - upon entry to work and periodically to maintain competence - once every two years.

All these requirements have been applied to workplaces with lasers, and laser safety training has been carried out in accordance with the specifics of the lasers/laser systems used. The trained persons have been entered into a register. The control over compliance with legislation was performed by the regional hygienic inspections belonging to the Ministry of health.

The transposition of Directive 2006/25/EC into national legislation does not change these requirements. The classification of lasers is carried out only by the manufacturers, but the next two requirements are omitted and are not controlled by control bodies.

Omitting the second requirement means that it is not clear whether adequate protective measures have been applied in relation to the laser system class. The problem with laser safety training is also very serious, since in most cases the training provided by the manufacturer concerns certain process or procedure carried out. The content of the training is mainly aimed at the correct implementation of the procedure, but it is not focused on laser safety.

Our opinion is that the limited and often non-existent application of the legislation is determined by several main factors:

- The complexity of the legislation and the lack of specialists to apply it in occupational health services;
- Classification and assessment are an extremely specific matter: lack of sufficient specialists/laboratories with the necessary competence.

Analyzing the problems in the field of laser radiation control in the work environment, the article proposes measures for its implementation including employers, workers, control bodies, laser safety officers, etc.

Some difficulties in risk assessment of exposure to physical factors

Michel Israel[1,2], Mihaela Ivanova[1], Victorya Zaryabova[1], Tsvetelina Shalamanova*[1]

[1] National Centre of Public Health and Analyses, Sofia, Bulgaria
[2] Medical University, Pleven, Bulgaria

https://doi.org/10.21175/rad.abstr.book.2025.23.6

Physical factors affect humans primarily through their energy. These are mainly noise, vibrations, atmospheric pressure, electromagnetic radiation (non-ionizing and ionizing), microclimate, gravity, as well as corpuscular ionizing radiation.

Risk assessment is usually done in several stages, the main ones being: hazard identification, exposure assessment, dose-effect curve assessment, and finally risk management decision-making. This assessment is made by occupational health physicians, based on data obtained from measurements, assessments, preliminary and ongoing examinations, etc. For us, this assessment is one-sided and does not include all aspects of the risk. It is necessary to take into account not only medical indications, but also engineering, ergonomic, measurements and physical assessments, economic risk, social risk and other indicators that are not discussed in the risk assessment.

Physical factors, besides being universal in the nature of their application (almost all factors), are also "inherent" to humans and biological species, due to their presence to one degree or another during evolution. It is very difficult to determine the dose-effect curve because of this reason.

Another problem is the hygiene standards themselves, which are based on short-term exposure and do not include chronic, secondary or long-term exposure over a long period of time. It is clear that risk assessment without exposure thresholds is difficult to carry out. In order to cover the "subtle" processes of changes in the body under the influence of one or another physical factor, especially in combination, it is necessary for Occupational Health Services not to look for diseases among workers, but to recognize the first symptoms of the preclinical manifestations of the effects.

Theoretical description of a dual-line spectrometer for absorption measurements based on integrating cavities

Alessandro Agugliaro*[1], Rino Persiani[2], Sebastiano Albergo[1], Roberto De Angelis[1], Alessia Tricomi[1]

[1] Università degli Studi di Catania, Catania, Italy
[2] INFN - Catania, Catania, Italy

https://doi.org/10.21175/rad.abstr.book.2025.23.7

The utilization of cuvette-based spectrometers constitutes a well-established technique for executing light absorption measurements; however, this technique falls short when it comes to detecting suspended or deposited substances within a solution, of particular interest for analyses concerning water pollution. Furthermore, the use of longer cuvettes to detect very low concentrations of contaminants (below 1 part per million) can introduce a significant amount of scattering, which in turn would lead to an overestimation of the absorbance.

Integrating cavities with high wall reflectivity can be exploited to extend the effective optical path traveled by light in materials, improving the sensitivity to low concentrations, as well as to suspended, floating or deposited particles. To this end, we have developed a prototype of spectrometer, based on two identical spherical cavities made of PTFE, that function as reference and analyte holders, respectively. The samples are irradiated with two identical lamp pulses, while the output light is collected for detection by fiber optics to a pair of silicon photomultipliers, and the wavelength is selected using a monochromator.

In this talk, the focus will be on the theoretical description of our experimental setup. A quantitative comparison between our dual-line spectrometer and conventional spectrometers can be made based on a few assumptions, establishing simple relationships between the properties of the instrument – such as sensitivity and resolution – and those of the sample holders – such as inner wall reflectivity and spherical radius.

18-FDG PET/CT in the diagnosis and treatment of drug-resistant epilepsy with autologous bone marrow mesenchymal stem cells (ABMMSC)

Elena Slobina*[1,2], Tatsyana Dakukina[3], Fedor Khlebokazov[2], Nikolai Misyuk[2]

[1] JSC "Medicina", Moscow, Russia
[2] National Center for Mental Health of Belarus, Minsk, Belarus
[3] Laboratory of Sports Psychology, National Sports Center of Belarus, Minsk, Belarus, Minsk, Belarus

https://doi.org/10.21175/rad.abstr.book.2025.24.1

Purpose/Objective

To investigate 18-FDG PET/CT in the diagnosis and treatment of drug-resistant epilepsy with AMCSC.

Material/Methods

The study included 34 patients with drug-resistant epilepsy and generalized seizures (main group) and 34 patients in the comparison group from 2011 to 2023. Main group patients received stem cell therapy, while in the comparison group, treatment was carried out only according to the current protocol. All of patients were assessed for brain bioelectrical activity, PET/CT, MRI, immune status, BDNF. The analysis consisted of comparing the PET data of each patient with the control group to identify areas of glucose hypometabolism or increased glucose metabolism. To assess the effectiveness of treatment regions of interest analysis was performed, which included combining images obtained before and after treatment.

Results

A total of 104 ABMMSC transplants were performed in patients of the main group: 52 i.v. and 52 intrathecally (14 men/20 women). The safety of ABMMSC transplantation was assessed in the first 18 patients received a single course of cell therapy during an observation period of 10 to 12 years (Me-11 years). Side effects and complications were not registered. 14 patients received 2 courses of cell therapy and 2 patients-3 courses. Retrospective analysis of treatment results (after 24 months or more) of 16 patients who underwent 2 or more courses of cell therapy showed the absence of generalized seizures in 5 (35.71%) patients with an observation period of 4 to 7 years. Of these, 2 patients had remissions for 14 and 40 months, after which the seizures resumed again. After 3 courses of cell therapy, the seizures stopped in these patients. A significant reduction in generalized seizures (more than 50%) or their transformation into milder forms was noted in 6 (37.5%) patients. Unsatisfactory treatment results were obtained in 31.25% patients, including 2 patients with hippocampal sclerosis and 2 patients with only simple and complex partial seizures. The data obtained showed that the degree of decrease in glucose metabolism in the epileptic activity zone is in a statistically significant correlation with the number of epileptic seizures in the anamnesis. The diagnostic accuracy of 18-FDG PET/CT in temporal lobe epilepsy 89.0%. In 54% patients with PET hypometabolism zone, any structural brain abnormalities were either absent in MRI or were represented by a slight expansion of the temporal horn of the lateral ventricle.

Conclusion

18-FDG PET/CT is an informative method, allowing high accuracy to identify epileptic foci in epilepsy patients.

References

1. Treatment of refractory epilepsy patients with autologous mesenchymal stem cells reduces seizure frequency: An open label study/F.Hlebokazov, T.Dakukina, M.Makhrov [et al.]//Advances in Medical Sciences.–2017.–Vol. 62,No.2.–P.273-279.–DOI 10.1016/j.advms.2016.12.004.–EDN XMZAFE.
2. 18-FDG PET/CT in evaluation of the effectiveness of the complex treatment of symptomatic pharmacoresistant epilepsy/E.Slobina, T.V.Dokukina, F.P.Khlebokazov [et al.]//Eighth International Conference on Radiation in Various Fields of Research:Virtual Conference. Book of abstracts–Serbia: RAD Centre,2020.–P.65.–EDN HWRWZD.

Cognitive and functional resilience as markers of longevity and successful ageing

Graziella Orru*, Ciro Conversano, Giorgia Papini, Aleandra Viti, Angelo Gemignani

Department of Surgical, Medical and Molecular Pathology and of Critical Care Medicine, University of Pisa, Pisa, Italy

https://doi.org/10.21175/rad.abstr.book.2025.24.2

Successful ageing and lifespan are increasingly recognized as results influenced by the preservation of cognitive and functional capacities. These indicators or markers, influenced by genetic, environmental, and lifestyle factors, are crucial for maintaining autonomy and quality of life in advanced age.

Aim: the purpose of this study was to examine the existing empirical research on cognitive and functional resilience, assessing their roles as biomarkers of lifespan and successful ageing.

Methods/Data Sources: we performed a literature search of peer-reviewed research investigating cognitive resilience, functional ability, and their predictors.

Results: findings indicate that the maintenance of cognitive and functional abilities, together with the absence of disease across one's lifetime are critical markers of successful ageing and longevity (i.e., Schupf et al., 2004). Rowe and Kahn's framework (1987) highlighted three essential components, the following: (i) absence of disease, (ii) active engagement or participation in life, and (iii) maintenance of both cognitive and physical functions. Similarly, the World Health Organization (WHO, 2020) defines healthy ageing as "the process of developing and maintaining the functional ability that enables wellbeing in older age", emphasising the significance of sustaining abilities such as fulfilling basic needs, acquiring knowledge, making decisions, preserving mobility, establishing relationships, and contributing to society. Studies such as the New England Centenarian Study, which collected data on functional activities (ADLs) and instrumental activities (IADLs) of daily living, medications, major medical diagnosis, hospitalisation, and life circumstances, revealed that individuals who achieved extreme old age had generally maintained good health and independence throughout most of their lives (Hitt, Young-Xu, Silver and Perls, 1999). Recent empirical studies indicates that cognitive resilience, cognitive reserve and functional independence are essential for improving quality of life and serve as predictors of longevity. These parameters are influenced by a complex interplay of genetic, environmental, and lifestyle, encompassing physical activity, diet, social interaction, and mental stimulation. The concept of cognitive resilience underscores the brain's ability to adapt for age-related changes, thereby influencing individual variability in the onset and progression of cognitive decline (Stern et al., 2019).

Conclusions: cognitive and functional resilience are closely interconnected and play a pivotal role in promoting healthy ageing and longevity. Ongoing advancements in neuroscience are elucidating the biological mechanisms underlying ageing, providing prospective methods for early identification of individuals at risk of decline and the development of personalized interventions to enhance longevity. Determining efficient strategies and techniques to maintain cognitive and functional capacities is essential for improving both lifespan and healthspan.

***Keywords**:* Cognitive resilience, functional ability, longevity, neuroplasticity, ageing.

Resveratrol loaded micelles with recognition memory protective effect and acetylcholine esterase inhibitory activity in hippocampus of rats with scopolamine induced memory impairment

Maria Lazarova*[1], Miroslava Stefanova[1], Elina Tsvetanova[1], Almira Georgieva[1], Krasimira Tasheva[2], Lyubomira Radeva[3], Krassimira Yoncheva[3]

[1] Institute of Neurobiology, Bulgarian Academy of Sciences, Sofia, Bulgaria
[2] Institute of Plant Physiology and Genetics, Bulgarian Academy of Sciences, Sofia, Bulgaria
[3] Faculty of Pharmacy, Medical University of Sofia, Sofia, Bulgaria

https://doi.org/10.21175/rad.abstr.book.2025.24.3

Resveratrol (RVT) is a natural phenolic compound with neuroprotective effects in animal models of Huntington's, Parkinson's disease, and memory decline, suggesting its potential in Alzheimer's disease treatment. However, its low bioavailability limits clinical application. This study aimed to evaluate Pluronic micellar formulation as a platform for brain delivery of RVT. For this purpose, the effects of micellar (mRVT) and pure RVT on recognition memory performance, cholinergic neurotransmitter system and the levels of brain-derived neurotrophic factor (BDNF) in cortex and hippocampus of rats with Sco induced dementia were evaluated and compared. Micelles (~33 nm) were prepared using Pluronic P123 and F127 copolymers. Male Wistar rats (200–250 g) were divided into six groups: Control (0.9% NaCl), Sco (2 mg/kg), and four test groups receiving RVT or mRVT at 5 or 10 mg/kg alongside Sco for 11 consecutive days. The learning and memory performance of the animals were tested using Novel Object Recognition test. The effect on acetylcholine (ACh) and BDNF levels and acetylcholine esterase (AChE) activity in cortex and hippocampus of dementia animals were evaluated biochemically. Our results revealed that both mRVT and pure RVT exerted a recognition memory protective effect, AChE inhibitory activity in the hippocampus and preserved control level of ACh and BDNF in the cortex and hippocampus. The micellar resveratrol (10 mg/kg) demonstrated the best memory protective effect and AChE inhibitory activity. In conclusion, resveratrol loaded in Pluronic micelles represents a promising neuronal delivery system for further examination on animal neurodegenerative models.

Funding: This research was funded by NATIONAL SCIENCE FUND - BULGARIA, Grant number KP-06-N 73/10

Salvia aethiopis extract from cultivated plants–effects on spatial memory, acetylcholine and monoaminergic brain neurotransmissions in rats with scopolamine-induced model of dementia

Maria Lazarova[1], Miroslava Stefanova[1], Elina Tsvetanova*[1], Almira Georgieva[1], Krasimira Tasheva[2]

[1] Institute of Neurobiology, Bulgarian Academy of Sciences, Sofia, Bulgaria
[2] Institute of Plant Physiology and Genetics, Bulgarian Academy of Sciences, Sofia, Bulgaria

https://doi.org/10.21175/rad.abstr.book.2025.24.4

The species *Salvia aethiopis* belongs to genus Salvia within the Lamiacea family. Its main chemical constituents included iterpenes and phenolics, particularly rosmarinic and caffeic acids. While many Lamiaceae species show therapeutic potential in neurodegenerative disorders such as Alzheimer's disease, there is limited information on the effects of *S. aethiopis*. This study aimed to investigate the cognitive and neuromodulatory effects of *S. aethiopis* extract in a rat model of scopolamine (Sco)-induced dementia. Male Wistar rats (200–250 g) were divided into four groups: (1) Control, (2) Sco (2 mg/kg, i.p.), (3) *S. aethiopis* (100 mg/kg, p.o.), and (4) Sco + *S. aethiopis*. Scopolamine was administered for 11 consecutive days. The extract, obtained from the aerial parts of *in vitro*-grown plants, was administered orally for 21 days—starting 10 days before and continuing throughout Sco treatment. Spatial memory was assessed using the T-maze test, and neurotransmitter levels in the cortex and hippocampus were analyzed by enzyme-linked immunosorbent assay method.

Our results showed that Sco treatment caused short and long-term memory impairment and suppressed acetylcholine (ACh) and monoaminergic brain neurotransmissions. In dementia rats, *S. aethiopis* treatment ameliorate cognitive decline, preserved monoamine content in the hippocampus and had no effect on Ach ergic neurotransmission in cortex and hippocampus. In healthy animals, increased dopamine and serotonin brain content more affectedly in the hippocampus. In conclusion: *S. aethiopis* treatment protect animal from Sco –induced cognitive deficits and monoaminergic damage.

Funding: This research was funded by NATIONAL SCIENCE FUND - BULGARIA, Grant number KP-06-N56/16

The role of neutron diagnostics in thermonuclear reactors

Marek Scholz*

The Henryk Niewodniczański Institute of Nuclear Physics Polish Academy of Sciences, Kraków, Poland

https://doi.org/10.21175/rad.abstr.book.2025.25.1

The fuel of the first thermonuclear reactors, such as ITER or DEMO, will be a mixture of hydrogen isotopes, i.e. deuterium and tritium. As a result of the fusion of these isotopes, an alpha particle with energy of 3.5 MeV and a neutron with energy of 14.1 MeV is created. Neutrons escape from the plasma and pass through the magnetic field without interference and are absorbed in the blanket, and their energy is converted into heat. Measuring their total emission informs us about the reaction rate of the fusion, i.e. the power produced in the reactor. Measuring the energy spectrum of neutrons gives us information about the temperature and fuel ratio of the thermonuclear fuel. Additionally, measuring neutron fluxes on the first wall of the reactor allows us to predict the possibility of its radiation damage.

For this reason, measurements of neutrons are crucial for ITER. Diagnostics related to these measurements will be important for future experiments in burning plasma at ITER. High neutron emission and the very large plasma size in ITER make the neutron diagnostics the main diagnostics used to measure plasma parameters such as the fusion power, the fusion power density, the ion temperature, the fast ion energy and their spatial distributions in the plasma core.

In my presentation I would like to present my point of view on the role of neutronics in fusion reactors and diagnostic systems for neutron measurement planned in the ITER tokamak. With special emphasis on high-resolution neutron spectroscopy based on the GEM gas detector.

Acknowledgments: This work has been carried out within the framework of the EUROfusion Consortium, funded by the European Union via the Euratom Research and Training Programme (Grant Agreement No 101052200 — EUROfusion). Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Commission. Neither the European Union nor the European Commission can be held responsible for them. This work has been published in the framework of the international project co-financed by the Polish Ministry of Education and Science, as program "PMW“. This work was done as a project co -financed by ITER Organization and the Ministry of Science and Higher Education of Poland.

A novel accelerator-based setup for national scale ^{99}Mo production: Radiation protection aspects

David Ohm*[1], Bernd Neumeier[2,3,4], Johannes Ermert[2], Erik Strub[4], Marco Michel[4,2], Andreas Dragoun[4,2], Christoph Langer[5], Michael Butzek[5], Thomas Gutberlet[6], Eric Mauerhofer[6], Doruntin Shabani[5], Tarek El-Kordy[5], Clemens Walther[1]

[1] Institute of Radioecology and Radiation Protection, Leibniz University Hannover, Hannover, Germany
[2] Institute for Neuroscience and Medicine, INM-5 Nuclear Chemistry, Forschungszentrum Jülich GmbH, Jülich, Germany
[3] Institute for Radiochemistry and Experimental Molecular Imaging, University Hospital Cologne, Cologne, Germany
[4] Department of Nulcear Chemistry, University of Cologne, Cologne, Germany
[5] Faculty 10 – Energy Technology, FH Aachen, Aachen, Germany
[6] Jülich Centre for Neutron Science (JCNS), Forschungszentrum Jülich GmbH, Jülich, Germany

https://doi.org/10.21175/rad.abstr.book.2025.26.1

The joint project 99MoBest is committed to develop an innovate production concept capable of meeting the entire German demand for the critical radionuclide ^{99}Mo, which is currently approx. 60 TBq per week. Accelerator-based neutron sources offer ways to replace nuclear-reactor based production. In the construction phase, we already consider not only operative radiation protection aspects during irradiation and extraction, but also decommissioning and clearance aspects after the end of the facilities service life. These include minimization of long-lived nuclear waste and activation of structural components by choosing optimum material composition and geometries. By iteratively combining design, irradiation experiments and radiation transport modelling, the layout of irradiation target, irradiation site and postprocessing steps are optimized. We aim at achieving specific activities of structural materials low enough to benefit from the German concept of clearance, and hence, avoid costly radioactive waste disposal.

The irradiation facility is set to be part of the HBS site, a proposed accelerator driven neutron facility with a llinear proton accelerator capable of a peak current of 100 mA with 70 MeV protons, which can be used in several experimental setups. These protons are used to irradiate a tantalum target (source target), producing reactor-like neutron fluxes via the (p,n)-reaction, which activate a natural molybdenum target (irradiation target) to the required demand. Development of the different aspects (target neutronics and engineering, chemical processing and radiation protection) takes place in an iterative process between the project partners, to manage the respective demands and restrictions. The radiation protection is primarily tasked with activation studies to assist the irradiation target development with selecting the appropriate materials, considering both cost efficiency and low nuclear waste generation. Furthermore, we aim at achieving specific activities of structural materials low enough to benefit from the German concept of clearance, and hence, avoid costly radioactive waste disposal.

For this purpose, a model was developed that can examine the various aspects of a radiation protection assessment, but is nevertheless flexible enough to be adapted to the current status of the irradiation target developments. A code from CERN (FLUKA) serves as a basis, as it contains extensive validations for accelerator setups. The model currently focuses on activation studies

- in the source target, required for neutron generation,
- the irradiation target, for the chemical reprocessing and
- the surrounding materials like moderator, reflector, shielding and structural materials.

In summary, this work presents the current developments for the production of the radio diagnostical isotope ^{99}Mo via an accelerator-based neutron source and gives an overview of the radiation protection concerns regarding the development of such an irradiation facility in the iterative process.

Activation of radioisotopes used for medical purposes in the Budapest Neutron Centre

Noémi Anna Buczkó*[1,2], Boglárka Maróti[1], Zoltán Kis[1], Katalin Gméling[1], László Szentmiklósi[1]

[1] HUN-REN Centre for Energy Research, Institute for Energy Security and Environmental Safety, Budapest Neutron Centre, Budapest, Hungary
[2] ELTE Eötvös Loránd University, Hevesy György PhD School of Chemistry, Budapest, Hungary

https://doi.org/10.21175/rad.abstr.book.2025.26.2

Budapest Neutron Centre is involved in the SECURE (Strengthening the European Chain of sUpply for next generation medical RadionuclidEs) project, whose major goal is to secure the therapeutic and diagnostic radioisotope supply in Europe. That includes target development and reliable solutions for production methods of medical radionuclides in research reactors.

This study is focusing on the possibilities to produce beta-emitting nuclides Tb-161, Ag-111 and Au-199 at the Budapest Research Reactor. A set of validation experiments was performed on gadolinium, palladium and platinum-containing samples of natural isotopic composition irradiated in three vertical channels with highly different flux and neutron energy characteristics.

The irradiated sample geometries were implemented in the MCNP6 simulation model of the VVR-type 10-MW Budapest Research Reactor to obtain the neutron energy distribution in a format that can be fed into the FISPACT-II program for activity calculations. The resulting MCNP6 F4 tally output data were tabulated according to the CCFE-709 group energy structure, one of the native energy-bin sets of FISPACT-II, ranging from 10^{-5} eV to 10^{9} eV. Using these neutron field parameters, the irradiation and cooling times and the composition of the target, a radioisotope inventory can be obtained using the FISPACT-II code.

Following the irradiation, the experimental activities of the samples were measured using well-calibrated HPGe detectors placed inside low-background counting chambers. Gamma spectrometry was also used for quality control of the chemical composition of the materials used for validation.

The results were compared with the FISPACT-II calculations, and an agreement within 30% was found. Only few discrepant cases were identified which required further investigation.

Acknowledgement: The study was performed within the project SECURE funded by the European Union under grant agreement No. 101061230.

From nature to nuclear application: The anticancer potential of radiolabeled *Pinus pinea* extract

Duygu Tuğçe Baran*[1], Elif Yağmur Erdem[2], Kadriye Buşra Karatay[1], Levent Akman[2], Fazilet Zümrüt Biber Müftüler[1]

[1] Ege University Institute of Nuclear Sciences, Izmir, Turkey
[2] Ege University Faculty of Medicine, Department of Obstetrics and Gynecology, Izmir, Turkey

https://doi.org/10.21175/rad.abstr.book.2025.26.3

Breast cancer is the most commonly diagnosed cancer among women and holds a significant place among cancer-related mortalities worldwide. Ovarian cancer, on the other hand, is often diagnosed at an advanced stage and is known to have the highest mortality rate among gynecological malignancies. Traditional cancer treatment methods, including surgery, chemotherapy, and radiotherapy, are widely used; however, these approaches are associated with high costs and can also cause severe side effects by damaging healthy cells. This has increased the need for more targeted therapeutic strategies with reduced side effects. In recent years, plant-derived radiolabeled compounds have emerged as an innovative approach, offering a more effective treatment by selectively targeting cancer cells while minimizing adverse effects on healthy tissues.

This study aims to evaluate the anticancer potential of *Pinus pinea* (Stone Pine) needle extract by radiolabeling it with Iodine-131 (^{131}I), a commonly used radioisotope in nuclear medicine. *Pinus pinea* contains bioactive compounds such as flavonoids, phenolic compounds, and terpenoids, which exhibit antioxidant, anti-inflammatory, and anticancer properties. However, scientific data on the anticancer potential of *Pinus pinea* needles remain limited.

Within the scope of this study, *Pinus pinea* needle extract was obtained, and its quality control was performed using High-Performance Liquid Chromatography (HPLC) and Liquid Chromatography–Mass Spectrometry (LC/MS-QTOF) techniques. The obtained *Pinus pinea* needle extract was evaluated using a nuclear method, radiolabeling with Iodine-131 (^{131}I) ($t_{1/2}$: 8.02 days), which is widely utilized in nuclear medicine for diagnostic and therapeutic purposes. The radiolabeling efficiency of the compound was assessed using Thin Layer Radiochromatography (TLRC), and the chromatograms indicated a radiolabeling yield exceeding 95% (n=3).

Future studies will involve *in vitro* cytotoxicity and apoptosis analyses in breast cancer (MCF-7) and ovarian cancer (SKOV-3 and MDAH-2774) cell lines. Additionally, the *in vitro* bioactivities of the *Pinus pinea* needle extract will be further evaluated using the radioiodination method. Moreover, the design of advanced studies involving *in vivo* animal models is planned, allowing comparisons between *in vivo* and *in vitro* results.

This study highlights the anticancer potential of *Pinus pinea* needle extract and demonstrates the potential application of plant-derived radiolabeled compounds in nuclear medicine. The findings provide a foundation for further research on the effects of *Pinus pinea* extract on breast and ovarian cancer cell lines, suggesting that such bioactive compounds may offer a novel alternative in cancer treatment.

In situ dose measurements in brachytherapy and teleradiotherapy using scintillation detectors based on the tissue-equivalent Al_2O_3:C, Al_2O_3:C,Mg and heavy GAGG:Ce crystals

J. Winiecki*[1,2], B. Sobiech[1], S. Witkiewicz-Łukaszek[3], M. Akselrod[4], Y. Zorenko[1,3]

[1] Medical Physics Department, Prof. F. Lukaszuk Oncology Center, Bydgoszcz, Poland
[2] Department of Oncology and Brachytherapy, Collegium Medicum in Bydgoszcz of Nicholas Copernicus University in Toruń, Bydgoszcz, Poland
[3] Department of Physics of Kazimierz Wielki University, Bydgoszcz, Poland
[4] Landauer Inc., Stillwater Crystal Growth Division, Stillwater, United States

https://doi.org/10.21175/rad.abstr.book.2025.27.1

Conventional detectors based on ionization chambers, semiconductors or thermoluminescent materials, in principle, cannot be used to verify in vivo the radiation dose delivered during brachytherapy treatments with γ-ray sources. Analysis of existing alternatives to accurate in vivo dosimeters for brachytherapy suggests that the future of such detectors will be connected with monitor radiation dose in real time. The best approach to use for this purpose of the dosimetric materials based on scintillation crystals. The delivered radiation dose was registered using the radioluminescence response of the crystal scintillator and recorded using very sensitive compact luminescence spectrometers connected to the scintillator via a long optical fiber (so-called fiber-optic dosimeter (FOD). This measurement method is completely non-invasive, safe and can be performed in real time. The scintillation crystals can be embedded in the patient's body using a long optical fiber placed intra-cavernously in front of or next to the tumor. The crystals with close-to tissue density can be used in any location, including the respiratory ways, because they do not interfere with dose distribution. However, in the cases of radiation therapy where the detector can be located behind the target, the use of high-density and high-Zeff scintillators is strongly preferred. Thus, the FOD will play a key role in in vivo dosimetry in radiotherapy, providing direct, real-time monitoring of radiation delivered to the tumor and nearby critical structures. For the realization of above mentioned task, the scintillation detectors based on the Al2O3:C and Al2O3:C,Mg sapphire crystals with close-to tissue density ρ=3.99 g/cm³ and effective atomic number Zeff=10.8 as well as Gd3Al2.5Ga2.5O12:Ce garnet crystal with high ρ=6.63 g/cm3 and Zeff=54.4 were used in this work. The obtained results are very promising for constructing the efficient FODs. We observed a very good linear correlation between the dose and scintillation signal registered by detector system based on the Gd3Al2.5Ga2.5O12:Ce garnet crystals, 3.5 m long optical fiber and AvaSpec-HERO spectrometer. Close to liner dependence dose/scintillation output was obtained also for Al2O3:C and Al2O3:C,Mg crystals using the same detector system. These measurements and testing were performed on specially prepared phantom in the clinical conditions of the Oncology Center in Bydgoszcz, Poland for in-situ measurement of applied dose in the 0.5-8 Gy range at brachytherapy treatment procedure with of 192Ir (392 keV) source.
In summary, all scintillation crystals under study are promising materials for in situ dose measurement in brachytherapy. The differences observed between scintillation properties of these materials provide valuable information for selecting the most appropriate type of crystal for specific clinical needs and radiation dose requirements. Finaly, we found also that FODs based on the GAGG:Ce crystals are also very effective for the in-situ dose measuring of X-ray radiation in teleradiotherapy on the patient's body surface. The advantage of such FOD for teleradiotherapy compared to semiconductor detectors is the very high homogeneity and accuracy of real-time dose measurement, regardless of the direction of X-ray radiation. This increases the precision of determining the effective dose and effectiveness of the teletherapy and reduces the toxicity of this treatment in relation to the tissues adjacent to the tumor.

Acknowledgement: The investigations was performed in the frameworks of Polish NCN OPUS 24 LAP No 2022/47/I/ST8/02600 project and also supported by the Ministry of Science and High Education of Poland in frame of Regional Excellence Initiative nr RID/SP/ 0048/2024/01 project.

Analysis of multiple delamination in viscoelastic multilayered beams with rectangular section subjected to pure torsion

Victor Rizov*

University of Architecture, Civil Engineering and Geodesy, Sofia, Bulgaria

https://doi.org/10.21175/rad.abstr.book.2025.28.1

The properties of continuously inhomogeneous materials depend on the location. This paper is focussed on the problem of multiple delamination in viscoelastic multilayered rectangular beams under loading that induces torsion. Beam layers are made by different materials that are continuously inhomogeneous along the length. The basic aim is to deduce the strain energy release rate (SERR). General approach is developed. The approach considers a beam made of adhesively bonded inhomogeneous layers with parallel delamination cracks. The approach uses the compliance of the beam. The external torques applied on the beam is smooth functions of time. The viscoelastic behaviour is taken into account by using a time-dependent shear modulus. The internal torques is determined by solving an internal statically undetermined beam structure. Analysis of the SERR in a cantilever beam structure with two parallel delaminations is presented. The SERR found by the general approach is checked by a method that is based on the energy balance in the beam.

Lengthwise fracture analysis of inhomogeneous frames at non-linear creep

Victor Rizov*

University of Architecture, Civil Engineering and Geodesy, Sofia, Bulgaria

https://doi.org/10.21175/rad.abstr.book.2025.28.2

The present paper analyses the lengthwise fracture of a continuously inhomogeneous portal frame in terms of time-dependent strain energy release rate (SERR). The frame is subjected to non-linear creep. The material of the frame exhibits inhomogeneity in both thickness and width directions of the cross-section. By considering the balance of the energy, a solution of the SERR is derived assuming that the material properties involved in the non-linear stress-strain-time relationship vary continuously along the width and the thickness of the frame cross-section. A solution of the SERR is derived also by considering the complementary strain energy for verification. The solution is applied to evaluate the variation of the SERR with the time. The effects of material inhomogeneity in the width and the thickness directions on the SERR are investigated. A time-dependent solution of the SERR is derived also for the case when a notch is introduced in the inner crack arm.

Non-linear viscoelastic beams with two-directional material inhomogeneity: A longitudinal fracture analysis

Victor Rizov*

University of Architecture, Civil Engineering and Geodesy, Sofia, Bulgaria

https://doi.org/10.21175/rad.abstr.book.2025.28.3

This paper is focussed on analysis of longitudinal fracture in non-linear viscoelastic beam structures with two-directional continuous material inhomogeneity (the material properties change continuously in both width and thickness directions). The viscoelastic model that is used for treating the mechanical behaviour of the beam represents a combination of four linear and two non-linear springs and dashpots. The model is under strains which change with time. The material properties involved in the constitutive law are distributed continuously in the cross-section. The strain energy release rate (SERR) is derived. For this purpose, the curvatures are determined by using the equilibrium equations. The method of the *J*-integral confirms the correctness of the SERR solution.

The Impact of hydrodynamic conditions on *Chlorella vulgaris* adhesion in biofilm reactors

Zakaria Ghobrini*, Tomas Branyik, Djillali Ghobrini, Tomas Potocar

Department of Biotechnology, University of Chemistry and Technology Prague, Praha, Czech Republic

https://doi.org/10.21175/rad.abstr.book.2025.28.4

Microalgae, such as *Chlorella vulgaris*, offer significant potential for biotechnological applications, particularly in food production, wastewater treatment, and biofuel production.

This study investigates the adhesion of *Chlorella vulgaris* to modified glass surfaces (hydrophilic and hydrophobic) in two types of reactors: a ring biofilm reactor and a bubble-column reactor. Various conditions were tested, including rotation speed, nutrient concentration, and light intensity.

The results indicate that rotation speed (30 and 50 rpm) has a limited impact on surface colonization, while low light intensity reduces it. The highest colonization was observed in the bubble-column reactor without rotation, regardless of surface properties.

These findings highlight the importance of hydrodynamic conditions for maximizing microalgae adhesion, providing practical insights for optimizing reactor design in biotechnological processes.

Keywords: *Chlorella vulgaris*, Adhesion, Biofilm, Hydrodynamic conditions, Bioreactor.

Archaeometrical study of Roman silver coins using portable X-ray fluorescence

Velislav Bonev*[1, 2], Deyan Lesigyarski[2, 3], Varbin Varbanov[4], Boika Zlateva[2,5]

[1]Faculty of History, University of Sofia "St. Kl. Ohridski", 15 Tzar Osvoboditel blvd, Sofia 1504, Bulgaria
[2]Center of Archaeometry, University of Sofia "St. Kl. Ohridski", 35 Galichica str., 1164, Bulgaria
[3]National Institute of Geophysics, Geodesy and Geography, Bulgarian Academy of Sciences, Acad. G. Bonchev Str., Bl.3, Sofia,1113, Bulgaria
[4]Regional Museum of History Rousse, 3 Knyaz Al. Batenberg Sqr., Rousse 7000, Bulgaria
[5]Faculty of Chemistry and Pharmacy, University of Sofia "St. Kl. Ohridski, 1 J. Bauchier blvd, Sofia 1164, Bulgaria

https://doi.org/10.21175/rad.abstr.book.2025.28.5

Ancient coins are among the most important archaeological artifacts due to their usefulness as a dating material. On the other hand, they usually supply information about the social, economic, and technological development of the ancient societies and for the trade routes as well. Therefore, archaeometric investigations of ancient coins are of utmost importance for archaeology.

In this study, we present a quantitative analysis by portable X-ray fluorescence (p-XRF) aiming to identify the major and trace elements in Roman silver-copper coins dated to the 1st-3rd centuries CE. The specimens are a part of a hoard in the Museum of History in Belogradchik (NW Bulgaria), which includes 520 coins. For the present investigation, we analyzed a set of 102 coins using a Titan S1 portable spectrometer (Bruker, Germany). Thus, we managed to assess changes in composition and to confirm the devaluation of the currency. The average content of Ag is 62.29 % with a maximum value of 99.72 % and a minimum of 20.36 %. The other elements (except the Cu) have concentrations less than 1 wt. percent. The elements highest in concentration are Pb and Sn, which is in agreement with the allredy published data. The multivariate analysis performed on the data reveals two main groups (clusters) of coins, corresponding to the two currencies. Additionally, these clusters are divided into four subclusters, which is in excellent agreement with the historical information about the time of production and circulation of the coins.

Acknowledgments: *This study is supported by BG05M2OP001-1.001-0001 Project "Creation and development of "Heritage BG" Centre of Excellence". The maintenance of the micro-XRF instrument at the Sofia University's Centre of Archaeometry is supported by the INFRAMAT Project.*

X-ray fluorescence and rock-magnetic analysis applied for a provenance and technology study of a set a Iron Age ceramic amphorae: preliminary results

Deyan Lesigyarski*[1, 2], Kalin Madzarov[3], Elena Vasileva[3], Velislav Bonev[2, 4]

[1]National Institute of Geophysics, Geodesy and Geography, Bulgarian Academy of Sciences, Acad. G. Bonchev Str., Bl.3, Sofia,1113, Bulgaria
[2]Center of Archaeometry, University of Sofia "St. Kl. Ohridski", 35 Galichica str., 1164, Bulgaria
[3]National Institute of Archaeology with Museum, Bulgarian Academy of Sciences, 2, Saborna str. Sofia 1000, Bulgaria
[4]Faculty of History, University of Sofia "St. Kl. Ohridski", 15 Tzar Osvoboditel blvd, Sofia 1504, Bulgaria

https://doi.org/10.21175/rad.abstr.book.2025.28.6

Determination of the elemental and mineralogical composition is crucial when studying archaeological ceramic artifacts. Such data helps with the interpretation of provenance and production technology.

Determining the elemental and mineral composition is of critical importance when studying archaeological ceramic artifacts. Such data significantly helps in interpreting origin, production technology, trade in ceramic products, etc. In archaeometric studies, one of the most commonly used methods for determining the concentrations of chemical elements is XRF, as it is affordable and allows for non-destructive analyses.

In this study, we present the initial results of the analysis of a collection of ceramic amphorae found during excavations of the ancient city of Bizone on the Bulgarian Black Sea coast. The finds are dated to the 4th century BC and are characterized by the presence of four types of maker's stamps, here conventionally marked with the letters A, M, S, and H. The aim is to establish whether the amphorae with different stamps were produced from the same material or by a similar technology. The elemental composition of a total of 43 ceramic and 7 clay samples was analyzed using p-XRF, and to determine the maximum firing temperatures of the ceramic fragments, stepwise laboratory heating and measurement of their mass-specific magnetic susceptibility at each step were carried out. This parameter is a function of the magnetic mineralogy of the sample, which in turn depends on the composition of the clay dough, the maximum temperature reached, and the presence of oxygen in the kiln during firing. This method allows determination of Tmax with an accuracy of ± 20°C.

The studied ceramics are relatively rich in calcium, which shows levels between 6.49 and 12.38 % for the entire collection. This content of the calcium component is significantly higher than in the studied clay from the area of the archaeological site (respectively between 1.3 and 3.9 % Ca). The obtained data on the concentrations and the other determined chemical elements lead to a relatively good separation of the fragments with stamps A and M. At the same time, the studied samples with stamps S and H are not significantly discriminated either among themselves or from the other two groups of fragments.

Regarding the maximum firing temperatures and the behavior of the magnetic susceptibility as a function of the laboratory temperature, a tendency is observed for the application of a relatively unified firing technology for the fragments of the four groups. The determined maximum temperatures occupy mainly values of 820-840-860 °C.

XRF magnetic methods have proven their effectiveness in studying the technology of ceramic production. In our case, however, it is necessary to study more clay deposits using methods that allow the determination of rare earth elements in low concentrations. This approach will allow us to establish with greater accuracy the origin of the studied fragments from Bizone.

Acknowledgments: *This study is supported by BG05M2OP001-1.001-0001 Project "Creation and development of "Heritage BG" Centre of Excellence" and project KP-06-N90/4 funded by The Bulgarian National Science Fund. The maintenance of the p-XRF instrument at the Sofia University's Centre of Archaeometry is supported by the INFRAMAT Project.*

XRF analyses of ancient coins from South Bulgaria (RIM Haskovo)

Boika Zlateva*[1,2], Deyan Lesigyarski[2,3], Mariana Slavova[4], Ilya Prokopov[5]

[1]Faculty of Chemistry and Pharmacy, University of Sofia, 1 J. Bauchier blvd, Sofia 1164, Bulgaria
[2]Center of Archaeometry, University of Sofia, 35 Galichitsa Str., Sofia 1164, Bulgaria
[3]National Institute of Geophysics, Geodesy and Geography – Bulgarian Academy of Science, 3 Acad. G. Bonchev Str., 1113 Sofia, Bulgaria
[4]Regional Museum of History Haskovo, 19 Svoboda sq., Haskovo 6300, Bulgaria
[5]Faculty of History and Law, South-West University "Neofit Rilski", 66 Ivan Mihaylov str., Blagoevgrad 2700, Bulgaria

https://doi.org/10.21175/rad.abstr.book.2025.28.7

The aim of this investigation is to obtain information about the elemental composition of a set of ancient bronze coins. This will help for their numismatic expertise and to draw conclusions about the alloys used technology of production, authenticity, etc.

The studied collection includes of a total of 65 ancient bronze coins: 45 from Maroneia, Philip II Macedonian, Alexander the Great (4 coins) and the rest from Messambria. The coins are dated to the 4th-3rd c. BCE and are found as illegal traffic in Bulgaria and provided to the Haskovo Regional Museum of History.

The analysis of the elemental composition was done by micro-XRF instrument (Mistral M1, Bruker, Germany) applying a fundamental parameters method and external calibration by SRMs (MBH-33X GM7 and MBH-33X RB1 metal alloy certified reference materials, produced by the MBH Analytical LTD, England and BS SU 936, Brammer Standard Company Inc., USA).

The contents of 42 chemical elements are determined, and the results show that copper (Cu), tin (Sn), and lead (Pb) are the macro-compounds (in %) with traces of silver (Ag), gold (Au), bismuth (Bi), chromium (Cr), iron (Fe), nickel (Ni), zinc (Zn).

Statistical treatment (correlation and cluster analysis (CA), Principal Component Analysis, (PCA), Factor Analysis, (FA)) allow contextualization of the analytical results and permit to obtain a better knowledge of the used metal alloys and manufacturing procedure of the investigated coins. The coins' authenticity is confirmed taking into account the numismatic expertise and the elemental composition of the coins.

Acknowledgement: The study used equipment of the Distributed Scientific Infrastructure INFRAMAT, part of the National Roadmap of Bulgaria for Scientific Infrastructure, financially supported by the Ministry of Education and Science and the project "Building and developing a Center of Excellence" Heritage BG

Evaluation of thyroid gland ultrasonographic abnormalities in nuclears medicine staff

Danilo Kostic*, Sladjana Vukovic, Zoran Tomic

Serbian Institute of Occupational Health „Dr Dragomir Karajovic“, Belgrade, Serbia

https://doi.org/10.21175/rad.abstr.book.2025.28.8

Recent study have shown that medical staff may have absorbed different doses radioiodine in the thyroid gland depending on their profession, which can result in thyroid damage. This risk is also recognized in our legislation. Occupationally exposed workers to radioiodine must provided preventive medical examinations, witch included thyroid gland. The ultrasonographic evaluation of the thyroid gland is of great importance in the detection, evaluation and monitoring of changes. Some ultrasound sings are suggestive of malignancy.

The aim of this study is to analysed the prevalence of thyroid gland ultrasonographic abnormalities in nuclear medicine staff.

The ultarasonographic examination was performed in 60 workers, average age 47 years, who have been working in nuclear medicine for 17 years. The largest number of examination workers were female (81.7%). Thyroid gland ultrasonographic abnormalities were found in 52% workers. These changes have 60% of nurses, 55% of laboratory and pharmaceutical technicians, 55% of medical doctors, 33% of medical physicists and 30% radiological technicians. The mast changes detected in women (97%) and have been occur more frequently than in men (χ^2=9.78; p=0.002). The ultrasonographic abnormalities are nodules (61.3%), cysts (16.1%) and thyroidits like changes (22.6%).

These results sugest that the ultrasonografic examination very important part of periodical medical examination in nuclear medicine staff. Further research mast be including detection thyroid hormone levels in this population. Some studies have suggested that occupational radiation exposure may be a potential predictor for thyreoid cancer and further research mast be including thyreoid examination in other population of occupationaly radiation exposure workers.

Keywords: ionisatione radiatione, nuclear medicine staff, thyroid gland, ultrasonographic examination

Promoting STEM education through student challenges

Nika Golob*[1], Maja Hmelak[1], Tomaž Bratina[1], Eva Kranjec[1], Irena Petrušić[2]

[1] University of Maribor, Faculty of Education, Maribor, Slovenia
[2] Faculty of Management Herceg Novi, Herceg Novi, Montenegro

https://doi.org/10.21175/rad.abstr.book.2025.28.9

In today's rapidly evolving world, knowledge in the fields of STEM (Science, Technology, Engineering, and Mathematics) is essential to achieving progress and innovation. The shortage of qualified STEM teachers and researchers in these fields can be recognized as an existing and forthcoming problem. Faculty of Education at the University of Maribor (UM) recognizes the importance of encouraging students to explore and deepen their understanding in these areas.

Through various projects and research initiatives, we aim to provide students with practical experiences that will benefit them in their future careers. We also pay special attention to promoting gender equality in STEM fields. The UM is committed to promote gender balance in study choices through a range of strategies and initiatives. Cooperation with institutions from the business and non-business sectors is also encouraged through interdisciplinary projects such as the "Student Challenges at UM", which aims to address real challenges in the workplace. In forming the student project team, the Faculty of Education aims to increase girls' involvement in STEM projects. This corresponds to the need and recommendations of the EU document Promoting gender equality in STEM education and careers.

The contribution will provide successful project examples from recent years, reflecting their dedication and innovation in STEM: Virtual reality in education from kindergarten, primary and secondary school, Botanic VR garden and Enriching the outside activities on the tourist farm.

Acknowledgments: We wish to thank funders of the GEAR (Gender Equality in Academia and Research) project for co-financing this contribution: the project is partly funded by the European Union through the Erasmus+ CBHE (Capacity Building in Higher Education).

Development of a method for the quantitative determination of kanamycin in the active pharmaceutical substance of insulin Degludec

Alyona Kabanova*

GEROPHARM, Saint-Petersburg, Russia

https://doi.org/10.21175/rad.abstr.book.2025.29.1

Introduction

Kanamycin sulfate is an antibiotic used for cell selection. Although kanamycin is eliminated during the preparation of raw materials, there is a risk that trace amounts may remain and carry over into the final product. Residual kanamycin could trigger allergic reactions in consumers. Therefore, it is essential to monitor the obtained active pharmaceutical ingredient (API) for the presence of residual kanamycin. This experiment aimed to determine optimal conditions for obtaining reproducible results on any high-performance liquid chromatography (HPLC) system, specifically ensuring the detection of kanamycin in the presence of insulin degludec.

Materials and Methods

The following reagents, materials, and equipment were used in the experiment: Disodium tetraborate, sodium octanesulfonate, phenol, m-cresol, and an XBridge C18 column (4.6 mm × 250 mm; 5 µm). Equipment included a Shimadzu liquid chromatograph, a Waters liquid chromatograph, a Mettler Toledo combined analyzer (China), and a magnetic stirrer.

Results

Neither the excipients nor insulin degludec affected the retention time or other parameters of the kanamycin peak. Chromatographic conditions were optimized to obtain reproducible results, ensuring clear detection of kanamycin in the presence of insulin degludec and excipients. The sensitivity of the method was increased more than 20-fold. The efficiency of the chromatographic system for kanamycin analysis was significantly improved.

Discussion

The chromatographic conditions described in the article "Assay of Kanamycin A by HPLC with Direct UV Detection" by B. Blanchaert, E. Poderos Jorge, P. Jankovics, E. Adams, and Ann Van Schepdael were reproduced. However, the resulting data did not meet method criteria such as high sensitivity (S/N > 3), efficiency (more than 1,500 theoretical plates), and stable reproducibility (RSD for retention time and area < 5.0%). Further studies examined the effect of remaining API components on kanamycin peak parameters, confirming no significant influence. When switching from the Shimadzu to the Waters HPLC system, results were not reproducible due to insufficient sensitivity in the Waters system. To address this, the buffer's elution strength in the mobile phase was increased by 2.5 times, and acetonitrile was added to the buffer as a second mobile phase to create a gradient and remove insulin and excipient residues from the column. These modifications enabled kanamycin detection even at lower substance concentrations and improved chromatographic peak efficiency by 1.5 times. Additionally, adjusting the mobile phase gradient reduced analysis time by 50%.

Conclusions

1. Optimal conditions for kanamycin elution were established.
2. Insulin degludec excipients do not affect kanamycin chromatography.
3. Sensitivity and efficiency of the method were significantly improved.
4. Reproducible results were achieved.
5. Analysis time was reduced by half.

DoE approach to investigating protein aggregation mechanisms: A case study on Fc-fusion protein

Polina Astrelina*

R&D GEROPHARM, Saint Petersburg, Russia

https://doi.org/10.21175/rad.abstr.book.2025.29.2

Introduction

Fc-fusion protein therapies have advanced rapidly due to their effectiveness in treating various diseases. However, protein aggregation poses a significant challenge, impacting drug quality, safety, and efficacy. Aggregates reduce bioactivity and may trigger unwanted immune responses, making it critical to understand and address this issue. Investigating aggregation causes is key to improving drug stability. Ongoing research is essential to develop better methods for preventing or reversing aggregation during manufacturing and storage. This study aimed to identify optimal conditions to break down protein aggregates, restore the protein's natural structure, and assess how various factors influence aggregation prevention using the Design of Experiments (DoE) approach.

Materials

The study focused on protein aggregates formed during size-exclusion chromatography (SEC) of an Fc-fusion protein (64 kDa), using Sephacryl S-200 resin (Cytiva). Based on literature data, five parameters were chosen as factors influencing disaggregation. A statistical model was created using MODDE® software to design and analyze 49 experiments. The experiments varied the presence of surfactants (Tween® 80, Tween® 20, Triton® X-100, Brij®, CHAPs), reducing agents (dithiothreitol [DTT] and cysteine), chaotropic agents (guanidine hydrochloride and urea), and alcohols (isopropanol, glycerol, polyethylene glycol). The pH was adjusted within a range of 7 to 10. Product purity and yield were measured using size-exclusion chromatography to evaluate the disaggregation process and recovery of the native Fc-fusion protein structure.

Results

The selected parameters were tested for their impact on Fc-fusion protein aggregation. Surfactants like 1% Tween® 80 and 1% Triton® X-100 positively affected product yield. For purity, 1% Triton® X-100, 0.1% Brij®, and 0.5% CHAPs improved results. Dithiothreitol (1 mM) enhanced both yield and purity. Chaotropic agents, particularly 2 M guanidine hydrochloride, improved yield, but had no effect on purity. Alcohols (10% isopropanol, glycerol, polyethylene glycol) showed no significant impact. Higher pH values (7 to 10) positively influenced both yield and purity, highlighting the importance of pH in stabilizing the protein and preventing aggregation.

Discussion

The findings suggest that electrostatic interactions drive protein aggregation. Guanidine, a strong base, increases the protein charge, promoting electrostatic repulsion and preventing aggregation. In contrast, a neutral pH reduces the charge, encouraging aggregation. Reducing agents played a significant role; Dithiothreitol (DTT) enhanced both yield and purity, while cysteine, a weaker reductant, had a negative effect, likely due to its partial and reversible reduction of disulfide bonds, leading to protein re-oxidation and aggregation. Surfactants and alcohols showed mixed results, with no dominant effect on aggregation. The primary aggregation mechanism likely involves the loss of electro-neutrality, leading to disulfide bond formation and aggregate stabilization. This study provides insights into aggregation mechanisms and lays the foundation for optimizing conditions to minimize aggregation in therapeutic proteins.

Conclusion

Optimal conditions for disrupting Fc-fusion protein aggregates were identified, achieving high yield and purity in an alkaline buffer (pH 10) with Triton X-100, guanidine hydrochloride, and dithiothreitol. These conditions improve therapeutic protein quality and support regulatory compliance..

Electrochemical studies on the reduction of nitro-containing imidazole and benzimidazole compounds as antiparasitic agents

Nikolay Lumov*[1,2], Kameliya Anichina[2], Simeon Stoyanov[1], Denitsa Yancheva[1,2]

[1] Institute of Organic Chemistry with Centre of Phytochemistry - Bulgarian Academy of Sciences, Sofia, Bulgaria
[2] University of Chemical Technology and Metallurgy, Sofia, Bulgaria

https://doi.org/10.21175/rad.abstr.book.2025.29.3

Imidazole compounds are widely used in therapy against parasitic and bacterial diseases. Very important representatives are nitro group-containing drugs such as tinidazole, metronidazole, etc. It is known that the nitro group can undergo bioreduction through transformation in radical anion, radical dianion, nitroso- and hydroxylamino derivative in hypoxic conditions becoming toxic because of the connection to the DNA with covalent bonds.

Tinidazole was developed as an analogue of metronidazole and has been in use in Europe since 1969. It is used against protozoal parasites and a great number of anaerobic bacteria. Its mechanism of action is based on the reduction of the nitro group.

In view of the nitro bioreduction mechanism of action, our team synthesized benzimidazole derivatives containing a nitro group in their structure in order to investigate the potential of the resulting structures as candidates for antiparasitic testing.

In our study, we compare the reduction process of the known and already used in medicine tinidazole, and some benzimidazole compounds synthesized by us. The ability of the compounds to undergo nitroreduction has been studied with electrochemical method in combination with IR spectroscopy. DFT calculations at the B3LYP/6-311++G** level of theory helped to evaluate the preferred geometry of the molecules and radical anions, as well as their properties such as spin density, electronic charges, frontier molecular orbital energies, and electron affinity. Band shifts for the functional groups in the IR spectra showed good agreement between the theoretical and experimental values. In both tinidazole and benzimidazole compounds, the spin density is mainly localized in the the nitro group, with those in the imidazole compound surpassing the benzimidazole derivatives. This higher spin density localization is accompanied by stronger frequency decrease for the asymmetrical vibration of the nitro group during the tinidazole electrochemical reduction. The generated radical anions of the benzimidazole derivatives showed greater stability and reversibility of the reduction.

Acknowledgments: This study is funded by the European Union, NextGenerationEU, through the National Recovery and Resilience Plan of the Republic of Bulgaria, project no. BG-RRP-2.004-0002, “BiOrgaMCT”. Equipment of INFRAMAT (Research Infrastructure from National roadmap of Bulgaria), supported by Contract with Bulgarian Ministry of Education and Science is used in the present investigations.

1. Noriega, S. et al. Pharm 2022, 15, 717
2. Fung, H.B.; Doan, T.; P. Clin Ther, 2005, 27, 12, 1859-1884

Defects creation by irradiation with 220 MeV Xe of $MgAl_2O_4$ (100), (110), and (111) single crystals

Abdirash Akilbekov*[1], Arseny Kiryakov[2], Damir Bajtimirov [3], Alexey Podshivslov[3], Zhuldyz Ospanova[1], Alma Dauletbekova[1]

[1] Department of Technical Physics, L N Gumilyov Eurasian National University, Astana, Kazakhstan
[2] Institute of Solid State Chemistry, Ural Branch of RAS, Ekaterinburg, Russia
[3] Institute of Physics and Technology, Ural Federal University, Ekaterinburg, Russia

https://doi.org/10.21175/rad.abstr.book.2025.29.4

$MgAl_2O_4$ spinel (MAS) is a complex oxide compound belonging to the wide bandgap dielectrics Eg ~ 8eV class. Spinel crystals are used in optoelectronic applications as substrates for light-emitting devices. Spinel is a material for experiments that study the interaction of high-energy ionizing radiation with matter. When SHI is applied to spinel, a variety of defects are generated. This enables us to investigate these defects using multiple approaches, including optical spectroscopy and sensitive techniques like electron paramagnetic resonance (EPR. The arrangement of ions in crystallographic planes in spinel (100, 110, 111) has unique features, and in the case of plane (111), there is a formation of a kind of “wells” - areas not filled with ions along the entire length of the unit cell. The study aims to investigate defect formation features in 220 MeV irradiated $MgAl_2O_4$ crystals with (100), (110), and (111) planes. Optical absorption in the VUV and UV range examined the initial and irradiated crystals using the Thompson polarizer. Classical bands are registered in the initial and irradiated crystals due to the presence of F and F+ centers and optically active centers with the maximum energy below 4.5 eV.

For the initial samples with orientation (100) and (110) and samples after irradiation in the ranges from 3.5 to 4.5 eV, an increase in the absorption intensity was observed when the polarizer was rotated by 900. This was not observed for the (111) plane. The range between the third and fourth bands of Mn^{2+} hyperfine splitting in the EPR spectra of irradiated samples is of particular interest. Several signals have been registered for this range due to the formation of vacancies with trapped unpaired charge carriers. The authors previously registered a similar set of signals during the irradiation of spinel crystals with fast neutrons. The position of the signals detected in the present work also shows angular dependence (change in the magnetic field) and azimuthal dependence (change in the magnetic field).

References

1. Akilbekov A. et al., Materials 16 (2023) 6414.
2. Seeman, V., et al.., Optical Materials 91 (2019) 42–49.

Dubna, ultra-low temperature, usage, history and traditions

Yury Usov*

JINR, Dubna, Russia

https://doi.org/10.21175/rad.abstr.book.2025.30.1

History

1952 - The principle of the 3He/4He dilution method was proposed by Heinz London 1962.

1962 - London H., Clarke G.R., and Mendoza E. proposed a scheme for continuously operating 3He/4He dilution refrigerator.

1965 - The world's first refrigerated dilution machine has been created at Leiden University. Das P., Ouboter R.B., Taconis K.W. (Tmin ≈ 220 mK)

1966 - Neganov B.S., Borisov N.S. and Liburg M.Yu. at JINR, they created a dilution refrigerator that allows obtaining a temperature of 25 mK in the circulation mode and 5mK in a single mode.

Today - Modern dilution refrigerators allow obtaining temperatures in the range 10-50 mK. The lowest temperature obtained using a cryostat dilution is Tmin ≈ 2 mK

Achieving Very Low Stationary Temperatures in 1966 at JINR by B.S.Neganov, N.S.Borisov and M.Yu.Liburg [1] and another group gave rise to the IDEA of using a radically new cooling technique based on dissolving 3He in 4He, to create a Frozen Spin Polarized Target. In fact, four facilities of this type had been developed which are used until now in experiments at the beams of IHEP-Protvino, PNPI-Gatchina, Charles University-Prague and Mainz University. The short history of the development of such proton and deuteron targets using this method for obtaining ultra-low temperatures at the JINR, is given. In 1975, the first (world's first, as turned out later) frozen polarized target [2] was used at the LNP synchrocyclotron in the experiment on the investigation of polarization effects in pp interactions at 500 to 630 MeV. That was the first use of the new method for producing ultralow temperatures in experimental physics. In 1977, an ultralow-temperature setup for studying short-lived nuclei was developed at the SLT (Sector of Low Temperatures) with the decisive participation of V. N. Pavlov [3]. It allowed the LNP Radiochemical Laboratory (RCL) to implement its vast research program. Surprisingly soon, in 1978, the second polarized target [4] of the frozen type, was made specially for the research at the Institute of High-Energy Physics (IHEP) in Protvino. In 1994 we have developed the new target 20 cm3 in volume intended for polarization parameter studies in np-scattering using a 15 MeV polarized neutron beam produced by the Van de Graaf accelerator of the Charles University, Prague [5]. The new frozen spin polarized target has been developed together with the group from Mainz University for experiments with the polarized beam of the "real" photons at the A2 facility of the "MAMI C" accelerator to measure the photon absorption cross-section at energies up to 1.5 GeV [6]. Also, it is supposed that the JINR team, SLT, with its unique experience [7] and achievements in this field (similar operating facilities in Gatchina, Protvino, Prague, and Mainz) will play a leading part in these activities. In 2015 the contract on producing a new cryostat was signed between JINR and Bonn University. According to this contract, our team should make the dilution cryostat with the following technical characteristics: The goal for the base temperature is 25 mK. At the moment, we have all the main parts of the Bonn cryostat and we started general assembling. Now about the main and new among our scientific activities: the SLT researchers currently participate in development of the precision Möller polarimeter for MESA, the new superconducting accelerator of polarized electrons at the University of Mainz. The main part of this polarimeter is a powerful 3He/4He dilution refrigerator, and this is just the area of the SLT's unique experience and best methodological practices.

References

1. B.S. Neganov, N.S. Borisov, M.Yu. Liburg, JETP 50 (1966) 1445.
2. N.S. Borisov et al., JINR Preprints 13-10253, 10-10257, Dubna 1976; Prib. Techn. Exp. 2 (1978) 32.
3. Pavlov V.N. et al. "Cryogenics", 1978, 2, p.
4. N.S.Borisov et al. JINR Communication 1-80-98, Dubna, 1980.
5. N.S. Borisov et al., Nucl. Instr. & Meth. A 345 (1994) 421.
6. Thomas et al., ISSN 1063-7796, Physics of Particles and Nuclei, 2013, Vol. 44, No. 6.
7. Yu.A. Usov, Nucl. Instr. & Meth. A 526 (2004) 153

Effect of 24.5 MeV ^{14}N ion irradiation on the EPR spectra and luminescent properties of $R_3Al_5O_{12}$:Ce (R=Lu, Y, Tb) single crystalline films scintillators

Alma Dauletbekova*[1], Abdirash Akilbekov[1], Nuraiym Pirzadayeva[1], Valentyn Laguta[2], Vitaliy Gorbenko[3], Artur Majewski -Napierkowski[3], Yurii Syrotych[3], Sandra Witkiewicz-Lukaszek[3], Yuriy Zorenko[3,4]

[1] Department of Technical Physics, L N Gumilyov Eurasian National University, Astana, Kazakhstan
[2] Institute of Physics, Academy of Sciences of Czech Republic, Prague, Czech Republic
[3] Physical Faculty of Kazimierz Wielki University in Bydgoszcz, Bydgoszcz, Poland
[4] Medical Physics Department, Prof. F. Lukaszuk Oncology Center, Bydgoszcz, Poland

https://doi.org/10.21175/rad.abstr.book.2025.30.2

In the last three decades, the Ce3+ doped A3B5O12 (A=Lu, Gd, Y, Tb; B=Al, Ga) garnets have become important scintillation and dosimetric materials. Nowadays, the garnets in the different crystalline forms (crystals, single crystalline films (SCF), ceramics, micro- and nanopowders) are considered as excellent luminescent transformers of various types of ionization radiations (α- and β-particles, electrons and neutrons, and X and γ-quanta) into emission in the broad spectral range. However, the scintillation figure-of-merit of different functional forms of garnets significantly depend on the presence and concentration of defect centers, which can be created in the garnet hosts depending on the method of their preparation. Due to their application, the scintillation detectors are always influenced by the high-dose ionization radiations, which also can produce defect centers if the irradiation energy overcomes the respective defects' energy creation. For garnets, the main type of defect is of antisite defects (AD) of A_B type with the lowest energy of formation and the aggregation of these defects with oxygen vacancy defect (VD) centers. However, the large concentration of these defects in melt-grown single crystals at high (1900-2000^{o}C) temperatures in an oxygen-free atmosphere prevents the estimation of the real radiation resistance of the garnet compounds because a large concentration of defects results in a decreasing onset of the radiation stability of these materials. On the other hand, the SCFs of garnets look much more suitable for estimating the radiation stability of these oxides. Indeed, the SCF of garnets, grown from the melt-solution at significantly lower (1000^{o}C) temperatures in the atmosphere using the LPE method, possess the stochiometric content and are free from the AD and AD-VD centers. For this reason, the SCFs of garnets can be considered excellent samples for determining the radiation stability of these compounds. In this work, the radiation stability of Ce^{3+} doped $R_3Al_5O_{12}$ (R=Lu, Y, Tb) SCF scintillators, irradiated with 24.5 MeV ^{14}N ions at 300 K with fluences in the 10^{11}–10^{14} ion/cm^2 at accelerator DC-60 (Astana, Kazakhstan), was investigated. In the case of irradiation with 24.5 MeV N ions, the range R of propagation N ions was equal to 11.19 μm [1]. The radiation stability of materials under study was investigated using conventional structural and optical techniques, as well as advance spectral and radiospectroscopy methods like electron-paramagnetic resonance (EPR) and time resolved luminescent spectroscopy measurements under excitation by synchrotron radiation (SR) with energy 3.7-12.5 eV range at 8 and 300 K at DESY, Hamburg, Germany. The mentioned energy range of SR covers part of the transmittance range, exciton range, and onset of interband transition of the respective garnet hosts. We have found that the condition of N ions interacting in the 10^{11}–10^{13} ion/cm^2 range with the garnet host resulted in small changes in the EPR spectra and luminescent properties of $R_3Al_5O_{12}$:Ce SCFs and significant changes after irradiation with a fluence of 10^{14} ion/cm^2. It looks very likely that the LPE-grown SCF of $R_3Al_5O_{12}$ (R=Lu, Y, Tb) garnet shows notably higher radiation stability than their crystal bulk analogues grown from high-temperature melt.

Acknowledgements: The work was performed in the frameworks of Polish National Centre (NCN) OPUS 24 LAP No 2022/47/I/ST8/02600 project and also supported by the Ministry of Science and High Education of Poland in frame of Regional Excellence Initiative nr RID/SP/0048/2024/01 project.

References

1. J.F. Ziegler, J. P. Biersack, M. D. Ziegler, SRIM - The Stopping and Range of Ions in Matter, Lulu Press, 2008

8.

Exploring the excited states of tetrahydropyran using electron energy loss spectroscopy

Maria Lachowicz*, Ireneusz Linert, Tomasz J. Wąsowicz

Division of Complex Systems Spectroscopy, Institute of Physics and Applied Computer Science, Faculty of Applied Physics and Mathematics, Gdansk University of Technology, Gdańsk, Poland

https://doi.org/10.21175/rad.abstr.book.2025.30.3

Heterocyclic molecules that belong to the ether group, such as tetrahydropyran (THP), attract the interest of scientists from a wide variety of fields. Starting from combustion chemistry through material engineering and ending in medical and pharmaceutical sciences, many new ways of using this compound are emerging. THP has gained particular recognition in environmental sciences due to its sustainable production process. By chemically treating lignocellulosic biomass and subjecting the resulting furfural to various reactions, it is possible to create an environmentally friendly fuel, THP. It can play a key role in combating climate change due to its non-carcinogenic and non-toxic properties. Therefore, understanding its physicochemical properties, including the structure of its excited states, is crucial.

Electron energy loss spectroscopy is a method that has been used to study excited states of many molecules. Its main advantage over optical measurements is the possibility of detecting triplet states, which are forbidden by optical rules. An additional technique used in these measurements was the magnetic angle changer (MAC), which enabled us to probe electron scattering over a wide range of angles, including backscattering (180°). Due to the interactions between the incident electrons and the molecules under specific conditions, we were able to favor singlet or triplet states selectively. For instance, in backscattering with low incident electron energy, triplet states were the most intense. Another type of spectra we measured was the threshold spectra. Using a beam electron spectrometer, we recorded several electron energy loss spectra for tetrahydropyran. After a detailed analysis, we determined the energies of the excited states for tetrahydropyran.

Power-dependent walk-off in bias-free nematic liquid crystals: Numerical results

Aleksandra Strinić*, Milan Petrović

Institute of Physics, University of Belgrade, Belgrade, Serbia

https://doi.org/10.21175/rad.abstr.book.2025.30.4

We investigate numerically full three-dimensional model for beam propagation in highly nonlocal bias-free nematic liquid crystals, which account for the power-dependent walk-off and absorption.

We calculate the fundamental soliton profiles using the modified Petviashvili method.

To check the stability of such optical soliton solutions, we propagate them in anisotropic bias-free nematic liquid crystals with arbitrarily large birefringence.

The numerical results are in good correlation with the experimental ones.

Simulation of vacuum conditions and ion beam losses for designing vacuum systems of heavy ion accelerators and radiation facilities

Alexander Tikhomirov*, George Gulbekyan, Boris Gikal, Igor Kalagin, Nikolay Kazarinov, Vasiliy Semin, Kirill Gikal, Oleg Chernyshev

Joint Institute for Nuclear Research, Flerov Laboratory of Nuclear Reaction, Dubna, Russia

https://doi.org/10.21175/rad.abstr.book.2025.30.5

The results of numerical simulation of vacuum conditions for the design of vacuum systems of the heavy ion accelerator complexes and radiation facilities are presented. The requirements to construction materials are determined. The developed method for estimating ion beam losses is based both on numerical modeling of the pressure distribution in vacuum chambers of practically any arbitrary geometry, and on calculating cross sections for recharging ions with residual gases. This method was implemented using computer programs GENAP and VACLOS, which provide a good agreement to experiments during a long-term experience of acceleration of heavy ions in cyclotron complexes of FLNR. These computer programs were used to design vacuum systems of accelerator complexes, such as the DC 72 cyclotron in Slovakia, the CYTREC cyclotron complex in Dubna, the DC-60 cyclotron complex at the Astana University in the Republic of Kazakhstan, the DC-110 cyclotron complex at the Dubna Center of Nano & Nuclear Technologies, the DC-280 heavy ion cyclotron complex and the upgraded cyclotron complex U400R at the FLNR, JINR.

Solution to the problem of occurrence of higher harmonics when using pyrolytic graphite PG (002) as a device for monochromatization of neutron flux

Aleksandra Paveleva*[1], Ksenia Busuek[2]

[1] Petersburg Nuclear Physics Institute named by B.P. Konstantinov of National Research Centre «Kurchatov Institute», Gatchina, Russia
[2] NR Tomsk Polytechnic University, Tomsk, Russia

https://doi.org/10.21175/rad.abstr.book.2025.30.6

Introduction. Polycrystalline materials are described not only by their microstructure but also by their texture, which is a function of the distribution of crystallographic orientations of grains relative to the external coordinate system. Which indicates the importance of new materials in texture research. The neutron diffraction method for texture analysis has the main advantage is that the interaction of neutrons with the material is much weaker and does not depend on the number of electrons. Therefore, the penetration depth of neutrons into the studied volume is approximately 3 orders of magnitude higher than that of X-ray radiation.

Experimental part. One of the main elements of the reseach station for neutron texture difraction is a monochromator, the use of which allows one to select a part of the neutron flux with the required wavelength from the total neutron flux, which directly affects the quality of the results obtained. The operating principle of this element is based on the Wolfe-Bragg law. It is proposed to use Cu (111), Cu (200), and PG (002) as a reflector crystal for the monochromator. The use of these crystals will allow one to implement the required range of neutron wavelengths necessary for a wide range of experiments. Pyrolytic graphite PG is effective due to its high reflectivity reaching 90%. Its application is especially relevant for samples with interplanar distances of more than 1.5 Å. However, in PG crystals, neutron flux is reflected not only from the (002) planes but also from their higher orders. Thus, there is a contribution of higher harmonics to the total intensity of the neutron flux arriving at the sample, which leads to the suppression of the contribution of neutrons from the useful wavelength to the obtained results, significantly reducing the resolution of the obtained data. Thus, to solve this problem, there is a need to use the neutron filter. This element is a graphite-based filter, effectively eliminating the second or third orders of reflection. The main characteristic of a graphite filter is its thickness. The selection of this value to ensure the required neutron flux parameters is possible by modeling the entire setup and this element in the McStas environment.

Results. To reduce the intensity of higher orders of reflection and to increase the resolution of the setup when using the PG (002) monochromator, a mathematical model of the setup with a filter in front of the monochromator was developed and implemented. To determine the optimal filter parameters, a parametric study was carried out, in which the graphite plate thickness was varied in the range from 0.00 to 0.15 meters with a step of 0.01 m for the modeling mode: rotation angle of the PG (002) monochromator with a lattice constant of 3.35Å $2\theta = 37.2°$, $\lambda min=0.8$ Å, $\lambda max=3$ Å. The modeling results are shown in Figure 2. The optimal thickness of the graphite filter is the one at which the assumption is fulfilled that the influence of second- and third-order neutrons on the spectrum of neutrons scattered by the sample will be insignificant and can be taken into account as noise in the process of processing the experimental data. The optimal neutron intensity on the sample should be no lower than 10e7 conventional units.

Up-conversion luminescence and energy levels structure of $CsPbCl_3$:Yb,Nd single crystals

Mykola Shevchuk[1], Serhiy Malynych[2], Taras Demkiv*[1], Iryna Moroz[3], Roman Gamernyk[1], Andriy Pushak[1], Oleh Antonyak[1], Anatolii Voloshynovskii[1]

[1] Ivan Franko National University of Lviv, Lviv, Ukraine
[2] Hetman Petro Sahaidachnyi National Army Academy, Lviv, Ukraine
[3] Lviv Polytechnic National University, Lviv, Ukraine

https://doi.org/10.21175/rad.abstr.book.2025.30.7

A key factor in utilizing materials as efficient detectors of high-energy quanta (X- and γ-ray ranges) is a high effective atomic number. Lead-containing alkali-halide perovskites belong to this class of compounds, which also exhibit a direct bandgap and a significant diffusion length-lifetime product for photoionized charge carriers. Additionally, these crystals are characterized by low phonon energy, which enhances the probability of radiative transitions during the relaxation of electronic excitations. These properties enable the development of current-mode electromagnetic radiation detectors operating across broad spectral ranges. Furthermore, doping alkali-halide perovskites with lanthanides increases the effective atomic number and introduces additional absorption bands.

This study investigates the photoluminescent and photoelectric properties of $CsPbCl_3$ single crystals doped with Yb and Nd impurities. The synthesis was carried out using CsCl and $PbCl_2$ precursors, with doping achieved by introducing controlled amounts of $YbCl_3$ and $NdCl_3$ into the melt during crystal growth via the Bridgman method. The resulting crystals appear transparent with a slight yellowish tint.

Trivalent lanthanide dopant ions, in conjunction with lead vacancies, form electrically neutral complexes $(2Ln_{Pb}+V_{Pb})^0$. In the presence of two different lanthanides, both homogeneous and heterogeneous complexes can form. The existence of heterogeneous impurity complexes facilitates resonant energy transfer from Yb^{3+} to Nd^{3+} ions. Up-conversion luminescence of Nd^{3+} ions was observed under excitation in the absorption band of Yb^{3+}, demonstrating the ability to generate excited lanthanide ions throughout the crystal volume due to its transparency. Given the low phonon energy of the crystal, this process provides a prerequisite for efficient laser generation.

The spectral dependence of the photodiffusion current allows for the determination of the fundamental energy level of impurity ions within the crystal's bandgap [1]. Using this approach, we established the positions of Yb^{3+} and Nd^{3+} levels in the bandgap and identified the photoionization generation ranges of charge carriers. It has been previously reported that Yb doping in $CsPbCl_3$ induces the quantum cutting effect, whereby two quanta are generated upon the absorption of a single high-energy quantum [2]. These characteristics support the development of high-energy electromagnetic radiation current detectors and photodiodes based on $CsPbCl_3$:Yb,Nd crystals. Furthermore, doping these crystals with Yb and Nd enables laser generation in Nd^{3+} ions upon excitation in the Yb^{3+} absorption band.

1. Bulyk L.-I., Gamernyk R., Chornodolskyy Ja., Malyi T., Vistovskyy V., Demkiv T., Shtablavyi I., Voloshinovskii A. J. of Alloys and Compounds, **2021**, 884, 161023. doi: 10.1016/j.jallcom.2021.161023;
2. Demkiv T.M., Chornodolskyy Ya.M., Muzyka T.M., Malynych S.Z., Serkiz R.Ya., Pushak A.S., Kotlov A., Gamernyk R.V. Optical Materials: X, **2024**, 22, 100303. doi: https://doi.org/10.1016/j.omx.2024.100303

Recent results from SND@LHC, the Scattering and Neutrino Detector at the CERN LHC

The SND@LHC Collaboration represented by Marco Dallavalle*

INFN, Bologna, Italy

https://doi.org/10.21175/rad.abstr.book.2025.30.8

SND@LHC is a compact and stand-alone experiment to perform measurements with very high energy neutrinos produced at the CERN Large Hadron Collider. The experiment is located 480 m downstream of the proton-proton interaction point IP1 in the unused TI18 tunnel. The detector is composed of a hybrid system based on an 800 kg target mass of tungsten plates, interleaved with emulsion and electronic trackers, followed downstream by a calorimeter and a muon system. The configuration allows efficiently distinguishing between all three neutrino flavours, opening a unique opportunity to probe physics of heavy flavour production at the LHC in the region that is not accessible to ATLAS, CMS and LHCb. This region is of particular interest also for future circular colliders and for predictions of very high-energy atmospheric neutrinos. The detector concept is also well suited to searching for Feebly Interacting Particles (aka Dark Matter) via signatures of scattering in the detector target. The first phase aims at operating the detector throughout LHC Run 3 to collect a total of 290/fb. The experiment has been running successfully since 2022, and it has published several results. This talk will focus on the experience gained from the first measurements and how this is being used to achieve the physics goals of SND@LHC.

An online procedure for evaluating the magnetic flux density emitted by complex conductor systems

Moreno Comelli*[1], Nicola Zoppetti[1], Bruno Spataro[2], Mostafa Behtouei[2], Martina Carillo[2]

[1] Institute of Applied Physics - National Research Council (CNR-IFAC), Florence, Italy
[2] National Institute for Nuclear Physics (INFN-LNF), Rome, Italy

https://doi.org/10.21175/rad.abstr.book.2025.30.9

The "Nello Carrara" Institute of Applied Physics at the National Research Council (CNR-IFAC) has developed the WebNIR portal, "Web Tools for Evaluating Occupational Exposure to Non-Ionizing Radiation" (https://webnir.eu). This portal provides several specialized tools, including one that calculates the magnetic flux density generated by systems of conductors with mixed geometries, such as broken lines, catenaries, and circular loops. This tool enables assessments in various environments (laboratories, workshops, clinics) where field sources can be modeled as combinations of simple conductors, including coils, solenoids, and linear or suspended conductors. For catenaries, approximations are made with segmented lines, while a precise calculation procedure developed by INFN for circular loops has been implemented, utilizing Python scientific packages (especially NumPy). This significantly improves computation times by at least an order of magnitude. The tool has been internally validated through comparisons with independently derived procedures, yielding positive results. The calculation tool is designed to integrate with visualization and mapping software such as QGIS, enabling the import/export of conductor geometries and simulation results in compatible formats for further analysis. It is applicable in both protective and accelerator physics contexts, supporting evaluations of magnetic induction inside coil structures, particularly off-axis behavior.

Evaluation of angular differential cross section of tungsten isotopes by interaction potentials obtained from nucleon densities

Ferhan Akdeniz[1], Unal Yildirir[2], Ismail Hakki Sarpun*[1,3,4], Abdullah Aydin[5]

[1] Akdeniz University Physics Dept., Antalya, Turkey
[2] MEB Goynuk Science High School, Antalya, Turkey
[3] Akdeniz University, Faculty of Medicine, Radiation Oncology Dept., Antalys, Turkey
[4] Akdeniz University, Nuclear Research and Application Centre, Antalya, Turkey
[5] Kırıkkale University Physics Dept., Kırıkkale, Turkey

https://doi.org/10.21175/rad.abstr.book.2025.30.10

In this study, an optical model based elastic scattering was investigated in which neutron was used as a projectile particle. The nucleon densities of the some tungsten isotopes were calculated to use in single folding method to obtain interaction potential of (n,el) reaction depending on the neutron incident energy. The nucleon densities of tungsten isotopes were calculated by Skyrme-Hartree-Fock method used with Woods-Saxon Potential (SHF-WS) The obtained densities were used in the Single Folding model to calculate nucleon-nucleus interaction potentials for the neutron incident energies of various neutron incident energies which experimental data is available in EXFOR Nuclear Data Library. The angle-dependent differential cross sections were obtained using these interaction potential values were compared with existing experimental results and other theoretical studies in the literature. The angular cross section values are also compatible with experimental results which was found in the EXFOR library.

In-field measurements of ^{226}Ra and ^{228}Ra in oil-scale with a Ce:LaBr3 Detector

Sheldon Landsberger*, Mete Bayrak, Brandon De Luna

University of Texas, Austin, United States

https://doi.org/10.21175/rad.abstr.book.2025.31.1

We have evaluated the use of a cerium-doped lanthanum bromide detector ($LaBr_3$:Ce) to determine ^{226}Ra and ^{228}Ra in oil scale to be used for in-field measurements in the oil exploration sector. Three oil scale samples were analyzed using a reference material of ^{226}Ra and ^{228}Ra supplied by Eckert and Zeigler by traditional high purity germanium (HPGe) gamma-ray spectrometry. Then one of the samples was used as a reference standard to be used in the analysis of the two other samples using the $LaBr_3$:Ce detector. A deconvolution method was used to separate out the overlapping peaks of 911.2 keV belonging to ^{228} Ac, the daughter product ^{228}Ra which is in secular equilibrium, the 934.1 keV photopeak belonging to ^{214} Bi peak and the 964.9 keV and 969.0 keV photopeaks also belonging to ^{228} Ac. The results from the $LaBr_3$:Ce detector obtained in two hours of counting agreed well within the uncertainties of those of HPGe. For regulatory purposes the $LaBr_3$:Ce detector is more than adequate to be used for in-field measurements instead of sending the samples to laboratories for analysis which may be both expensive and time-consuming

^{210}Po/^{210}Pb activity concentration in resuspended aerosols

Edit Tóth-Bodrogi[1], Dániel Vincze[1], Beatrix Jancsek-Turóczi[2], Anita Csordás*[1], Tibor Kovács[1]

[1] Department of Radiochemistry and Radioecology, University of Pannonia, Veszprém, Hungary
[2] Air Chemistry Research Group, University of Pannonia, Veszprém, Hungary

https://doi.org/10.21175/rad.abstr.book.2025.31.2

The ^{210}Po and ^{210}Pb content of the resuspended aerosols and the PM-10 fraction separated from them was determined. Sampling was adapted to the observed rainfall events, sampling before and after the rain. First, the sample was transferred to solution by total acid digestion, then the alpha source for the ^{210}Po measurement was prepared by spontaneous deposition on a high Ni content stainless steel disc. Determination of ^{210}Po activity concentration in resuspended aerosols was carried out using semiconductor (PIPS) detector alpha spectrometry. ^{210}Pb activity concentration was measured via the liquid scintillation counting method.

Sampling was carried out in two stages: first, samples were taken at various locations in the city of Veszprém to investigate whether anthropogenic influences affect the activity concentrations of polonium and lead. In a second step, we investigated the effect of rainfall on the activity concentrations of polonium and lead in resuspended aerosols. The bulk resuspended samples and the PM1-10 fraction separated from them were analysed.

Based on our measurements, the activity concentrations of polonium and lead in the resuspended aerosol samples are typically higher at traffic junctions. In the samples analysed before and after rainfall, a decrease in polonium and lead activity concentrations is observed after rainfall, returning to baseline levels days later.

The research was funded by the Sustainable Development and Technologies National Programme of the Hungarian Academy of Sciences (FFT NP FTA).

Challenges in the determination of Pb-210 in oil scale

Sheldon Landsberger*, Christopher Martin, Kayla Cockerline

University of Texas, Austin, United States

https://doi.org/10.21175/rad.abstr.book.2025.31.3

Radioactivity charaterization of oil scale has been done done for many years, often focusing on Ra-226 and Ra-228. However, due to disequilibrium in the U-238, Pb-210 is also at unusually high levels. Because of the 46 keV gamma-ray of Pb-210 and the amount of high-Z elements such as Sr and Ba, correct analysis can be challenging due you severe attenuation. Our results with a specially made reference material and standard efficiency curve show the need for careful evaluation of Pb-210 in this unusual TENORM specimen. An overall view of this procedure will be given.

Eastern European peatlands as living archives of anthropogenic pollution: Insights from ^{210}Pb dating

Begy Robert-Csaba[1,2], Bozsik Anita*[1], Szwarczewski Piotr[3], Mazeika Jonas[4], Tonkov Sapassimir[5], Tănăselia Claudiu[6]

[1] Babes-Bolyai University, Faculty of Environmental Science and Engineering, Cluj-Napoca, Romania
[2] Interdisciplinary Research Institute on Bio-Nano-Science, Babeş-Bolyai University, Cluj-Napoca, Romania
[3] Faculty of Geography and Regional Studies, Department of Geomorphology, University of Warsaw, Warsaw, Poland
[4] Nature Research Centre, Vilnius, Lithuania
[5] Sofia University, Sofia, Bulgaria
[6] INCDO INOE2000 Research Institute for Analytical Instrumentation (ICIA), Cluj-Napoca, Romania

https://doi.org/10.21175/rad.abstr.book.2025.31.4

Peatlands are some of the most important ecosystems on the planet. They store about twice as much carbon dioxide as all the world's forests combined, making them extremely important in the fight against climate change. Besides capturing carbon, peatlands act like natural archives, recording environmental changes and human impacts over hundreds or even thousands of years. Despite their huge importance, peatlands are increasingly threatened by agriculture, industrial pollution, and land development. Protecting them is essential if we want to slow down climate change and preserve vital environmental information for future generations.

In this study, we present the results of our research on peatlands from four countries in Eastern Europe: Lithuania (LT-LD), Poland (PL-SJ, PL-ZG), Bulgaria (BG-KY), and Romania (TCH). We used lead-210 dating to estimate the age of different peat layers, which mainly cover the last 100–150 years, and X-ray fluorescence (XRF) to measure the elementar composition.

The peatlands selected for study were chosen based on the principle that each should represent a specific type of anthropogenic impact, and that there should also be a comparable site within a protected natural area in each country. As a result, the study included peatlands influenced by urban activities, those located near agricultural operations, as well as those affected by past mining activities

Our results show that peatlands located near big cities have much higher levels of heavy metals, such as lead and zinc, mostly from industrial pollution. In Romania's old mining region (TCH), we found some peat layers dating back to the early 20th century, where zinc and lead concentrations were extremely high, well above the natural background. In one of these layers, the lead concentration even reached 16,074±232 ppm (more than 1.6%).

In contrast, at the Lithuanian site (LT-LD), we detected a very different pollution pattern. Here, only zinc concentrations were exceptionally high — reaching up to 129,743±297 ppm — in a peat layer estimated to have formed during the 1960s. Other heavy metals remained at natural background levels. This suggests that the contamination is linked to agricultural activity, most likely from fertilizer use, rather than industrial sources. This interpretation is supported by the fact that there are no major towns nearby, while extensive agricultural lands surround the peatland.

Our findings highlight the double importance of peatlands: they are not just excellent carbon sinks, but also sensitive indicators of environmental pollution over time. By studying the different layers and their ages, we can trace how human activities have changed ecosystems decade by decade. As climate change intensifies, peatlands represent critical ecosystems for carbon sequestration and paleoenvironmental reconstruction. Their conservation and restoration are essential to mitigate greenhouse gas emissions and preserve unique archives of Earth's environmental history.

Effect of traffic on Po-210 and trace elements in urban aerosol in Hanoi, Vietnam

Nguyen Duc Toan[1], Thanh-Xuan Pham-Thi*[2], Tien Chu Trung[2], Hong Nguyen Thi[3,4], Nga Phung Thi[5], Van-Hao Duong[2], Serwaa Adjei-Kyereme[6], Miklós Hegedűs[6], Tibor Kovács[6]

[1] The Vietnam Agency of Seas and Islands, Ministry of Natural Resources and Environment, Hanoi, Vietnam
[2] VNU School of Interdisciplinary Sciences and Arts, Vietnam National University, Hanoi, Vietnam
[3] Environment and Sustainable Development Research Group, Dong Nai Technology University, Bien Hoa City, Vietnam
[4] Faculty of Technology, Dong Nai Technology University, Bien Hoa City, Vietnam
[5] Thanh Do University, Hanoi, Vietnam
[6] Institute of Radiochemistry and Radioecology, University of Pannonia, Veszprem, Hungary

https://doi.org/10.21175/rad.abstr.book.2025.31.5

Urban air pollution is a critical issue in densely populated areas, adversely affecting public health, and it is a significant cause of respiratory and cardiovascular diseases. This is especially the case for rapidly developing economies including Hanoi. There can be multiple sources of air pollution ranging from transportation, domestic use of fossil fuels, industrial activity, power generation, combustion and agriculture. To identify the effect of traffic Po-210 activity and trace element concentrations were determined from aerosol harvested in both roadside and residential areas in Hanoi. The ^{210}Po concentrations reached concentrations up to 3500 μBq.m^{-3} with a mean concentration of 1395 μBq.m^{-3}. Roadside samples had elevated concentrations compared to residential areas, and were high compared to typical values in the international literature. Most trace element concentrations show a similar pattern, higher in the roadside area compared to the residential areas. Enrichment factor analysis indicates Cr, Ni, Cu, Zn, Cd, Sb, and Pb concentrations are linked to anthropogenic activity, especially traffic and internal fuel combustion engines, while as Li, Al, Ti, V, Mn, Fe, Co, and Ba are associated with crustal sources. The main source of Po-210 was identified as fossil fuel combustion due to its correlation with Ni and Cr, and despite the potential diversity of sources in the Hanoi area our findings indicate the dominant influencing effect of local supply.

Keywords: ^{210}Po, aerosol, radionuclide, heavy metal, air quality, Hanoi

Environmental signals in peat: A ^{210}Pb-based study of climate and pollution history in Eastern and Southeastern Europe

Begy Robert-Csaba*[1,2], Bozsik Anita[1], Szwarczewski Piotr[3], Mazeika Jonas[4], Tonkov Sapassimir[5], Nikolov Jovana[6], Tănăselia Claudiu[7]

[1] Babes-Bolyai University, Faculty of Environmental Science and Engineering, Cluj-Napoca, Romania
[2] Interdisciplinary Research Institute on Bio-Nano-Science, Babeş-Bolyai University, Cluj-Napoca, Romania
[3] Faculty of Geography and Regional studies, Department of Geomorphology, University of Warsaw, Warsaw, Poland
[4] Nature Research Centre, Vilnius, Lithuania
[5] Sofia University, Sofia, Bulgaria
[6] Faculty of Science, Department of Physics, University of Novi Sad, Novi Sad, Serbia
[7] INCDO INOE2000 Research Institute for Analytical Instrumentation (ICIA), Cluj-Napoca, Romania

https://doi.org/10.21175/rad.abstr.book.2025.31.6

Peatlands play a significant role in carbon sequestration due to their unique climatic conditions. It is widely accepted that peatlands are capable of sequestering twice as much carbon dioxide as forests of the same area, provided that peat accumulation occurs under favorable conditions. However, global warming and the deposition of pollutants into peat bogs can substantially influence peat growth and, consequently, its carbon storage capacity.

In this study, peatlands are used as natural archives to examine the chronological impacts of climatic and anthropogenic factors on peat development. Samples were collected from Eastern and Southeastern Europe, covering latitudes between 45°N and 55°N, including sites in Bosnia and Herzegovina, Serbia, Bulgaria, Romania, Poland, and Lithuania. Peat chronology was established using two dating methods: radiocarbon (14C) and lead-210 (210Pb). In this work, 210Pb dating was applied to investigate changes since the onset of industrialization. The applicability of this method is supported by both the Constant Initial Concentration (CIC) and Constant Rate of Supply (CRS) age-depth models. Inorganic elements in the peat layers were analyzed using X-ray fluorescence (XRF) spectroscopy. Elevated concentrations of metals such as Pb, Zn, Cu, Co, Cd, and Ni are indicative of anthropogenic activities, with mining identified as the source in Romanian and Polish peatlands, and agricultural fertilizers in Lithuanian sites. Climatic influences were assessed through elemental ratios such as Ca/Mg and Al/Si, which effectively reflect the dynamics of inorganic input and water table fluctuations, serving as indicators of dry and wet periods. Historical changes in peatland water levels were reconstructed using testate amoebae analysis. The results indicate that peat accumulation rates are significantly influenced by drought periods and their variability. Furthermore, it is suggested that the carbon sequestration response in peatlands is slower following dry phases compared to wet periods, likely due to biological alterations occurring during peat desiccation.

Additionally, the observed changes in climatic conditions, particularly global warming, have had a notable impact on peat development. In all studied peat cores, a general increase in peat accumulation has been detected over the past two decades, coinciding with rising temperatures. In several cases, this accumulation rate has doubled, as seen in Polish and Lithuanian peatlands, and even tripled in specific Romanian sites such as the Iezerul Mare (IZM) bog. The preservation of the ecological conditions necessary for healthy peatland development is therefore essential to maintain their role as effective carbon sinks.

Heavy metal historical trends in sediments of Casla and Somova Lakes (Danube Delta)

Brisan Nicoleta*[1], Roba Carmen[1], Begy Robert-Csaba[1,2]

[1] Babeş-Bolyai University, Faculty of Environmental Science and Engineering, Cluj-Napoca, Romania
[2] Babeş-Bolyai University, Interdisciplinary Research Institute on Bio-Nano-Science, Cluj-Napoca, Romania

https://doi.org/10.21175/rad.abstr.book.2025.31.7

The Danube Delta is one of Europe's largest wetlands which provides important ecosystem services. Flowing through numerous industrial and urban centres, Danube River may receive significant amounts of pollutants, which are then carried further towards the Danube Delta. These pollutants can accumulate in the sediment and depending on the external environmental condition, they can be easily released into the water, causing secondary pollution and serious ecological harm to organisms and aquatic systems.

In the present study it was assessed the historical trend of heavy metals content in the sediment samples from two lakes (Casla and Somova) located in Somova - Parches aquatic complex lakes from the predeltaic area of the Danube Delta, West of Tulcea (Romania). The presence of heavy metals in the sediments is of particular interest due to the former anthropogenic activities, such as the production of ferroalloys and alumina, which were carried out in the area, starting with the 70s.

Sediment cores were collected from the two lakes and were transported to the laboratory, where they were subsampled into 1-2 cm thick slices. Each subsample was dried at 105°C, sieved through 63µm and mineralised with *aqua regia*. The heavy metals content was analysed by atomic absorption spectrometry, using the air-acetylene flame or the graphite furnace atomisation system, depending on the metal. Supplementary, each subsample was analysed for radiometric dating with 210Pb isotopes.

The radiometric analysis indicated that the age of the analysed sediments ranged between 1843 and up to present. The results showed significant differences regarding the metals content in the sediments of the two lakes, the concentration being generally higher in the Somova lake. Zinc content ranged between 68.2 – 176.1 mg/kg (Casla lake) and 378.1 – 2122.3 mg/kg (Somova lake), exceeding the recommendation of the national regulation (150 mg/kg). The analysed sediments proved to have high content of copper, comparing to national recommendation (40 mg/kg), being within 29.8 – 54.1 mg/kg in the sediments from Casla lake and respectively 47.2 – 180.7 mg/kg in Somova lake. Cadmium content in sediments from Casla lake, was relatively low (0.13 – 0.92 mg/kg), most of the samples being within national recommendation (0.8 mg/kg), comparing to Somova lake (0.29 – 2.81 mg/kg). Nickel level proved to be higher in Casla lake (34.6 – 60.1 mg/kg), than in Somova lake (19.2 – 44.9 mg/kg), frequently exceeding the limit value of 35 mg/kg (national law – Ministerial Order 161/2006).

The heavy metals chronological trend was relatively similar in the case of Zn, Cu and Cd, showing a changing trend composed of various stages, some of them being correlated with the dynamic of the anthropic activities performed in the area. Nickel presented a particular trend, different from the other metals, which could not be correlated with a possible impact caused by the anthropic activities from the investigated area.

This work was financially supported by the Romanian Ministry of Research, Innovation and Digitalization, within the project PNRR-III-C9-2022-I5-18_ResPonSE (contract 760010/2022).

Preliminary investigation of Po-210 and heavy metals in cigarettes sold in Kazakhstan

Miklós Hegedűs[1], Juzsakova Tatjána[1], Svetlana Zh Kuzhamberdieva[2], Bakhytbek B Abzhalelov[2], Máté Novák[1], Gergely Tóth[1], Edit Tóth-Bodrogi[1], Amin Shahrokhi*[1], Tibor Kovács[1]

[1] University of Pannonia, Veszprém, Hungary
[2] Korkyt Ata Kyzylorda University, Kyzylorda, Kazakhstan

https://doi.org/10.21175/rad.abstr.book.2025.31.8

Smoking various tobacco products is a well-known lung cancer risk, with cigarettes containing risk factors such as natural radioactive isotopes and heavy metals. Kazakhstan has a tobacco consumption rate close to the world average, 20% of the population smokes, with tobacco use reaching 36.5% amongst men [1]. Despite its importance for public health, there are relatively few studies on the radionuclide content of cigarettes sold in Kazakhstan, with some data available for Pb-210 content [2], showing levels comparable to previously reported in Hungary [3].

To better evaluate the risk posed to the local population Po-210 concentrations were measured with alpha-spectrometry and heavy metal concentrations (As, Cd, Co, Cr, Cu, Fe, Mn, Mo, Ni, Pb, Se, Sn and Zn) were determined by ICP-OES measurement in 5 different brands of cigarettes commercially available in Kazakhstan.

As, Cu, Mo, Se and Sn were not detected in the evaluated samples, while Cd ranged between 0.5-1.4 mg/kg, Co 0.5 and 1.0 mg/kg, Fe 540-1444 mg/kg, Mn 135-213 mg/kg, Ni 0.2-1.5 mg/kg, and Zn 24 – 33 mg/kg, while Pb concentrations up to 0.7 mg/kg were measured. Observed Po-210 concentrations and the resulting risks from smoking were comparable to values reported for Hungary and other countries.

References:

1. Glushkova et al. (2023). Prevalence of Smoking Various Tobacco Types in the Kazakhstani Adult Population in 2021: A Cross-Sectional Study International Journal of Environmental Research and Public Health 20:1509 doi: 10.3390/ijerph20021509
2. Zaripova et al. (2024). The activity of 210Pb in cigarette smoked in Kazakhstan Radiation and Environmental Biophysics 63:125–131 doi:10.1007/s00411-023-01048-x
3. Kovács et al. (2007). Po-210 and 210Pb concentration of cigarettes traded in Hungary and their estimated dose contribution due to smoking Radiation Measurements 42:1737-1741 doi:10.1016/j.radmeas.2007.07.006

Preliminary results in: Simultanious determination of ^{210}Bi and ^{210}Po with spontaneus deposition on wire surfaces by Liquid Scintillation Counting

Bálint Farkas - Áron*[1], Begy Róbert – Csaba[1,2]

[1] Babeş-Bolyai University, Faculty of Environmental Science and Engineering, Cluj-Napoca, Romania
[2] Institute for Interdisciplinary Research in Bio-Nano-Science, Cluj-Napoca, Romania

https://doi.org/10.21175/rad.abstr.book.2025.31.9

The ^{210}Pb ($t_{1/2}$ = 22.2 years) radionuclide-based dating method is crucial in environmental and geological sciences, enabling precise dating of soils and sediments from the past two centuries. In addition, ^{210}Pb is widely utilized in environmental science research, playing an essential role in investigating the origin and transport of aerosols. Its presence in vegetation and drinking water is also significant from a radiological perspective. While the radiological hazard associated with ^{210}Pb itself is minimal due to its low-energy beta emission, it rapidly reaches equilibrium with its decay products, most notably ^{210}Po ($t_{1/2}$ = 138.4 days), which poses a considerably higher radiological risk. Based on these considerations, the measurement of the aforementioned isotopes is of paramount importance.

^{210}Pb can be measured using all three major spectrometric techniques, each with its advantages and limitations. Gamma spectrometry is non-destructive but has a high detection limit due to the low gamma yield of ^{210}Pb (4.25%). Alpha spectrometry can be applied after ^{210}Pb reaches secular equilibrium with ^{210}Po, which requires more than two years. Beta spectrometry can be used when ^{210}Pb and ^{210}Bi ($t_{1/2}$ = 5.01 days) reach secular equilibrium, after 28 days of storage.

The aim of this work is to develop an improved methodology for ^{210}Pb determination via ^{210}Bi and ^{210}Pb measurements using liquid scintillation counting (LSC), while addressing the main limitation of this technique: quenching.

The method, similar to ^{210}Po disk deposition, uses spontaneous ion deposition on Cu, Ag, and Ni surfaces. A key innovation is replacing the disk with a wire, which allows easy introduction into the LSC cocktail without altering its composition or increasing quenching. This improves the geometry for the LSC spectrometer (Packard Tri-Carb 2300TR) and minimizes the "shadow" effect. The method ensures high chemical yield, enabling low detection limits for low-activity samples with minimal sample preparation. The goal is to maintain a consistently high chemical yield during deposition.

Firstly, we examined the efficiency using copper wires of varying thicknesses, revealing that the highest efficiency (65.85% ± 5.17%) was achieved with a 3 mm wire. Subsequently, the 3 mm copper wire was coated with silver, resulting in a measured efficiency of 72.93% ± 6.07%. We also performed measurements using wire coiled into a spiral shape, but its efficiency was not significantly higher compared to the previously tested methods. (64,29 ± 2,99%)

We observed that the count rate decreased over time, indicating that both ^{210}Po and ^{210}Bi were deposited on the surfaces. Moreover, the distribution of ^{210}Bi and ^{210}Po differs between copper and silver, suggesting material-dependent behavior. In most natural systems, ^{210}Bi and ^{210}Po are initially in equilibrium. Their simultaneous deposition nearly halves the detection limit, making detection limits as low as 7–12 mBq easily achievable.

For practical application, a sample digestion procedure was developed for peat moss samples from Crveni Potok in Tara National Park, Serbia. The proposed digestion method achieved an average efficiency of 78.28%, with a standard deviation of 7.09%. The overall uncertainty of the methodology remains around 14%, making it suitable for environmental, radiological, and geological applications.

Reconstructing sediment accumulation histories in Casla and Somova lakes (Danube delta) using ^{210}Pb dating

Brisan Nicoleta[1], Roba Carmen[1], Begy Robert-Csaba*[1,2]

[1] Babes-Bolyai University, Faculty of Environmental Science and Engineering, Cluj-Napoca, Romania
[2] Interdisciplinary Research Institute on Bio-Nano-Science, Babeş-Bolyai University, Cluj-Napoca, Romania

https://doi.org/10.21175/rad.abstr.book.2025.31.10

Due to their genesis, lake sediments act as natural archives that record the ongoing processes within their catchment areas. In recent decades, the number of environmental studies has significantly increased, aiming to precisely track both anthropogenic and natural impacts, and to develop future-oriented strategies based on past trends. In this study, we examined two lakes from a lacustrine system associated with the Danube Delta, focusing on the dynamics of sediment formation. The lakes of the Danube Delta are of great importance for investigating environmental parameter changes, as their catchment areas are extensive, and sediment transported by the Danube can travel over considerable distances before deposition. Our research targeted Casla and Somova Lakes for detailed analysis.

Casla Lake (45°10'54"N 28°42'40"E), located near Tulcea, covers approximately 1.1 hectares and lies close to the Danube Delta. Somova Lake (45°10'58"N 28°41'12"E) is situated near Somova village, about 5.2 km west of Casla Lake. Both fluvial and shoreline lakes were formed by sediment accumulation from the Delta's distributary channels and exhibit signs of eutrophication, primarily due to agricultural runoff that affects water quality and local ecosystems.

From each lake, two sediment cores were collected and analyzed. Following the determination of physical parameters such as porosity, water content, organic, inorganic, and carbonate content, ^{210}Pb dating was performed on the sediment layers. Based on the obtained age models, we reconstructed the sedimentation dynamics. In Casla Lake, three distinct periods of sedimentation were identified. Over the past 20 years, the sedimentation rate averaged 0.256 ± 0.051 g/cm^2/year, while between 2004 and 1998 this rate increased significantly to 0.400 ± 0.093 g/cm^2/year. Between 1992 and 1952, the average sedimentation rate was considerably lower at 0.151 ± 0.034 g/cm^2/year, and during the interval from 1843 to 1933, it averaged only 0.040 ± 0.012 g/cm^2/year.

In Somova Lake, recent sedimentation trends over the past two decades closely match those observed in Casla Lake, with an average rate of 0.202 ± 0.027 g/cm^2/year. However, subsequent sedimentation rates varied between 0.175 ± 0.026 and 0.439 ± 0.063 g/cm^2/year. Notably, an exceptionally high sedimentation rate of 0.917 ± 0.133 g/cm^2/year was recorded around 1972 ± 2 years, which most likely corresponds to the catastrophic 1970 flood event. This flood was among the most severe ever recorded within the Danube basin and Romania, causing extensive damage, particularly along the lower Danube reaches, including Tulcea and the Danube Delta region. Between 1951 and 1966, the sedimentation rate in Somova Lake was almost three times higher than the rates observed in the past two decades, averaging 0.612 ± 0.100 g/cm^2/year.

The study highlights those changes within the catchment area, particularly those leading to increased erosion, are clearly reflected in the sediment deposition patterns within these lake ecosystems.

This work was financially supported by the Romanian Ministry of Research, Innovation and Digitalization, within the project PNRR-III-C9-2022-I5-18_ResPonSE (contract 760010/2022).

A study on the importance of controlling precursor concentration, pH, polymer concentration and molecular mass on obtaining well-defined magnetic iron oxide nanoparticles using γ-irradiation

Ivana Landripet*[1], Ivan Marić[1], Ivan Ilakovac[1], Anđela Pustak[1], Marijan Gotić[2], Tanja Jurkin[1]

[1] Radiation Chemistry and Dosimetry Laboratory, Ruđer Bošković Institute, Zagreb, Croatia
[2] Laboratory for Molecular Physics and Synthesis of New Materials, Ruđer Bošković Institute, Zagreb, Croatia

https://doi.org/10.21175/rad.abstr.book.2025.32.1

Magnetic iron oxide nanoparticles (NPs) are used in various applications, including magnetic storage devices, environmental remediation technologies, magnetic hyperthermia and drug delivery. Iron chemistry is highly diverse due to the versatile behavior of iron in aqueous media. The presence of two stable oxidation states (+2 and +3) and their relative concentrations influence the final product. Extensive research has been conducted on the synthesis of iron oxides. However, the radiolytic synthesis of iron oxide NPs remains much less explored. γ-irradiation is environmentally friendly, efficient method for producing various nanomaterials. It ensures the homogeneous generation of electrons and other reducing species through the system. The final properties of the magnetic material depend crucially on particle size, dispersion, and aggregation. Various polymers can act as stabilizers for NPs in suspension, as well as growth and surface modifiers. In this study, deaerated aq. suspensions of Fe(III) precusor in the presence of 2-propanol and a polymer stabilizer were γ-irradiated. The effect of dextran-based polymers (dextran, dextran sulfate and DEAE-dextran), their molecular weight and concentration, Fe(III) precursor concentration and pH on the reduction of Fe(III) to Fe(II) on irradiation, and hence on the phase composition and morphology of synthesized NPs were examined. Additionally, to determine the role of polymer and 2-propanol as reducing agents experiments under different atmospheres and with/without various alcohols as scavengers were performed. Along with the dose, the concentration of Fe^{3+} salt is a major factor influencing the degree of reduction. Decreasing the Fe^{3+} concentration enhanced the reduction, with 100% Fe^{3+} conversion at doses as low as 10 kGy, resulting in formation of feroxyhyte (δ-FeOOH) magnetic nanodiscs, formed by quick oxidation of Fe(OH)2. Higher pH values (12 vs 9) led to lower reduction. Polymer concentration and molecular weight have a notable impact on reduction and final product. At low concentrations (0.185%) the precursor particles were not stabilized, while high polymer concentrations (10%) impeded the interaction of reducing species with precursor particles; in both cases the reduction was lower than with intermediate concentration (1.85%). Higher molecular weight dextrans (40,000 and 500,000) yielded better stabilization and reduction, while low molecular weight dextran (6,000) could not stabilize precursor particles, so no significant transformation of ferrihydrite occurred. Different dextran-based polymers resulted in different products at the same reduction degree. In the case of DEAE-dextran, NPs consisted of magnetite or δ-FeOOH, depending on the absorbed dose, while dextran sulfate led to multiphasic systems. The role of radiolytically generated polymer radicals and their short-lived degradation products in the reduction was minor in comparison to the role of electrons and isopropanol radicals. This systematic research highlights the importance of precise control of synthesis parameters, not only the dose, in order to obtain well-defined iron oxide NPs using radiolytic method.

Acknowledgments: This work was supported by the Croatian Science Foundation under the projects numbers UIP-2017-05-7337 and IP-2022-10-3687.

REFERENCES

1. Marić, G. Dražić, G. Štefanić, K. Zadro, M. Gotić, T. Jurkin, Mater. Char. 159 (2020) 110038
2. Marić, M. Gotić, G. Štefanić, A. Pustak, T. Jurkin, Radiat. Phys. Chem. 170 (2020) 108648
3. Marić, I. Landripet, I. Ilakovac, A. Pustak, M. Gotić, T. Jurkin, Radiat. Phys. Chem. 235 (2025) 112842

Application of aqueous extract of L*edum palustre* in "green" synthesis of selenium nanoparticles for assessment of radiation sensitivity of yeast cells

Gazimagomed Magomedov*, Irina Antropova, Sergey Kalenov, Phyo Myint Oo, Eldar Magomedbekov

Mendeleev University of Chemical Technology of Russia, Moscow, Russia

https://doi.org/10.21175/rad.abstr.book.2025.32.2

The interaction of Ledum palustre extract with selenium nanoparticles was studied. The system demonstrated enhanced antioxidant and radioprotective properties, effectively reducing oxidative stress under irradiation. The formation of selenium nanoparticles was confirmed by spectroscopic analysis and electron microscopy. The results indicate the potential of this system as a natural radioprotector with improved antioxidant efficiency.

Keywords: *Ledum palustre*, selenium nanoparticles, antioxidant activity, radioprotector, green synthesis.

Microstructural and magnetic properties of radiolytically synthesized iron-oxide ferrofluids and their SAR values for hyperthermia treatment with respect to iron concentration, stabilizer and absorbed dose

Ivan Ilakovac*, Ivana Landripet, Ivan Marić, Anđela Pustak, Tanja Jurkin

Ruđer Bošković Institute, Zagreb, Croatia

https://doi.org/10.21175/rad.abstr.book.2025.32.3

The purpose of this study was to utilize γ-irradiation, an environmentally friendly method that efficiently controls the phase composition of iron oxide NPs, to produce magnetic iron oxide suspensions (ferrofluids) with desirable properties for magnetic hyperthermia applications. Magnetic hyperthermia is a process in which alternating magnetic fields induce changes in the magnetization of nanoparticles (NPs), resulting in energy dissipation as heat via the Néel and Brown relaxation mechanisms. This technique shows significant promise for cancer treatment, as cancer cells are more susceptible to damage in the 41-45°C temperature range compared to healthy tissue. A key parameter used to evaluate the efficiency of magnetic hyperthermia in nanoparticles is the specific absorption rate (SAR), which quantifies the amount of heat dissipated per unit of time and mass of magnetic material. SAR is also influenced by the amplitude and frequency of the alternating magnetic field.

The investigation focused on the effect of different polymers as stabilizers and size-capping agents (polyvinyl alcohol (PVA), dextran and diethylaminoethyl-dextran hydrochloride (DEAE-dextran)), the initial Fe3+ salt concentration in the precursor solution, and the absorbed dose on the formation of concentrated iron oxide suspensions and their corresponding SAR values (ILI: their magnetic heating properties in alternating magnetic field). Ferrofluids were synthesized by γ-irradiation to different absorbed doses of deoxygenated precursor suspensions, using 2-propanol as a hydroxyl radical scavenger and PVA, dextran or DEAE-dextran of high molecular weight. Synthesized samples were characterized both as suspensions (ferrofluids), as well as the isolated powders.

The ferrofluids demonstrated excellent stability, as confirmed by dynamic light scattering (DLS), zeta potential measurements, and magnetic attraction to a permanent magnet. The reduction degree, represented by the [Fe2+]/([Fe2+]+[Fe3+]) ratio, was assessed using UV-VIS spectrophotometry with 1,10-phenanthroline method, and showed dependence not only on the absorbed dose and the Fe(II) precursor concentration, but to a small degree on the stabilizer used. X-ray diffraction analysis showed that the samples contained magnetite or feroxyhyte depending on the absorbed dose. Scanning electron microscopy images and DLS confirmed that both the initial Fe3+ concentration and the type of polymer influenced the size of the spherical magnetite nanoparticles. Mössbauer spectroscopy and SQUID measurements confirmed the superparamagnetic properties of the particles, and their magnetization behavior was found to be influenced by all tested experimental parameters.. SAR measurements, conducted at varying frequencies and field strengths revealed major influence of the iron oxide phase on the SAR values, as well as the influence of the Fe3+ concentration and the type of the polymer.

References:

1. G. Vallejo-Fernandez et al., J. Phys. D: Appl. Phys. 46 (2013) 312001, doi: 10.1088/0022-3727/46/31/312001
2. I. Marić et al., Materials Characterization 159 (2020) 110038, doi: 10.1016/j.matchar.2019.110038
3. I. Marić et. al., Radiat. Phys. Chem. 170 (2020) 108648, doi: 10.1016/j.radphyschem.2019.108648

Acknowledgements: This work was supported by the Croatian Science Foundation under the project number IP-2022-10-3687..

Synthesis of POEGMA Hydrogels via Polymerisation and Crosslinking Induced by various types of radiation – comparative studies.

Jakub Józiewicz*[1], Masza Góralczyk[1], Sławomir Kadłubowski[2], Marcin Kozanecki[1]

[1] Department of Molecular Physics, Lodz University of Technology, Lodz, Poland
[2] Institute of Applied Radiation Chemistry, Lodz University of Technology, Lodz, Poland

https://doi.org/10.21175/rad.abstr.book.2025.32.4

In this study, we explore the innovative synthesis of thermosensitive poly(oligo(ethylene glycol) methyl ether methacrylate) (POEGMA) polymer gels using three different types of radiation, namely: gamma radiation, fast electrons, and UV radiation. Each of these methods offers unique advantages and challenges in the gelation process, which we will examine and compare in detail.

Our research presents a comprehensive analysis of the gelation dose, ease and availability of synthetic equipment and gel fraction obtained through each radiation technique. Gamma radiation is known for its high penetration and uniform energy distribution, fast electrons provide a high dose rate and can be fine-tuned for synthesis of gels in various forms (from nano to macrogels). UV radiation offers more safety to the users and significantly cheaper approach, however it requires the use of additional chemicals (initiators, crosslinking agents).

We will discuss the experimental setup, including the choice of radiation sources, monomer structure and reaction conditions. The resulting POEGMA gels were characterized using FTIR spectroscopy, differential scanning calorimetry (DSC), scanning electron microscopy (SEM), and gravimetric methods to assess their thermal properties and structural characteristics.

Our findings highlight the comparative advantages and potential applications of each radiation method in the synthesis of POEGMA polymer gels. By understanding the strengths and limitations of these techniques, we aim to provide valuable insights for researchers seeking to optimize gel synthesis for various applications.

Development of a new wide-aperture backscattering detector for a High-Resolution Fourier Diffractometer at the IBR-2 reactor

Valentina Bulavina*, Vasil Milkov

Joint Institute for Nuclear Research, Dubna, Russia

https://doi.org/10.21175/rad.abstr.book.2025.33.1

The High-Resolution Fourier Diffractometer (HRFD) at the IBR-2 pulsed research reactor at the Joint Institute for Nuclear Research (Dubna, Russia) is one of several neutron diffraction facilities in the world where experiments requiring a resolution of Dd/d » 0.001 or better can be carried out. The main purpose of HRFD is the precision structural analysis of polycrystalline substances with an average unit cell volume of up to ~500 Å^3. As part of the HRFD modernization program, a project was implemented to create a new wide-aperture backscattering scintillation detector based on the ZnS (Ag)/6LiF scintillator using combined electron-geometric focusing. The new detector has a ring structure reflecting the axial symmetry of neutron scattering on the sample. The detector contains 6 annular assemblies (rings) of scintillation screens, 12 sectors, 216 recording channels, and has a resolution of $\Delta d/d \approx 0.0005$. Six ring assemblies completely cover the area of scattering angles $2\theta=(133\text{-}175)^\circ$. The total solid angle of the detector is WD ≈ 2 cr.

To ensure high resolution, the detector is based on a thin 0.42 mm thick ZnS(Ag)/6LiF scintillation screen. Light from scintillation screens is collected and wired to photomultipliers using optical spectrum-substituting fibers. This thickness is optimal in terms of balancing efficiency and light output with two-way light collection. Two-layer screens are used to increase the efficiency of neutron detection. The detector efficiency varies from 59%-96% and increases on average to 85%. The mechanical design of the detector remains virtually unchanged.

New technical solutions, such as the unique curved shape of the detector screen, due to the requirement of space-time focusing, make it possible to almost completely eliminate technological losses when the solid angle is blocked. Thus, the solid angle will increase up to ~12.5 times in comparison with the existing detector in the PDVR.

This increase in efficiency, combined with an increased aperture of up to two steradians, takes the backscatter detector to a whole new level. The commissioning of a new wide-aperture backscatter detector is currently underway.

Development of accurate dosimetry SiPM-based detectors for FLASH RT

Georgios Mystridis*[1,2], Fabio Acerbi[2], Benedetto Di Ruzza[1]

[1] University of Foggia, Foggia, Italy
[2] Fondazione Bruno Kessler, Trento, Italy

https://doi.org/10.21175/rad.abstr.book.2025.33.2

FLASH radiotherapy and particle therapy are performed using ultra-high dose rate radiation (UHDR), specifically a dose rate higher than 40 Gy/sec. The advantage of FLASH compared to conventional therapy (CT) is based on the FLASH effect: improved normal tissue sparing while still maintaining tumor control. Accurate dosimetry and real-time beam monitoring are critical for its clinical translation, but current detectors suffer from saturation effects in the signal production and signal read-out when dealing with UHDR beams.

We report on our development and preliminary tests a novel dosimeter for high-dose rate particle therapy, based on advanced Silicon Photomultiplier (SiPM) detectors coupled with scintillating fibers (SciFi). The SciFi detector aims towards an improved time and space resolution, with respect to the present commercial readout system. In our first tests we will develop and compare dosimeters made also with standard optical fibers (exploiting the radiation induced emission) coupled with the SiPM.

We will describe the present status of the devices and facilities used for FLASH RT. We will show the preliminary design of the detector that is expected to be tested using a proton UHDR beam with the beam's energy ranging from 70 MeV (CT) to 228 MeV (FLASH RT).

The ultimate goal is a detector working for both FLASH and Conventional Radiotherapy, with good sensitivity, as well as spatial and energy resolution.

Innovative silicon carbide detectors for ribs: timing, energy resolution, and simulation insights

Giuseppe Ferdinando D'Agata*[1,2], Martorana Nunzia Simona[2], Alice Barbon[1,2], Giuseppe Cardella[2], Elena Geraci[1,2,3], Luis Acosta[4,5], Carmen Altana[6], Andrea Castoldi[7,8], Enrico De Filippo[2], Saverio De Luca[6], Pierpaolo Figuera[6], Brunilde Gnoffo[1,2], Chiara Guazzoni[7,8], Concettina Maiolino[6], Emanuele Vincenzo Pagano[6], Sara Pirrone[2], Giuseppe Politi[1,2], Lucia Quattrocchi[9], Fabio Risitano[9,2], Francesca Rizzo[1,3,6], Paolo Russotto[6], Giuseppe Sapienza[6], Marina Trimarchi[9,2], Salvatore Tudisco[6], Cristina Zagami[1,3,6]

[1] Università degli Studi di Catania - Dipartimento di Fisica e Astronomia, Catania, Italy
[2] INFN - Sezione di Catania, Catania, Italy
[3] CSFNSM, Catania, Italy
[4] Instituto de Física, Universidad Nacional Autónoma de México, Mexico City, Mexico
[5] Instituto de Estructura de la Materia, CSIC, Madrid, Spain
[6] INFN - LNS, Catania, Italy
[7] DEIB Politecnico Milano, Milano, Italy
[8] INFN - Sezione di Milano, Milano, Italy
[9] Dipartimento MIFT, Università di Messina, Messina, Italy

https://doi.org/10.21175/rad.abstr.book.2025.33.3

Among all the possible new technologies for radiation and charged particle detectors, Silicon Carbide (SiC) based one are considered one of the most promising solutions. SiC high radiation hardness, strong mechanical resistance, excellent thermal stability, high breakdown field and saturation velocity – that could allow a fast charge collection – proper of the material are in fact extremely favourable characteristics for new generation detectors. On the other hand, the biocompatibility and relative insensitivity to light, makes SiC-based detectors a good possibility for high-performing and easy-to-use biomedical sensors and dosimeters.

Within the SAMOTHRACE ecosystem a new SiC detector array, devoted to the detection of radioactive ion beams (RIBs), is under development. Such beams – like for example 11C – represent the new frontier from both nuclear and medical physics perspectives, while the array is projected to be coupled with fast front-end electronics to provide useful information on the detected RIBs. Studies concerning the time performances of the detector are therefore necessary: the presented results, obtained using radioactive α-sources as well as low-energy proton beams, will focus on evaluating the detector performances in terms of both timing performance and energy resolution. To study the former, a novel method based on crossing time and time-sharing analysis has been employed. Also, a comparison of the timing resolution of the SiC detector with typical ones of better-known detectors, will be presented.

Finally, to better characterize the detectors, the development of accurate simulations is also of pivotal importance. For this reason, the signals expected from the SiC array in a 2x2 padded configuration were reproduced – by means of Geant4 simulations – when irradiated by alpha radioactive sources of 3-4 MeV. Such simulations consider all the different possible configurations and manufacture of the detector, to better understand the electric field of the inter-pad regions, and to get a proper identification of lost events. Also, a thorough evaluation of electric field effects, performed using different simulations tools, is ongoing. A comprehensive report of the state of the simulation will be also presented.

Novel cost-efficient scintillators for fast radiation detection

Gintautas Tamulaitis*, Saulius Nargelas, Arnoldas Solovjovas, Sarunas Scefanavicius, Gabija Soltanaite, Zydrunas Podlipskas, Monika Skruodiene, Aivaras Kareiva

Vilnius University, Vilnius, Lithuania

https://doi.org/10.21175/rad.abstr.book.2025.33.4

Fast scintillating materials are currently in especial demand for the future high-spatial-resolution medical imaging, high-luminosity high energy physics experiments, and other applications of radiation detectors. Cerium-doped multicomponent garnets are promising scintillators exhibiting great flexibility in engineering their scintillation properties. However, the best-performing single crystals of this type have to be fabricated at high temperatures in expensive iridium crucibles. Current efforts to develop less expensive bulk Ce-doped multicomponent garnets have had only partial success.

This report presents our results on an alternative approach: growing microcrystals of Ce-doped garnets using a cost-efficient sol-gel technique. Composite materials consisting of scintillator microcrystals in silica matrix were fabricated in two steps: the synthesis of Ce-doped garnet powder followed by the synthesis of the composite scintillator. A set of samples with varying contents of $Y_3Al_5O_{12}$:Ce (YAG:Ce) was synthesized for this study. In addition, two analogous sets with Y partially or completely substituted in the garnet by Lu (YLuAG:Ce, or LuAG:Ce) to increase the stopping power for ionizing radiation.

X-ray diffractometry (XRD) confirmed the garnet structure of the microcrystals without significant contribution of other phases. Scanning electron microscopy (SEM) images revealed that the composite contains submicrometer grains that tend to agglomerate as their content increases. The agglomeration does not affect the emission spectra and has no negative impact on emission intensity, at least up to 2 wt% of the scintillating material. In fact, the intensity increases more rapidly than the scintillator content. We observed that the weak emission bands in silica matrix are spectrally separated from the emission band of Ce^{3+} and decay faster (with decay time of 14 ns compared to 60 ns for Ce^{3+}). The quantum efficiency, measured using an integrating sphere, tends to increase with the garnet content and approaches values close to those in the single crystals with a corresponding composition.

The major part of the intensity of the photoluminescence (PL) excited resonantly to the emitting level 5d1 of Ce^{3+} decays exponentially, whereas a small contribution of faster decay due to defect-modified Ce^{3+} is also observed. The fast decay component is more pronounced in LuYAG:Ce samples at a low LuYAG:Ce content. The behavior of the composite scintillator at high-energy excitation was studied using time-resolved cathodoluminescence (CL) spectroscopy. In all samples studied, the decay rate of CL intensity is slower than that of PL intensity. The slower decay rate is interpreted by the delay in excitation transfer to the emitting Ce^{3+} ions due to carrier trapping, which is absent in direct excitation of Ce^{3+} ions in PL experiments. Thus, the formation of trapping centers is evidenced in the microcrystals fabricated via sol-gel processes at relatively low temperatures, which are unfavorable for the formation of antisite defects being the lowest-energy intrinsic defects in YAG and LuAG.

In summary, we have developed two-step sol-gel procedures that enable the low-cost fabrication of composites containing microcrystalline Ce-doped multicomponent garnets YAG, LuYAG, and LuAG in a silica matrix and demonstrate the promising properties of these composite materials, which are important for their application as scintillators.

Triplet exciton reflection in organic composite scintillator grains: Modeling with cubic symmetry

Nataliya Karavaeva, Ilarion Khromiuk*, Anton Krech, Igor Lazarev, Sergiy Makhota, Eugenia Martynenko, Oleg Tarasenko

Institute for Scintillation Materials of National Academy of Sciences of Ukraine, Kharkiv, Ukraine

Nataliya Karavaeva, Ilarion Khromiuk*, Anton Krech, Igor Lazarev, Sergiy Makhota, Eugenia Martynenko, Oleg Tarasenko

Institute for Scintillation Materials of National Academy of Sciences of Ukraine, Kharkiv, Ukraine

https://doi.org/10.21175/rad.abstr.book.2025.33.5

Organic scintillators have gained popularity due to their high pulse-shape discrimination capability. This effect has applications in many areas: from environmental monitoring and radiomedicine to customs control and analysis of the consequences of nuclear disasters. The advantages of this class of scintillators are low atomic number and nonhygroscopicity, but obtaining large-area detectors from them is a challenge. The manufacture of large-diameter single-crystal detectors is an expensive, laborious process, requires mechanical processing. To overcome these disadvantages of organic scintillators, we have recently proposed new types of detectors based on them - heterostructured scintillators. These include polycrystalline (obtained by sintering organic scintillator grains under pressure) and composite (obtained by embedding organic scintillator grains in a transparent non-scintillating gel composition) scintillators. When a scintillator consists of individual grains, it is necessary to take into account the processes occurring within this grain. For composite scintillators, depending on the size of its grains, the influence of these processes can become critical. The approach to describing the physical processes occurring in the grains of heterostructured scintillators can obviously be based on that for small-sized crystals. Thus, Agranovich and Galanin in their 1983 work [1] predicted the possibility of triplet exciton reflection from the grain boundary. Since it is the recombination of triplet excitons that is the basis for the pulse-shape discrimination, this reflection process in the grains can improve the separation of signals from radiation with large specific energy losses. Thus, the creation of a model that would allow calculating the optimal size of crystal grains specifically for pulse-shape discrimination tasks and would take into account the reflection effect is a relevant, but not yet explored direction of scintillation science. This work is devoted to the study and confirmation of the influence of the size of grains of organic composite scintillators on the transport of triplet excitons in them and the increase in the number of acts of their recombination. This may be useful for separation tasks, but at the same time this effect is not observed in single-crystal and liquid scintillators. It has been experimentally shown that for the organic scintillators under study, namely trans-stilbene and p-terphenyl, the optimal grain size is up to 60 μm when irradiated with alpha particles from a 239Pu source. This result was obtained when studying sets of grains of fractions from <40 μm to 0.5-1.0 mm. The work presents a set of models (spherical and cubic) for describing the transport of triplet excitons within one grain taking into account the reflection effect. In particular, analysis of the transport of triplet excitons when modeling an organic scintillator grain with cubic symmetry is presented for the first time, and a stronger closeness of such modeling to experimental results is shown. When modeling grains with cubic symmetry, the calculated optimal grain size corresponds to the arithmetic mean size for the experimentally optimal fraction. When modeling with spherical symmetry, the value of the largest grain in the experimentally optimal fraction was obtained. Prepared for publication with the grant support of the National Research Foundation of Ukraine within the framework of the project No. 2021.01/0042: “Development of effective detection systems for the most harmful ionizing radiation for humans, for radioecology tasks”. The contents of this abstract do not necessarily reflect the views of the National Research Foundation of Ukraine and are the sole responsibility of Institute for Scintillation Materials of NAS of Ukraine.

1. Agranovich, V. M. & Galanin, M. D. Electronic Excitation Energy Transfer in Condensed Matter. Amsterdam: North-Holland, 1983.

Vlora radiation portal monitor failure analysis and repair in Albania

Dritan Prifti*, Gani Demiraj, Kozeta Tushe

University of Tirana, Institute of Applied Nuclear Physics, Tirana, Albania

https://doi.org/10.21175/rad.abstr.book.2025.33.6

Radiation Portal Monitors (RPMs) are key components of Albania's national security infrastructure, designed to prevent the illicit trafficking of radioactive and nuclear materials across its borders. Installed at major border crossings, ports, and critical infrastructure points, RPMs automatically scan vehicles, cargo, and pedestrians for radioactive sources without interfering with the flow of traffic.

The installation of RPMs in Albania has been supported since 2005 by the International Atomic Energy Agency (IAEA), through various security cooperation projects. These efforts aim to align Albania with international standards for radiation detection and nuclear security. Key uses and functions of RPMs in Albania include Border Security, Illicit Trafficking Prevention, Support for Customs and Law Enforcement and Compliance with International Regulations.

RPMs are deployed at key land border crossings such as Kakavija, Vlora, Kapshtica, Qafë Thanë, and Durrës Port, providing automatic screening of vehicles and goods. RPMs help detect unauthorized movements of radioactive materials, thereby reducing risks related to nuclear smuggling or radiological terrorism. RPMs provide Customs officers (FLOs - Front Line Officers) with real-time alarms and detection data, enabling immediate secondary inspections when radioactive materials are detected.

The root cause analysis for the Radiation Portal Monitor (RPM) at Vlora Border Crossing Point (BCP) is thoroughly discussed in this paper. Initially, the methodology for conducting the root cause analysis was defined. This approach included a detailed technical investigation of the RPM system, an assessment of the causes behind failures or malfunctions, and the formulation of recommended corrective and preventive solutions.

Overall, the use of Radiation Portal Monitors in Albania has significantly strengthened the country's ability to detect and deter nuclear and radiological threats, though continuous investment in maintenance, operator training, and infrastructure upgrades remains critical for sustaining these capabilities.

The effects of cathodic materials on CF3+ degradation process obtained by quantum chemical calculation

Jelena Jovanovic*[1], Nebojsa Begovic[1], Ekaterina Kuznetsova[2], Predrag Milenovic[3,4]

[1] Institute for General and Physical Chemistry, Studentski Trg 12-16/V 11158 Belgrade, Serbia, Belgrade, Serbia
[2] University of Florida, Gainesville, United States
[3] CERN - European Particle Physics Laboratory Experimental Physics Department, Geneva, Switzerland
[4] University of Belgrade, Faculty of Physics, Belgrade, Serbia

https://doi.org/10.21175/rad.abstr.book.2025.33.7

The CF_4 is one of the most frequently used gas in gaseous detectors such as CMS (compact muon solenoid), RPC (resistive plate chamber), CSC (cathode strip chamber) etc. The CF_4 is usually mixed with Ar and CO2. Its function is to enable the easiest and fastest movement - drifting of electrons in gas detectors whose movement produces a measurable signal. An additional function of CF_4 is to clean both the cathode and the anode from unwanted deposits that degrade the performance of the detector itself during operation.

During the operation of the detector, CF_4 is ionized under the influence of ionizing radiation into CF_3+ which drifts towards the cathode. During this time, its degradation and further transformation occur through a series of products that culminate in the formation of C^+ which builds various amorphous structures on the cathode. The aim of our investigation was to get deeper insight into the interactions of CF_3+ with different cathode materials such as Al, Ag and Au, and to compare with Cu which are typically used for cathode material. These metals catalyze CF_3+ decomposition and make it different than one in the bulk - vacuum.

Quantum chemical calculation (QCC) was employed to construct potential energy curves (PES) for each sample - cathode material, without additional external field. The obtained PES for different metals is analyzed. It was concluded that different cathode materials perturb the whole process in different ways.

Activation energies (Ea) were calculated for each stage and compared with those obtained in bulk - vacuum. The obtained results for potential energy show that Cu as a cathode material and especially Al accelerates cations that drift towards the cathode. On the other hand, Au and Ag permanently-continuously raise the value of the potential energy of cations, i.e. slow them down on their way. The obtained results for potential energy show that Cu as a cathode material and especially Al causes stabilization interaction with cations, which can be possible explanation for forming double layer in the system.

Investigating total ionizing dose effects on LVDS receivers with impedance spectroscopy

Arbab Imtiaz*[1], Vincenzo Izzo[2], Riccardo Vari[3], Antonio Vanzanella[2], Claudio Principe[2], Pierluigi Casolaro[4], Alberto Aloisio[4]

[1] Dipartimento di Fisica e Astronomia G. Galilei, Università degli Studi di Padova, Padova, Italy
[2] INFN Sezione di Napoli, Napoli, Italy
[3] INFN Sezione di Roma, Roma, Italy
[4] Department of Physics, Napoli, Italy

https://doi.org/10.21175/rad.abstr.book.2025.34.1

Low-Voltage Differential Signaling (LVDS) receivers are widely used in high-speed serial links in several environments with radiation, including nuclear and high-energy physics experiments, spacecraft and satellites, and medical physics. In this work, we studied Total Ionizing Dose (TID) effects induced by 60Co gamma rays on LVDS receivers (part number DS90LV048A, from Texas Instruments) exposed to a high dose of 15.4 kGy at a dose rate of 364 Gy/h. TID tests have been performed at the CERN CC60 facility, that hosts a ~ 3 TBq 60Co radioactive source. Radiation effects were studied using both conventional techniques, such as current and voltage monitoring during irradiation, waveform analysis, and bit error rate, and Impedance Spectroscopy (IS), a frequency-domain technique well established in electrochemistry but still underexplored in the field of radiation effects on electronics.

Conventional analysis revealed no significant degradation in key performance metrics, including signal integrity, rise and fall times, amplitude, and common-mode voltage range. However, the proposed approach based on IS and I–V curve analysis enabled the observation of subtle TID effects. Equivalent circuit modeling based on two time-constant networks was employed to analyze specific device sections, including the power rail network, Electrostatic Discharge (ESD) protection circuit, input and output stages. In the power rail, IS identified a dominant time constant associated with a 96 pF lumped capacitance, whose value remained stable after irradiation. A second, slower time constant, attributed to charge trapping and detrapping mechanisms, showed a significant increase after radiation exposure. The ESD protection circuit, based on NPN avalanche breakdown, exhibited no change of its capacitance values due to TID, although a slight decrease in leakage resistance was observed. Moreover, IS revealed that the breakdown avalanche is triggered at around 5 kHz and, beyond this frequency, the circuit exhibits the behavior of a parallel RC network, with no shift in this frequency value observed after irradiation. In the input stage, IS measurements showed that the differential switching threshold remained within the 30–120 mV range, with current variations <15% after irradiation. The output driving capability exhibited a 6% reduction in the maximum sourcing current and a 4% increase in series output resistance. IS analysis also showed the presenced of a lumped inductance of the order of magnitude of 1H in the output driving circuit that did not change after irradiation.

Overall, these findings confirm that the investigated LVDS receivers maintain all system-level functionality after exposure to a high dose of 15.4 kGy. However, IS revealed subtle changes in the device internal physical mechanisms that are not detectable through conventional methods. This study highlights IS as a valuable, non-destructive technique for assessing radiation effects in digital microelectronics. By enabling the detection of changes in time constants, parasitic and lumped elements, IS nicely complements traditional characterization methods and offers a powerful method for selecting and validating components intended for use in radiation environments.

The ATLAS Forward Proton (AFP) sub-detector and the adverse effects of radiation from Large Hadron Collider (LHC) collimators during pp-collisions at 13.6 TeV

Marko Milovanovic*

ATLAS, Gießen, Germany

https://doi.org/10.21175/rad.abstr.book.2025.34.2

The ATLAS Forward Proton (AFP) sub-detector, located in the forward region of ATLAS experiment (between ~205m and 218m from ATLAS Interaction point) and also near the closest aperture defining collimators (TCL6, ~219m from IP1) within the Large Hadron Collider (LHC), has encountered significant operational challenges during pp-collisions at 13.6 TeV (Run-3) due to excessive and increasing radiation exposure with higher integrated luminosity being delivered to ATLAS. This study analyses the negative impact of this proximity on AFP electronics and various detector components, but also on the personnel involved in detector maintenance and failing component replacement during short accesses. These ever-growing radiation levels complicate maintenance procedures by limiting hands-on access time and necessitate the development of different procedural strategies as well as appropriate work dose planning.

Radiation-induced failures, including reduced detector efficiency and electronic component damage, but also the impact on long-term occupational health, have been systematically assessed through monitoring data and simulation studies. The findings indicate that the deployment of any detector and/or radiation sensitive electronics in close proximity to the LHC collimators have exacerbated radiation-related issues, posing a substantial risk to long-term detector functionality and significantly contribute to cumulative radiation doses acquired by the personnel, even within the regulatory limits.

Therefore, in this talk, possible mitigation strategies will be discussed, including different collimator settings and shielding configurations (both for electronics and personnel) implemented to tackle the harmful radiation effects, but also potential enhanced radiation-hardened electronics to improve detector resilience for future LHC runs. This work underscores the necessity of a comprehensive radiation impact assessment in the design and placement of forward detectors in high-radiation environments.

The effect of metallic materials on the filtering of the bremsstrahlung spectrum of mobile X-ray generators with regard to the possible initiation of improvised explosive devices

David Zoul*[1], Marián Zelený[2]

[1] Research centre Rez, Husinec-Rez, Czech Republic
[2] Department of education of the Police of the Czech Republic, Čeperka, Czech Republic

https://doi.org/10.21175/rad.abstr.book.2025.34.3

The work deals with the study of changes in the spectrum of bremsstrahlung X-ray radiation produced by mobile generators, when passing through various metallic filters. The main goal is to provide an overview of the effect of these materials on the radiation spectrum, which is crucial for applications in the field of IEDs (Improvised Explosive Devices) detection and other security measures. The results will be used as study material for students dealing with this issue.

In the detection of suspicious objects or IEDs, X-ray systems play a key role. In practice, however, IEDs can also be found equipped with sensors that react to X-ray radiation, and one pulse is often enough to initiate an unwanted detonation of an explosive device. For this reason, filters made of various metals are used in portable X-ray systems, which reduce the probability of activation of the IEDs sensor. The filters are installed directly in front of the X-ray generator. The aim of our work was to determine the effect of filtration with various materials on the spectrum of bremsstrahlung and to determine the extent of this effect on the function of IEDs switches. The filter materials chosen for our experiments were Al, Ti, Cu, Pb, W.

The industry urgently needs to know what number of photons is safe for X-ray sensitive sensors that could be used in IEDs. Current knowledge on this issue is insufficient, and many methods and techniques are used that are very poorly understood at a fundamental physics level. It is therefore necessary to conduct a professional study that would allow to penetrate the issue more deeply based on scientific data.

Alanine Dosimetry in Italian National Institute of Ionizing Radiation Metrology (ENEA-INMRI)

Alessia Embriaco*[1], Alessia Ciccotelli[1], Vanessa De Coste[1], Alvaro de Farias Soares[2,3,4], Maria Cristina D'Oca[2,3,4], Beatrice D'Orsi[5], Fabio Di Martino[6,7,8], Maurizio Marrale[2,3,4], Giuliana Milluzzo[3], Francesco Romano[3], Jessica Scifo[5], Luca Silvi[1]

[1] ENEA-INMRI, Rome, Italy
[2] Department of Physics and Chemistry "Emilio Segrè", University of Palermo, Palermo, Italy
[3] INFN, Istituto Nazionale di Fisica Nucleare, Sezione Catania, Catania, Italy
[4] Advanced Technologies Network (ATeN) Center, University of Palermo, Palermo, Italy
[5] ENEA, NUC-IRAD-GAM, Casaccia Research Center, Rome, Italy
[6] UO Fisica Sanitaria, Azienda Ospedaliero-Universitaria-Pisana (AOUP), Pisa, Italy
[7] INFN, Istituto Nazionale di Fisica Nucleare, Sezione Pisa, Pisa, Italy
[8] CPFR@Cisup, Pisa, Italy

https://doi.org/10.21175/rad.abstr.book.2025.35.1

Purpose: Electron paramagnetic resonance (EPR) is a technique used to study materials with unpaired electrons (radicals). Alanine could serve as a radiation-detector material in which free radicals are produced after irradiation. Alanine has several features that make it suitable for medical dosimetry: tissue-equivalence, small size, small energy dependence of the response over a wide energy range, dose rate independence, low fading and the non-destructive readout. Last year, a new EPR spectrometer used for Alanine dosimetry was installed in the dosimetry laboratories of the Italian National Institute of Ionizing Radiation Metrology (ENEA-INMRI). In the following, we report on the methodology and preliminary results obtained on dosimeters irradiated in Ultra-High-Dose-Rate (UHDR) beam. Furthermore, an intercomparison with the EPR laboratory of the University of Palermo (UniPa) is performed.

Materials and Methods: A Bruker-Elexsys spectrometer operating in the X band is used for EPR measurements in both laboratories. Alanine pellets used by ENEA are produced by Aerial (France), with 4 mm diameter, 2.3 mm height, and 35 mg average mass. These alanine pellets were calibrated in terms of absorbed dose to water in a 60Co gamma radiation at the CALLIOPE facility. Sensitivity variations of EPR spectrometer were monitored with a reference sample (alanine dosimeter irradiated at 1 kGy) measured during each section. The mean value of five repeated measurements was considered, obtained by randomly repositioning the sample in the cavity. The EPR spectrometer parameters used are: 6 mW microwave power, 2.5 mT sweep width and 1 mT modulation amplitude and 8 accumulations. Alanine pellets used by the University of Palermo are supplied by Gamma Service (Germany), with 4.9 mm diameter, 3.1 mm height, and 68.1 mg average mass. EPR experimental parameters included a 2.99 mW microwave power, a sweep width of 3 mT, an amplitude of modulation of 1 mT, and 4 accumulations. In this case, each pellet was measured four times, by modifying the orientation within the cavity, and the signal is given in terms of mean and standard deviation. The absorbed dose was estimated through a calibration curve (using a calibrated 60Co irradiation source) with doses ranging from 2.5 to 20 Gy. The sensitivity was also monitored with a standard pellet.All alanine dosimeters were irradiated in an electron UHDR beam at the CPFR (Centro Pisano Flash RadioTherapy) with a delivered dose of about 20 Gy. Specifically, the pellets were irradiated with a 9 MeV electron beam at different doses per pulse (from 0.026 Gy/p to 4 Gy/p). For each irradiation setup, nine alanine pellets were placed on a square PMMA holder array (four pellets from ENEA and five from UniPa) and irradiated at the buildup depth (about 14 mm) using solid water slabs.

Results: The EPR measurements were performed in different sections and the results were normalized to the reference sample. For the ENEA pellets, the standard deviation in 5 repeated measurements is about 1%. For each irradiation setup, the comparison between pellets shows a standard deviation between 0.4% and 2%. These values corroborate the ones obtained by the intercomparison laboratory, in which the percent relative standard deviation for the same pellet is around 1 %, and between 0.6 and 3% for a set of pellets irradiated at the same dose.

Conclusion: The preliminary results on the UHDR beam showed excellent reproducibility of the EPR spectrometer. Additionally, the results from the intercomparison demonstrated good agreement, despite the differences of pellet and signal acquisition parameters. In the next future, a new calibration will be planned in a clinical LINAC accelerator. Afterwards, a new set of measurements will be carried out in both conventional and UHDR beams. Furthermore, the EPR spectrometer could be applied also to study radicals in irradiated materials and in other sectors of ENEA-INMRI, as neutron dosimetry and radiodiagnostics.

Assessment of Radon concentrations and environmental correlations in public schools of Safi, Morocco: a spatial and statistical analysis

Lachhab Abdeslam*[1], Otmani Anas[1,2], Nachab Abdellatif[3], Chakir El Mahjoub[1]

[1] Faculty of Sciences, Ibn Tofail University, Kenitra, Morocco
[2] Laboratoire National des Études et de Surveillance de la Pollution (LNESP), Rabat, Morocco
[3] Laboratory of Fundamental and Applied Physics, Polydisciplinary Faculty, Cadi Ayyad University, Safi, Morocco

https://doi.org/10.21175/rad.abstr.book.2025.35.2

Radon, a naturally occurring radioactive gas and the second foremost contributor to lung carcinoma subsequent to tobacco consumption, necessitates systematic surveillance in educational contexts due to the extended exposure hazards for inhabitants. This inquiry, conducted between September 21, 2024, and February 21, 2025, across thirty public educational establishments in Safi, Morocco, evaluated radon (^{222}Rn) concentrations utilizing DSTN LR-115 passive detectors alongside Airthings devices (View Plus and View Radon) for the real-time measurement of radon, temperature, and humidity. The principal objectives encompassed mapping spatial concentrations via ordinary kriging in QGIS, scrutinizing correlations with environmental variables, and estimating potential health risks. The study reveals that the radon levels average around 34 ± 23 Bq/m^3, with a peak measurement of 138 Bq/m^3, and notably, 31% of the readings exceed the global benchmark of 39 Bq/m^3. Environmental parameters averaged 17 ± 2 °C (temperature) and 60 ± 9% (humidity). Statistical analyses revealed significant negative correlations between radon levels and both temperature ($p = 0.0008$) and humidity ($p = 1\times10^{-5}$). These findings furnish a foundational reference for subsequent inquiries on radon exposure in educational environments and underscore the necessity for targeted preventive interventions in high-risk institutions.

Characterization of optically stimulated luminescence silicone foils based on MgB_4O_7:Ce,Li material – towards a high-resolution and reusable tool for 3D dosimetry

Michał Sądel*, Pawel Bilski, Jan Swakoń, Leszek Grzanka, Anna Mrozik

Institute of Nuclear Physics Polish Academy of Sciences IFJ PAN, Kraków, Poland

https://doi.org/10.21175/rad.abstr.book.2025.35.3

A novel reusable silicon foil dosimeter based on the promising optically stimulated luminescence (OSL) material, MgB_4O_7:Ce,Li (MBO), has been developed and characterized for various radiation modalities. This innovative dosimeter utilizes a specially designed optical detection setup, which includes a light source (such as LEDs) to illuminate the dosimeter and a high-sensitivity CCD camera that captures the 2D OSL light emitted from the foil. As a result, this emerging dosimeter can be employed for 3D dose mapping in clinically relevant proton radiotherapy applications.

The fundamental concept of 2D OSL dosimetry involves the creation of a foil-shaped dosimeter. This flexible, optically active foil combines an OSL powder material with a transparent matrix. To measure the spatial dose distribution, the foil is illuminated with a laser or LEDs, and the emitted luminescence is registered using a CCD camera (for spatial 2D/3D measurements) or another photo-detector (for point dose measurements).

This work presents an advanced silicon foil dosimeter that utilizes the new MBO OSL material, which exhibits minimal LET-quenching effects and possesses other favorable properties, including low fading and high sensitivity (ranging from μGy to kGy). The new MBO-based silicon prototype foils have an effective atomic number ($Z_{eff} \approx 8.4$), which is close to that of soft tissue ($Z_{eff} \approx 7.4$), helping reduce energy dependence in photon/proton dosimetry and enhancing the accuracy of dose measurements.

The presentation will show the comparison of measurement results using the new MBO OSL-based foil samples with different radiation modalities, specifically beta (Sr/Y^{90}), gamma (Co^{60}) sources, and a 60 MeV monoenergetic proton beam. Key dosimetric capabilities of the MBO silicon-based dosimeters will be highlighted, along with details about the newly designed optical setup that employs a highly sensitive CCD camera to measure the spatial distribution of clinically relevant proton doses. These results will be compared to the clinical gold standard of passive dosimetry—Gafchromic™ EBT3 films. Furthermore, a series of measurements dedicated to characterizing essential dosimetry features, such as fading, dose response, and repeatability of the prototype foil, has also been conducted using a photomultiplier tube.

This work was supported by the National Science Center (project No. 2021/43/D/ST5/03042).

Development of large-scale soil reference material for improving the quality of gamma-ray measurements in environmental radioactivity monitoring

Minju Lee*

Korea Research Institute of Standards and Science, Daejeon, South Korea

https://doi.org/10.21175/rad.abstr.book.2025.35.4

Method validation is important to ensure reliable results in environmental radioactivity monitoring. The laboratory should establish a process to verify the accuracy and reliability of results[1]. Reference material (RM) is used to verify the accuracy of specific measurements and assist in the development of new measurement techniques. The Korea Research Institute of Standards and Science (KRISS) has developed a new soil RM for environmental radioactivity monitoring. The homogenized raw materials were placed in the drum container, and the standard solution containing the 137Cs and 60Co radionuclides was gradually sprayed into it. This method allows for the large-scale production of homogeneous spherical RM, similar to a snowball. Ten samples were randomly selected for among-bottle homogeneity and two samples were taken from each bottle for within-bottle homogeneity. The homogeneity test for the soil RM fulfilled the requirement of the ISO 33405:2024[2]. The self-absorption correction factor and the coincidence summing correction factor were calculated by the Monte Carlo N-Particle (MCNP) code and the efficiency transfer (EFFTRAN) code, respectively. Twenty samples were measured using an High-Purity Germanium detector to characterize the RM. In conclusion, the reference values of 137Cs and 60Co in the soil RM were determined to be 118.7 and 124.4 Bq/kg, respectively. And the expanded uncertainties of the radionuclides were around 8 %. As a result, approximately 100 kg of soil RM was developed to validate environmental radioactivity measurements.

Reference

1. ISO/IEC 17025:2017, General requirements for the competence of testing and calibration laboratories, Geneva, Switzerland.
2. ISO 33405:2024, Reference materials – Approaches for characterization and assessment of homogeneity and stability, Geneva, Switzerland.

Development of Neutron Dosimetry System

Şamil Osman Gürdal*

RADKOR, Ankara, Turkey

https://doi.org/10.21175/rad.abstr.book.2025.35.5

In this study, a neutron dosimetry system was investigated for measuring individual dose using Solid State Nuclear Trace Detectors (SSNTDs). The neutron dosimetry system developed in this study consists of a reader, dosimeter and a chemical etching system. The reader of the system leverages advanced image processing techniques, incorporating deep learning and artificial intelligence algorithms to analyze the geometric characteristics of the tracks, thereby providing accurate dose predictions. Thus, It has capacity to discriminate thermal neutron, fast neutron and radon. In the dosimeter, CR39 detector was preferred due to its advantages like stability, simplicity, neutron sensitivity and gamma insensitivity etc. In the developed dosimeter, two types of filters High-Density Polyethylene (HDPE) and Boron Nitride (BN) were employed to enable the measurement of a broad energy range, encompassing both thermal and fast neutrons according to ISO 21909. Then, a chemical etching system and process were improved to enhance visibility of the tracks and measurement efficiency. The performance of developed neutron dosimetry system was tested applying qualification tests according to ISO 21909. The qualification tests were performed at neutron irradiation laboratories which have traceability chain like PTB and STUK. The results of the qualification tests required by the ISO 21909 standard have shown that the system meets the required criteria.

Estimation of activation around a proton cyclotron CYRCé: Modelling approach and validation with gamma spectrometry

Collin Jonathan[1], Nourreddine Abdel-Mjid*[1], Arbor Nicolas[1], Horodynski Jean-Michel[2], Schutz Yves[1], Lacaze Guilhem[3]

[1] Institut Pluridisciplinaire Hubert Curien, Strasbourg, France
[2] Ingénierie Radioprotection Sûreté Démantèlement, Saclay, France
[3] Transmutex SA, Geneva, Switzerland

https://doi.org/10.21175/rad.abstr.book.2025.35.6

Nuclear activation concerns particle accelerators used in various fields, from medical to industrial applications, both in operation and in the decommissioning phase. For more than three decades, the possibility of using cyclotrons for nuclear power generation and nuclear waste reduction has also been discussed, i.e. in the case of accelerator-driven systems. The issues of radiation protection and dismantling of accelerator facilities, which have recently been raised, are even more important for such facilities. Monte Carlo simulations are the most appropriate techniques to obtain an estimate of the radionuclide inventory. In this work, we are particularly interested in the activation due to secondary neutrons produced by (p,n) reactions in the vicinity of accelerators. This work focuses on the study of the radioactivity induced in different materials (Sc, Tb, W, Ta) around the operating IPHC cyclotron CYRCé. The experimental results will be compared with estimates from Monte Carlo programs, including FLUKA, GEANT4 and PHITS. The capabilities of these programs will be discussed, as well as the importance of the choice of physics models, in particular of neutron cross-sections evaluated libraries. The main distributors of this data are ENDF/B-VIII.0, JENDL-5 or JEFF-3.3. The MC tools have been coupled with the deterministic software FISPACT-II and TMX_Bateman (a Bateman resolver developed by TRANSMUTEX), to estimate activity. We have compared the modeled relaxation gamma spectra with the experimental measurements performed by high-resolution gamma spectrometry using LabSOCS.

Influence of heating rate on thermally stimulated luminescence properties of LiF: Mg,Cu,P dosimeter

Kemal Firat Oğuz*[1], Talat Aydin[2]

[1] Maltepe University, İstanbul, Turkey
[2] TENMAK, Nuclear Energy Research Institute, Ankara, Turkey

https://doi.org/10.21175/rad.abstr.book.2025.35.7

In this study, influence of various heating rates on thermally stimulated luminescence (TSL) properties, TL glow peak-temperatures, heights and integrated TSL intensities of the main TSL glow peak of recently produced LiF:Mg,Cu,P has been investigated after beta radiation at room temperature. The TSL glow curve of Mg, Cu and P doped LiF dosimeter has four peaks at 100 ^{o}C, 150 ^{o}C, 210 ^{o}C and 250 ^{o}C. In addition, dosimetric characteristics of the dosimetric material such as stabilty and dose response were investigated. It was determined that the dose response curve of the dosimeter is linear between 1 and 20 Gy. Based on the results of the stability test, it was observed that the stability of the material changed only slightly during the repeated annealing and irradiation cycle.

Intercomparison exercise on the characterization of norm samples by gamma spectrometry

Manjola Shyti*[1], Hermes Plaku[2], Erjon Spahiu[3]

[1] Institute of Applied Nuclear Physics, University of Tirana, Tirana, Albania
[2] Office of Radiation Protection, Radiation Protection Commission, Institute of Public Health, Tirana, Albania
[3] Department of Physics, Faculty of Natural Sciences, University of Tirana, Tirana, Albania

https://doi.org/10.21175/rad.abstr.book.2025.35.8

The main scope of this study is to assess the capabilities of Gamma Laboratory in the Institute of Applied Nuclear Physics for the radiological characterization of Naturally Occurring Radioactive Material (NORM) in line with the International Atomic Energy Agency (IAEA) safety standards with a primary focus on radiation protection of workers in industrial processes involving NORM. The gamma laboratory in Albania with labcode 20 was participated in this intercomparison exercise (IE) in the framework of IAEA RER Project 9155 together with 28 radioanalytical laboratories from Europe region. The activity concentration of natural radionuclides in phosphate ore and phosphogypsum samples has been determined. The main radionuclides contributing to gamma exposure from the ^{238}U decay series are ^{214}Pb and ^{214}Bi, while from the ^{232}Th decay series are ^{228}Ac, ^{212}Pb and ^{208}Tl. In the phosphate industry, exposure to gamma radiation from radionuclides in the ^{238}U decay series is the main concern for radiation protection and, as in many other industries involving NORM industries, arises mainly from accumulations of mineral concentrates or residues. For determination of natural radionuclides concentration in NORM non-destructive measurement technique with High Pure Germanium detectors (HPGe) is used. The results of Z-score in this exercise for characterization of NORM samples have all been accepted and clearly showed that the calibration procedure as well as the detector type, geometry used, and laboratory staff skills play a major role in the laboratory performance.

Low-energy X-Ray dosimetry using a parallel plate chamber and fricke gel

Fábio Sabará Dias*, Brena Peres, Paulo Victor dos Santos Tavares, Dalton Giovanni Nogueira da Silva, Orlando Rodrigues Jr, Cibele Bugno Zamboni, Maria da Penha Albuquerque Potiens

Instituto de Pesquisas Energéticas e Nucleares, São Paulo, Brazil

https://doi.org/10.21175/rad.abstr.book.2025.35.9

Introduction: Low-energy X-ray radiation plays a key role in several nuclear applications, ranging from medical analysis, such as X-ray Fluorescence (XRF) for blood analysis, to diagnostic imaging such as mammography, to therapeutic applications, such as Intraoperative Radiotherapy (IORT) using electronic brachytherapy for cancer treatment [1, 2]. The present work aims to compare 3D dosimetry with measurements using a parallel plate ionization chamber in systems that use low-energy beams.

Methods: Low-energy X-ray dosimetry was performed using a Pantak Seifert industrial X-ray equipment and a miniature X-ray tube system, model Mini X2, from Amptek, with an Au target. In both configurations, parallel plate ionization chambers, PTW, model 23342, calibrated in the quantity absorbed dose in water and the Fricke Xylenol Gel (FXG) dosimeter were used.

In the Pantak Seifert equipment, the measurements were conducted following the TRS 398 formalism for determining the absorbed dose in water, in the T-50 (b) reference quality and at a distance of 50 cm from the equipment focus. FXG dosimeters were subsequently irradiated in this equipment under the same conditions, with doses of 3 Gy and 5 Gy [3].

Irradiations using portable X-ray fluorescence (pXRF) equipment were conducted as close as possible to the beam exit, with a voltage of 50 kV and a current of 200 μA for both dosimeters.

Results: The measurement values showed good agreement for both dosimeters for the doses worked. Using the FXG, a 3D dose map was obtained where it was possible to observe the expected characteristics for low-energy X-ray beams, which tend to deposit most of the energy close to the surface, and which, due to the interaction of the radiation with the matter, obtain a maximum dose, and which has a significant reduction in the dose in a few cm.

Conclusions: The results highlight the potential of combining dosimetry using parallel plate ionization chambers and, together with FXG as a three-dimensional dosimeter in applications, for example in IORT, and dose distribution studies in low-energy X-ray beams.

References

1. ZAMBONI CB, DA SILVA GIOVANNI DN, DE ALMEIDA MR, TODO AS, DIAS FS, JUNIOR OR. X-ray experimental set-up for in-vitro nail test. Brazilian Journal of Radiation Sciences. 2023;11(1A (Suppl.)):1-10
2. TEHRANI, Y. A; SETAYESHI, S. Intra-operative radiotherapy in breast cancer treatment: A literature review. Iranian Red Crescent Medical Journal, v. 21, n. 9, 2019.
3. IAEA - INTERNATIONAL ATOMIC ENERGY AGENCY. Absorbed dose determination in external beam radiotherapy. An International code of practice for dosimetry based on standards of absorbed dose to water. Vienna, 2024. (Technical Report Series, 398).

Radionuclide analysis of the simulated contaminated surface sample for the purpose of iaea-terc-2024-01 proficiency test

Isidora Najdhefer*, Lazar Tomic, Nevena Zdjelarevic, Natasa Lazarevic, Dalibor Arbutina, Tijana Vujic

Public Company Nuclear Facilities of Serbia, Belgrade, Serbia

https://doi.org/10.21175/rad.abstr.book.2025.35.10

In accordance with general requirments for the competence of testing and calibration laboratories (SRPS ISO/IEC 17025:2017 standard), a regular participation of an accredited laboratory in the international and/or interlaboratory intercomparisons is required. The laboratory within Department of radiation safety and environmental protection, Public company "Nuclear Facilities of Serbia", participated in the proficiency test on determination of anthropogenic and natural radionuclides in water, soil (gamma-ray spectrum analysis exercise) and simulated contaminated surface, organized by the International Atomic Energy Agency (IAEA-TERC-2024-01 ALMERA). This international intercomparison involved over 300 laboratories from more than 70 countries.

The purpose of this paper is to present the outcome of the radionuclide analysis for the simulated contaminated surface sample. A portable surface contamination monitor for surface emission rate was used in order to determine the presence of alpha and beta emitters on a 10 cmx 15 cm rectangle that was printed (blue ink) on a matte polyester canvas carrier material. A blank sample of the same size has also been provided. The alpha and beta emitters are distributed evenly across the printed area and the stability and hemogeneity of the samples have been checked.

This paper shows the obtained values, as well as the results evaluation in terms of accuracy and precision. Since all the resluts were satisfactory, the laboratory showed its reliability and competence. This experience will bu used for further quality improvement of analytical capabilities.

Routine calibrations of ionizing radiation dosimeters in the context of the sustainability of measurements in radiotherapy

Iwona Grabska*, Wioletta Ślusarczyk-Kacprzyk, Marcin Szymański

The Secondary Standards Dosimetry Laboratory, Department of Medical Physics, The Maria Sklodowska-Curie National Research Institute of Oncology, Warsaw, Poland

https://doi.org/10.21175/rad.abstr.book.2025.35.11

In 2024, the theme of World Metrology Day was sustainability. At first sight, sustainability does not seem to have much overlap with the activities of secondary standards dosimetry laboratories. However, when one considers the meaning of sustainability in the light of the 17 United Nations Member States Sustainable Development Goals (SDGs) it becomes more obvious that ionizing radiation measurements play an important role in achieving the goals set in 2015.

These 17 goals are an urgent call for action by all countries - developed and developing - in a global partnership. They recognize that ending poverty and other deprivations must go hand-in-hand with strategies that improve health and education, reduce inequality, and spur economic growth – all while tackling climate change and working to preserve our oceans and forests.

Ionizing radiation metrology contributes to “Ensure healthy lives and promote well-being for all at all ages” (Sustainable Development Goal 3). Ionizing radiation is one of humanity's main tools in the fight against cancer, with radiation therapies becoming increasingly varied and tailored to the biological specificities of each patient.

Calibration of ionizing radiation dosimeters is an essential process ensuring that dosimeters used in radiotherapy centers to measure radiation provide valid measurement results that correspond to the actual radiation dose delivered to the patient. This contributes to effective and safe treatment of patients. In Poland such calibrations are performed by the Secondary Standards Dosimetry Laboratory in Warsaw. Thanks to cooperation with international organizations such as International Atomic Energy Agency and investments in modern technologies, Polish SSDL plays a key role in ensuring high standards in the field of dosimeter calibration, which contributes to progress in cancer treatment and public health protection in Poland.

In this work we will discuss some aspects of Polish SSDL routine activity in the context of the sustainability of measurements in radiotherapy with reference to the previously mentioned Sustainable Development Goal 3. We will also pay attention to the challenges faced in the field of calibration as radiotherapy becomes more and more advanced.

Secondary cosmic radiation variations at ground and flight altitudes in the Czech Republic during autumn 2024

Iva Ambrožová*[1], Jakub Šlegl[1,2], Marek Sommer[1], Lucie Švihrová[1], Martin Kákona[1], Ondřej Ploc[1]

[1] Nuclear Physics Institute of the CAS, Řež, Czech Republic
[2] Faculty of Nuclear Sciences and Physical Engineering, Czech Technical University in Prague, Prague, Czech Republic

https://doi.org/10.21175/rad.abstr.book.2025.35.12

Temporal variations of secondary cosmic-ray intensity reflect the intricate interplay between geophysical and solar phenomena. The amplitude of these flux changes depends on the type and energy of radiation, as well as on the geographical coordinates and the detector's characteristics. To study the effects of space radiation on the terrestrial atmosphere, several measurement campaigns within the BIOSPHERE project have been conducted at various locations across Europe.

This contribution presents results from a measurement campaign carried out in the Czech Republic during autumn 2024. Variations in different components of secondary cosmic radiation, measured both on the ground and at aviation altitudes, will be discussed using data from various detectors. These include the SEVAN detector, which discriminates between different types of particles; a novel neutron detector that distinguishes between photon and neutron components; a gamma-ray spectrometer; and Si-diode-based devices measuring on board aircraft. During this campaign, several solar energetic particle events were observed, influencing the secondary radiation measured on the ground and resulting in detectable changes in flux.

Acknowledgments: The project 21GRD02 BIOSPHERE has received funding from the European Partnership on Metrology, co-financed by the European Union's Horizon Europe Research and Innovation Programme and by the Participating States.

Semiconductor-based detectors and conventional dosimeters comparison performed at the Calliope ^{60}Co gamma facility (ENEA Casaccia research centre)

Jessica Scifo*[1], Roberto Bedogni[2], Abner Ivan Castro Campoy[2], Rocco Carcione[1], Jessica Scifo*[1], Roberto Bedogni[2], Abner Ivan Castro Campoy[2], Rocco Carcione[1], Ilaria Di Sarcina[1], Beatrice D'Orsi[1], Miguel angel Caballero Pacheco[3], Luigi Russo[2], Adriano Verna[1], Alessia Cemmi[1]

[1] ENEA, Rome, Italy
[2] INFN-LNF, Frascati (Rome), Italy
[3] INFN, Rome, Italy

https://doi.org/10.21175/rad.abstr.book.2025.35.13

Many physical and chemical properties of matter are modified by radiation exposure. These variations can be used to realize a system, known as dosimeter, able to measure the absorbed dose.

At Calliope ^{60}Co gamma facility of the ENEA Casaccia research centre in Rome, several dosimetric systems are used, depending on the absorbed dose range of interest [1]. This work presents a comparative study among conventional and passive dosimetric systems, such as Fricke solution and alanine-ESR dosimeters [2], and an online dosimetric system based on semiconductor detectors.

In the framework of the ENEA-INFN (Italy) collaboration, a test campaign was organized to evaluate the performance of semiconductor-based gamma detectors as active dosimeters for gamma dose rates in the range of 10 Gy/h -10 kGy/h. These gamma detectors, based on Silicon, Silicon Carbide and GaAsP substrates, were manufactured at the LEMRAP Laboratory (INFN Frascati) and tested at the Calliope facility at three dose rates, ranging from a few Gy/h to a few kGy/h. The results of the comparison will be reported, focusing on sensitivity, radiation resistance and scalability to multi-dosimeter systems.

Spectral EMF measurement in educational institutes in Hungary

Péter Pál Necz*[1], Zsuzsanna Vecsei[1], Péter János Varga[2], Márk Tamás Baross[2], György Thuróczy[1]

[1] NCPHP, Budapest, Hungary
[2] Óbuda University, Budapest, Hungary

https://doi.org/10.21175/rad.abstr.book.2025.35.14

Electromagnetic field (EMF) exposure to young adults and children are on main focus of non-ionizing radiohygiene. To determine the exposure to this age group, measurements were performed in schools in Hungary between February-April 2023. Two primary schools, three high schools and two universities were involved in this measurement campaign. Every measurement was performed both indoor (inside the building) and outdoor (on the courtyard or next to the entrance) with a Narda SRM-3006 spectrum analyzer. At each measurement point, we placed the spectrum analyzer at a fixed location where students typically stay. The device was positioned at a height of 1.5 meters. To simulate the real-world mobile technology usage, a test mobile phone was settled at around 1 meter distance from the measurement device. At each measurement point two scenarios were simulated: *non-user*, which represents a mobile phone in the surrounding of the measurement device but there is no forced data usage (NU); *download*, which means that the test phone was forced to download a huge amount of data (DL). The measurement protocol was both indoor and outdoor the following: we switched the mobile phone to the appropriate mode: NU or DL. In NU mode, only the network parameters were registered by the QualiPoc mobile phone app (Rohde& Schwartz, Germany). In DL mode, a big data file was downloaded through the mobile network. The phone used that mobile network (4G or 5G) which was available at the place of the phone. Then, we started the spectrum analyser's data collection for exactly 6 minutes between 700 MHz and 4 GHz. During the measurement, we maintained a distance of at least 1.5 meters around both the mobile phone and the spectrum analyzer. At the finish of the measurements, the device was stopped, and then we turned off the mobile phone data collection as well. After the measurements we analysed the collected data. The results shows that the registered electric field strength values were at around 0,5 V/m in NU and around 0,6 V/m in DL mode indoor, respectively. Outside the buildings the measured electric field strength values were also under 0.5 V/m in NU mode while during download these values are around 0.6 V/m. All of the measurement values are quite below the exposure limit values of ICNIRP levels (41-61 V/m).

Studies for alpha particle spectroscopy using TASTRAK (CR-39) Detectors

Ionel Elisei*[1], Ioana Lalau[2]

[1] University of Bucharest, Faculty of Physics, Magurele, Romania
[2] IFIN-HH, Magurele, Romania

https://doi.org/10.21175/rad.abstr.book.2025.35.15

This communication discusses the possibilities to obain spectroscopic results of measured alpha particle tracks in solid state nuclear detectoers, based on image analysis of etched alpha particle tracks in TASTRAK (CR-39 type) plastic detectors. Ra-226 and its descendants, which belong also to the U-238 decay chain, is an important naturally occurring radioactive chain, often used for experimental studies. The main decay probability of the Ra-226 alpha decay chain is presented in the form Nuclide, Energy (keV), Transition Probability (%): (Ra-226, 4870.54, 94.038; Ra-226, 4684,5.95; Rn-222, 5590.2, 99.92; Po-218, 6114.7, 99.97; Po-214, 7833.24, 99.99). In the experimental investigations, only traces that approach the circular shape were selected. Because this condition is difficult to fulfil, using Image J (FIJI) software, the selection was imposed so that the difference between the minimum and maximum axis of the selected traces satisfies the condition that the relative difference is less than 10%. The experiment was carried out in he IFIN-HH/LMRI laboratory and the measurements were made using an optical microscope (model LEITZ WETZLAR, objective CARL ZEISS 40X, optical etalon 10 micrometer/div) at the University of Bucharest with the recording of images using a CMEX 18PRO camera and analysed with the IMAGE FOCUS ALPHA software. CR-39 plastic detectors were exposed for 3 days in the radon chamber with a volume of 1m^3 ta a radon concentration of 1035.79Bq/m^3 calculated from measurements of activity with a HPGe gamma detector. Before the exposure, a radon source was prepared using the Radon System from IFIN-HH. The radon was extracted from a Ra-226 solid source traceable to NIST, USA. Because the alpha particles are emitted at different distances from the CR-39 plates, the energies with which they enter the detector are different due to energy loss in the air. We analyse and discuss the correlation between energy of the alpha particle, its range in the detector and the parameters of the etching process (concentration of the NaOH solution, temperature and etching time), which is a complex problem.

Thermal quenching effect on the glow curves of lithium and magnesium borate dosimeters at different doses

Engin Aşlar*[1], Şule Kaya-Keleş[1], Gaye Özgür Çakal[1], G.S. Polymeris[2]

[1] Institute of Nuclear Sciences, Ankara University, Ankara, Turkey
[2] Institute of Nanosciences and Nanotechnology, NCSR Demokritos, Paraskevi, Greece

https://doi.org/10.21175/rad.abstr.book.2025.35.16

Thermal quenching is the decrease in luminescence efficiency due to the increasing probability of non-radiative transitions with increasing measurement temperature. If the material possesses a thermal quenching effect, the use of high heating rates can lead to a distinct decrease in the radiation doses. Hence, investigating the presence of thermal quenching is of great importance for any material that can be utilized as dosimeters. Lithium borate ($Li_2B_4O_7$, Z_{eff} = 7.3) and magnesium borate (MgB_4O_7, Z_{eff} = 8.4) are both considered to be tissue-equivalent materials. Due to this feature, these materials are preferable in the field of personal and medical dosimetry. In this study, the thermal quenching effect of In and Cu-doped $Li_2B_4O_7$ and a Dy-doped MgB_4O_7 dosimeters were investigated on their glow curves at two different doses. The $Li_2B_4O_7$:Cu,In dosimeters were annealed at 300°C for 1 h and MgB_4O_7:Dy dosimeters were annealed at 500°C for 1 h for before the measurements. Then, the glow curves of both dosimeters were obtained at two different dose levels (100 mGy, 1 Gy) using a $^{90}Sr/^{90}Y$ beta source with a dose rate of 0.1 Gy/s. A Hoya U-340 filter was used for the $Li_2B_4O_7$:Cu,In dosimeter and a BG-39 filter for the MgB_4O_7:Dy dosimeter during the thermoluminescence (TL) measurements in a Risø TL/OSL DA-20 device. In the study, the heating rates of 1, 2, 4, 6, 8, and 10°C/s were selected. The glow curves were obtained for each heating rate and deconvolved into their individual peaks. To examine the thermal quenching behaviors of the dosimeters, the variations in the areas under the deconvolved TL peaks and the total area of the entire glow curves for each heating rate were analyzed. As a result, even if increases and decreases were observed in the individual peaks for both types of dosimeters with different heating rates, the total areas under the entire glow curves showed a decrease with increasing heating rates. This finding indicates that both dosimeters were affected by thermal quenching. When the heating rates were increased from 1°C/s to 10°C/s, nearly 10% decrease was observed for $Li_2B_4O_7$:Cu,In, while 30% decrease was observed for MgB_4O_7:Dy in the total area of the glow curves. In addition, although the peaks exhibited different behaviors depending on the applied dose, no significant change was observed in the total area under the glow curves. In conclusion, this study suggests selecting the lowest possible heating rate to avoid low luminescence signal intensity, especially when using the MgB_4O_7:Dy dosimeter.

Thermoluminescence signals of natural and synthetic zeolite materials: A preliminary study

Şule Kaya Keleş*[1], Engin Aşlar[1], Zuhal Akyürek[2], Gaye Özgür Çakal[1]

[1] Institute of Nuclear Sciences, Ankara University, Ankara, Türkiye
[2] Burdur Mehmet Akif Ersoy University, Energy Systems Engineering Department, Burdur, Turkey

https://doi.org/10.21175/rad.abstr.book.2025.35.17

Zeolites are microporous aluminosilicate minerals with extensive applications in catalysis, adsorption, ion exchange, and environmental remediation. Due to their structural stability, physical and chemical properties, they have the potential to be used in radiation dosimetry as a luminescent material. Türkiye has one of the largest clinoptilolite (natural zeolite) reserves in the world. This study aimed to investigate the presence of radiation-induced thermoluminescence signals in natural and various synthetic zeolites and their sensitization by annealing. Here, the variation of the luminescence intensities as a function of annealing temperatures was acquired, and the natural and one of the synthesized zeolite samples having the highest luminescence sensitivity was studied in terms of their dose response behaviors. In the study, the natural zeolite sample obtained from Tuzköy, Nevşehir, Türkiye, and synthetic zeolites coded A, X, P, 4A, and ZSM-35 were used. TL measurements were performed by a Risø TL/OSL DA-20 reader equipped with an internal $^{90}Sr/^{90}Y$ beta source and a Hoya U-340 detection filter. For TL measurements, 10.0 ± 0.5 mg samples were placed in stainless steel cups. TL glow curves were recorded up to 500°C with a heating rate of 2°C/s. Annealing processes were performed by heating the samples to temperatures between 300–900°C with steps of 100°C for an annealing time of 1 h. After annealing, the samples were irradiated with a test dose of 100 Gy to measure and compare the luminescence intensities. Then, to observe the behavior of dose response curves of natural zeolite and the most sensitized synthetic zeolite, the samples were irradiated with radiation doses between 50 Gy and 1 kGy. The results indicated that all studied zeolite samples exhibited a prominent low-temperature TL peak at 90°C, whereas the TL peaks observed above 90°C showed lower luminescence intensities. According to the results, the natural zeolite (clinoptilolite) and the most sensitized synthetic zeolite (zeolite 4A) were compared depending on their dose response curves. These findings contribute to a preliminary study toward a better understanding of the TL properties of zeolite materials and their potential applications in dosimetry studies.

TL glow curve analysis of potassium chloride using deconvolution method at different beta radiation doses

Engin Aşlar, Şule Kaya Keleş, Gaye Özgür Çakal*

Institute of Nuclear Sciences, Ankara University, Ankara, Türkiye

https://doi.org/10.21175/rad.abstr.book.2025.35.18

Alkali halides are well-known wide band gap materials, which are very important for luminescence dosimetry. Potassium chloride (KCl), one of the alkali metal halides, is a salt that is used as a fertilizer, in medicine, in scientific applications, domestic water softeners, and in food processing. KCl also occurs in nature as the mineral sylvite. In this study, the undopped KCl salt was investigated as a potential material for retrospective dosimetry regarding its thermoluminescence (TL) characteristics. TL measurements were performed by a Risø TL/OSL DA-20 reader equipped with an internal $^{90}Sr/^{90}Y$ beta source and a Hoya U-340 detection filter. Measurements were carried out using 5.0 ± 5% mg samples placing these samples in stainless steel cups. TL glow curves were recorded up to 500°C with a heating rate of 2°C/s. The variations in the TL glow curves of KCl was examined between 0.1 Gy and 100 Gy beta doses. The obtained glow curves were deconvolved by using computerized glow curve deconvolution (CGCD) method. The results showed that KCl had a total of 7 peaks according to the results of the deconvolution method. The maximum peak temperatures were found as 50, 107, 147, 197, 232, 289 and 395°C. The corresponding activation energies were obtained as 0.72, 0.78, 1.18, 1.20, 1.24,1.31, and 1.40 eV, respectively. When the dose response curves were examined, it was seen that each peak showed a different behavior in terms of its linearity with increasing doses. When the total area intensity was taken into consideration, it showed a linear behavior up to 7 Gy. The preliminary results showed that KCl salt have a potential to be used as a TL dosimeter in retrospective dosimetry.

Activation of ^{165}Dy isomer states by neutrons from the photodisintegration of ^{164}Dy nuclei

Tamara Krasta*[1], Anastasiia Chekhovska[2], David Chvatil[3], Daina Riekstina[1]

[1] Institute of Solid State Physics of the University of Latvia, Riga, Latvia
[2] NSC Kharkiv Institute of Physics and Technology, Kharkiv, Ukraine
[3] Nuclear Physics Institute of the Czech Academy of Sciences, Prague, Czech Republic

https://doi.org/10.21175/rad.abstr.book.2025.36.1

According to cosmic nucleosynthesis models, abundances of most elements heavier than iron depend on the number of free neutrons available for capture reactions. Equilibrium between (n,γ) and (γ,n) reactions plays important role while nuclear isomer states serve as β-decay waiting points [1]. Photonuclear reactions can give considerable contribution for abundances of some nuclides of the 150≤A≤190 region including seven stable dysprosium isotopes.Experimental measurements of bremsstrahlung photoactivation reactions on targets made of enriched (97.8% of 164Dy) and natural dysprosium were performed at photon bremsstrahlung end-point energies Eph ranging from 7.11 up to 22.82 MeV with a step of 2 MeV at the Prague microtron MT-25. The decay γ-spectra after different cooling times have been measured with HPGe detector. Most of γ-lines observed in the spectra of enriched and natural dysprosium targets activated with Eph above 16 MeV were assigned to the β-decay (T1/2=19.5 min) of 163Tb to the levels of 163Dy following reaction 164Dy(γ,p)163Tb (see Ref. [2]), and the β-decay (T1/2=7.60 min) of 162Tb to the levels of 162Dy following reaction 163Dy(γ,p)162Tb. Since products of (γ,n) reactions on the most abundant Dy isotopes are stable, one cannot see corresponding decay lines. However, our experimental results show that capture reactions of produced thermal and epithermal photoneutrons give notable contribution to the total measured activity. Starting with Eph=9.75 MeV, we observe in the spectra of irradiated enriched 164Dy target the most intense 165Dy decay lines to 165Ho (T1/2=2.33 h). In the decay spectra of both natDy and enriched 164Dy targets registered after cooling times less than 4 min, we observe also the 108.2 keV decay line of the 165mDy isomer (T1/2=1.257 min) [3]. Since the intensity ratio of observed 165Ho lines in the enriched 164Dy and natDy target spectra corresponds to the number ratio of 164Dy nuclei in both targets, we conclude that captured neutrons are mostly produced via the 164Dy(γ,n)163Dy and 164Dy(γ,2n)162Dy reactions. Intensities of 165Ho lines, measured at Eph= 9.75, 12.12 and 13.79 MeV when the 164Dy(γ,p) reaction channel is suppressed by the Coulomb exit barrier and below the (γ,2n) reaction threshold, allowed to assess the portion of the total photoneutron yield participating in the activation of 165Dy nuclei.

1. E.M.Burbidge et al., Rev.Mod.Phys. 29 (1957) 547-650.
2. A.Chekhovska et al., RAD Conference Proceedings, vol. 7, pp.1-5, 2023.
3. Evaluated Nuclear Structure Data File (ENDF), https://www-nds.iaea.org..

Preliminary assessment of different irradiation regimens for large-volume breast cancer metastases in the brain, taking into account the immunohistochemical variant of the tumor

Ksenia Shilova*, Vladimir Krasnyuk, Roman Goncharov, Komer Sharipov, Anastasia Kakotkina

Dr. Sergey Berezin Medical Institute, Novosibirsk, Russia

https://doi.org/10.21175/rad.abstr.book.2025.36.2

Breast cancer is the leading cause of cancer among women in most countries of the World, including the Russian Federation. According to the Global Cancer Observatory, 2.3 million cases were diagnosed in 2022, and about 685,000 women died from the disease. The development of metastatic lesions (MTS) of the brain is an unfavorable prognostic factor. The incidence of damage to the central nervous system, in the event of the disease developing, averages 10-30%. It is worth noting that the risk of brain damage is associated to a greater extent with the tumor belonging to a particular molecular genetic subtype. For example, the incidence of breast cancer metastasis in Her2neu-positive patients can reach 50%. Throughout the history of the development of MTS treatment in the brain, the main methods have been formed, which include general irradiation of the entire brain, surgical removal of tumors and methods of stereotactic radiation therapy. If surgical removal of large metastases in the brain is impossible or inappropriate, stereotactic staged radiosurgery or stereotactic radiotherapy in hypofractionation mode may serve as an alternative. Particular interest in the treatment of large brain metastases is the analysis of the effect of different doses of ionizing radiation on breast cancer metastases, taking into account the immunohistochemical characteristics of the tumor.

From January 2020 to January 2025, a retrospective analysis was carried out at the Berezin Sergey Medical Institute in Novosibirsk, which included 39 patients (43 lesions) with breast cancer who underwent treatment with the Leksell Gamma Knife in the staged radiosurgery and hypofractionation mode.

According to preliminary analysis, it was possible to reveal that the methods of staged radiosurgery and stereotactic radiotherapy in hypofractionation mode provide a high level of local control of lesion; a dependence of local control of brain metastases on the characteristics of the immunohistochemical variant of the tumor was also established.

The development of a ^{109}Cd-based XRF system for the detection of iron in human skin

Michelle Yap*, Michael Farquharson, Fiona McNeill

[1] McMaster University, Hamilton, Canada

https://doi.org/10.21175/rad.abstr.book.2025.36.3

Iron is essential to numerous metabolic processes in humans [1]. XRF measurements of skin iron have been correlated with iron storage in the liver, heart, and kidneys [2]. Skin iron XRF measurements are thus a potential measurement of iron levels in these and other organs at risk of iron overload and iron deficiency.

An XRF system has been developed using a 109Cd source in a backscatter geometry to measure iron in skin. This system has a minimum detectable limit (MDL) of 1.35 ± 0.35 µgFe/g [3], enabling it to measure iron at clinically relevant levels. A drawback of the system is that a measurement time of 30 minutes is required [3] which is too long to be a suitable point-of-care device for in vivo measurements. Furthermore, this system has only been used to measure iron-doped water calibration phantoms and ex vivo animal tissue samples.

We will present details on improvements to the system aimed at maintaining an adequate detection limit of iron in skin while reducing the measurement count time. Optimization parameters include sample-detector distance, rise time, and processing time. New detector components have been developed which aim to further improve the detection limit of the system by reducing the background spectrum at relevant energies.

We will also detail the results from our pilot study investigating the feasibility of using this measurement device in vivo. We will present data from 24 normal volunteers within an age range of 18 to 80. The improved system employs an optimized setup including the development of a hand holder for in vivo measurements on the thenar eminence. The goal of the pilot study is to understand the precision and uncertainty of this system for the measurement of iron in humans over the normal range of levels.

Reference:

1. N. Abbaspour, R. Hurrell, and R. Kelishadi, “Review on iron and its importance for human health,” J. Res. Med. Sci. Off. J. Isfahan Univ. Med. Sci., vol. 19, no. 2, pp. 164–174, Feb. 2014.
2. E. Dao, “X-ray Fluorescence Measurement of Iron Accumulation in Skin as a Surrogate Marker for Iron Levels in Critical Organs and Total Body Iron Burden”.
3. S. U. K. Bangash, F. E. McNeill, M. J. Farquharson, and D. R. Chettle, “Feasibility of a 109 Cd-based portable XRF device for measuring skin iron concentration in anaemic and β–Thalassaemic patients,” Biomed. Phys. Eng. Express, vol. 8, no. 6, p. 065034, Nov. 2022, doi: 10.1088/2057-1976/ac9e02.

Angular dependence of $H_p(3)$ – Radial vs. polar rotation

Rolf Behrens*

Physikalisch-Technische Bundesanstalt (PTB), Braunschweig, Germany

https://doi.org/10.21175/rad.abstr.book.2025.37.1

Introduction: With the International Commission on Radiological Protection (ICRP) lowering the annual dose limit for the lens of the eye to 20 mSv, precise monitoring of eye lens exposure has become essential. The personal dose equivalent at a depth of 3 mm, Hp(3), is the measuring quantity for monitoring the lens dose. This quantity is, according to the International Commission on Radiation Units and Measurements (ICRU), defined at 3 mm depth in a rectangular cylinder (20 cm in diameter and 20 cm high) made of ICRU 4-element tissue. Conversion coefficients hpK(3) for photons from the basic quantity air kerma, Ka, to the quantity Hp(3) are available for normal ($\alpha = 0°$) and oblique ($\alpha \neq 0°$) radiation incidence for radiation impinging from the left or right, i.e., when the cylinder is rotated about a vertical axis. However, this rotation direction does not adequately account for bottom-to-top radiation exposures which are common in real-world situations (such as radiation scattered by the patient reaching medical staff). Therefore, this study investigates how much the conventional quantity value (true value) changes when the ICRU 4-element cylinder is rotated about a horizontal axis compared to the common vertical rotation axis.

Method: Conversion coefficients hpK(3) were calculated for both vertical (normal) and horizontal rotation of the ICRU 4-element tissue cylinder for mono-energetic photons from 2 keV to 10 MeV. From the results, the ratio of the values for horizontal and vertical rotation were determined. For comparison, the corresponding values for the equivalent dose to the lens of the eye, hlens, were calculated and their ratios compared to the corresponding ratios for the operational quantity Hp(3). Corresponding ratios were determined for reference beta-particle radiation fields.

Results: The described ratios for photon radiation showed the following behavior:

- the larger the angle of radiation incidence α and the smaller the photon energy E_{ph} the smaller the ratio $r_{Hp3} = h_{pK}(3;E_{ph};\alpha)_{horizontal} / h_{pK}(3;E_{ph};\alpha)_{vertical}$: for example, r_{Hp3} falls below unity ($r_{Hp3} \leq 0.98$) for
  - $\alpha = 30°$ and $E_{ph} < 10$ keV and
  - $\alpha = 75°$ and $E_{ph} < 500$ keV;
- simultaneously, the ratio $r_{Hlens} = h_{lens}(E_{ph};\alpha)_{horizontal} / h_{lens}(E_{ph};\alpha)_{vertical}$ is significantly smaller than 0.98 for the same values of α and E_{ph}:
  - $r_{Hlens} \leq 0.88$ for $\alpha = 30°$ and $E_{ph} < 10$ keV and
  - $r_{Hlens} \leq 0.85$ for $\alpha = 75°$ and $E_{ph} < 500$ keV.

Similar results (with different actual numbers) were obtained for beta radiation.

Conclusions: For oblique radiation incidence ($\alpha \neq 0°$) the conventional quantity value (true value) of Hp(3) is significantly smaller when rotation about the horizontal instead of vertical (normal) axis is performed. This effect is even much stronger for the dose to the lens of the eye, Hlens. These findings may serve ICRU to judge whether or not it should be considered for an updated definition of the operational quantity Hp(3) – and, consequently, for type-testing of dosemeters.

Assessment of the effectiveness of the personal protective equipment against the impact of radiological contaminants

Natasa Pajic*, Maja Vitorović-Todorović, Tamara Vujatović-Velimirov

Military Technical Institute, Belgrade, Serbia

https://doi.org/10.21175/rad.abstr.book.2025.37.2

Introduction: In order to reduce the impact of radiological contamination on humans, it is necessary for individuals to take protective measures, which can be either active or passive. It can be stated that radiological protection encompasses a series of measures carried out to avoid the consequences of radiological contamination. Personal protective equipment plays a crucial role and can be divided into general (belonging to every individual) and special (designed to protect individual performing tasks in conditions of enhanced contamination) categories. General protective equipment includes respiratory protection devices (masks and half-masks) and body protection gear (protective suits and coveralls).

This study defines the procedures for decontamination and the effectiveness of modern decontamination agents in use by the Serbian Armed Forces, with a focus on the impact of the relationship between contaminants and contaminated surfaces. The study presents a comparison of the effectiveness of protective materials decontamination by using two decontamination agents, namely, 1% detergent solution and a DECON gel (Cellular Bioengineering, Inc., 1946 Young Street, Suite 480, Honolulu, HI, USA). The materials tested were sampled from the following military equipment: protective mask M3, protective overall M4, protective boots M5 and protective gloves M5 and Tyvec suit.

Experimental: Samples for the evaluation of the efficiency of decontamination were painted textile and rubber plates dimensions (50 × 100) mm and thickness 2 mm, which were contaminated by contamination solution.

Contamination of samples was performed by the solution for contamination (specific activities 10350.94 Bq/ml and pH = 2.5), which is a dilute mixture of liquid standard radioactive isotopes 60Co (800.56 Bq/ml) in the form of $CoCl_2$, 133Ba (420.79 Bq/ml) in the form of $BaCl_2$, 152Eu (8320.12 Bq/ml) in the form of $EuCl_3$ and 241Am (1100.47 Bq/ml) in the form of $Am(NO_3)_3$. Marked area on the samples - 15cm2, (50 × 30) mm, was contaminated by the applying of the solution in 30 drops of respective volumes of 10 µl in symmetrical form. Contaminated samples were dried in standard laboratory conditions. Decontamination was performed by 0.5% solution of detergent and DECON gel decontamination agent from the free market.

Results and discussion: For all twenty material samples, decontamination was performed after obtaining the initial activity. The applied radiological decontaminant alters the physical properties of the material from which the M4 protective overgament is made causing deformation. The applied method proved to be successful in evaluating the effectiveness of decontamination of rubber and textile materials. The efficiency of decontamination decreases linearly with increase in contaminant retention time on the samples.

Analysis of the obtained results after the contamination and subsequent decontamination process leads to the conclusion that the highest decontamination efficiency was achieved by DECON GEL for all the samples tested. It showed 95,4 % efficiency on rubber samples from the mask facepiece and 95% on rubber from boots. A lower decontamination efficiency was observed with the detergent solution, showing 83,3% on rubber samples from the mask facepiece and 84,9 on the rubber from protective boots M5.

Conclusion: The proposed methodology demonstrated reliability in assessing the efficacy of decontamination agents and is applicable to a wide range of specific conditions regarding different contaminants, decontamination agents, and materials and surfaces. Furthemore, our findings indicate that the retention time of contaminants on surfaces plays a critical role in the overall decontamination efficiency.

Keywords: radiological decontamination, formulation protective equipment, contaminated surfaces.

Development of integrated safety and security risk criteria for radiation protection in nuclear and radiological facilities

Jason Harris*

Purdue University, West Lafayette, IN, United States

https://doi.org/10.21175/rad.abstr.book.2025.37.3

The safety and security of nuclear and radiological materials and their associated facilities share a common objective which is to ensure the protection of people, property, society, and the environment from the harmful effects of ionizing radiation. Integrating the two disciplines of safety and security to harmonize radiation protection has received more attention over the last several years to cut costs, improve operations, and reduce risk. Risk assessment is used to determine the likelihood and consequences of harmful events occurring at a nuclear for radiological facility. Historically, many analytical methods have been developed and implemented to support safety- based risk assessment and decision analysis. Adapting and extending risk assessment to nuclear security applications has been limited because of the adaptive nature of sub-state actors and the lack of historical data of malicious attacks. Given the rising threat of both nuclear and radiological terrorism, and state-sponsored actions, it is imperative to assess if facilities have the means to fully understand and evaluate the security of their radioactive sources. In an effort to model both nuclear safety and security risk, the Potential Facility Risk Index (PFRI) was developed and modified to evaluate and quantify these risks associated with nuclear and radiological facilities. The PFRI framework is centered on a facility-based approach, signifying that the risk is exclusive to the facility, and varies depending on several factors, such as the type and location of the facility, the number and types of radioactive materials available, and the security culture at the facility. The framework comprises three components: threat, vulnerability, and consequences. The modification of the PFRI to integrate safety and security was achieved by using traditional safety probabilistic risk assessment (PRA) techniques with security pathway analysis. While assessment is important, valid indicators of nuclear safety and security risk must also be established for the decision-making process. The indicators, coupled with the PFRI result, show the overall risk score, which has been categorized into five levels to provide a clear understanding of the potential risks associated with nuclear facilities. Additionally, a linear regression analysis was conducted using a logarithmic scale to establish a clear correlation between the PFRI and risk assessment outcomes. These criteria enable the determination of acceptable and unacceptable risk levels, which is especially important if this process is to be applied to new nuclear and radiological facilities, especially advanced and small modular reactors (SMR). In this most recent study, two nuclear facilities were analyzed using the modified PFRI model. The facilities were based on an existing and planned SMR. In both cases, hypothetical scenarios of nuclear safety and security incidents were analyzed. Results obtained from the analysis show that for both facilities, the security risk exceeds the safety risk. In both cases however, the overall risk is still considered low when compared to values provided in the design final safety analysis reports. Overall, results of the study are expected to aid in the rational and quantitative assessment of overall nuclear and radiological facility risk. This presentation will briefly describe the PFRI model, show how it was applied to two nuclear facilities, and discuss the results and conclusions.

Education and training in radiation protection in Albania: Current challenges

Kozeta Tushe*, Manjola Shyti, Florinda Cfarku

University of Tirana, Tirana, Albania

https://doi.org/10.21175/rad.abstr.book.2025.37.4

This study provides a short-summarized information about the education and training in radiation protection in Albania for employees who are exposed to ionizing radiation. Based on the law "On Protection from Ionizing Radiation ", No. 8025, date 09.11.1995, Albania has approved the training program in the field of protection from ionizing since 2011 by Commission of Radiation Protection. The Institute of Applied Nuclear Physics, University of Tirana is one of the basic syllabus training providers who trains about 100 employees per year which are exposed to various fields of application, medical workers (radiology, nuclear medicine), industry (non- destruction test, oil well, mining), dentistry (dentist, doctor), etc. By Albania regulation employees who use sources of ionizing radiation and who have received the relevant training in radiation protection must undergo retraining courses after a period of five years. This is necessary to refresh the knowledge acquired in the previous training course, as well as to familiarize themselves with possible new developments in the field of radiation protection. In more than ten years' experience of basic syllabus training some gabs, weaknesses and challenges have been encountered. Complexity of radiation science, physics and biology concepts: Workers with different education backgrounds try to understand dose limit, protection principles with shielding principles. Training involves quantities dosimetric concepts which are difficult to understand for non - specialist or for workers with high school. During the short test after training questions with alternatives are more efficient compared explaining questions. Practical with theoretical learning is another weakness because training more focus on theoretical aspects but lacks sufficient hands -on practice with monitoring equipment. Lack of on-the-job training, good knowledge of radiation equipment and emergency response. Weakest point comes to lack of awareness and safety culture. Most of the exposer workers may not fully understand radiation risks or the importance of protection measures, to protect themselves and patients too.

Empowering medical physicists in radiation emergencies: Bridging expertise with frontline response

Chiara Ferrari*[1], Guglielmo Manenti[2], Andrea Malizia[2]

[1] Department of Industrial Engineering, University of Rome Tor Vergata, Rome, Italy
[2] Department of Biomedicine and Prevention, University di Rome Tor Vergata, Rome, Italy

https://doi.org/10.21175/rad.abstr.book.2025.37.5

Nuclear and Radiological Emergencies are exceptional events characterized by specific critical issues in their management, in addition to those naturally connected to all types of emergencies. An effective response requires intervention teams with training and dedicated instrumentation. The low probability of occurrence and the specificity of the resources needed to deal with them implies a considerable effort if one wants to be ready to respond anytime and anywhere The emergency and health services must address critical decisions that cover many practical aspects, ranging from managing medical emergency response to long-term follow-up of those exposed. The risk of being overwhelmed is strong, special equipment and abilities are required. Optimizing existing resources in the territory is a necessary step towards building a sustainable healthcare model. Because of their background, Medical Physicists can carry out numerous duties since the early moments, the most critical, if they have been trained to handle an emergency. They could serve as an additional resource, for example, by providing guidance in radiation surveys, conducting dose assessments for support activities, and effectively communicating associated risks. The International Atomic Energy Agency promotes the participation of Medical Physicists in emergency teams, within hospitals (in-hospital emergency team) and on the incident site (pre-hospital emergency team). Such integration requires overcoming organizational and logistical challenges, especially the case of integration in the pre-hospital first responders' teams. The Medical Physicist professional program should incorporate emergency management courses as part of its curriculum. Regular retraining through mandatory continuing education is essential to fully prepare medical physicists for their roles as healthcare professionals. This presents both a new and ongoing challenge, particularly following the recent update to the educational framework to include Artificial Intelligence. This emerging expertise can play a pivotal role in implementing advanced tools for addressing emergency situations. This study aims to explore organizational challenges and enhance the involvement of Medical Physicists in hospital emergency response, as well as their integration into on-site emergency medical teams.

Eye lens dosimetry: Does the direction of rotation (vertical or horizontal) play a role in type testing?

Behnam Khanbabaee*, Rolf Behrens, Onur Erdem

Physikalisch-Technische Bundesanstalt (PTB), Braunschweig, Germany

https://doi.org/10.21175/rad.abstr.book.2025.37.6

With the International Commission on Radiological Protection (ICRP) lowering the annual dose limit for the eye lens to 20 mSv, precise monitoring of eye lens exposure has become essential. The personal dose equivalent at a depth of 3 mm, $H_p(3)$, is the measurement quantity for monitoring the dose to the lens of the eye. In typical dosemeter type-tests with non-normal angles of radiation incidence ($\alpha \neq 0°$), usually lateral radiation exposure scenarios with radiation incidence from the left or right are used, which requires rotation of the dosemeter-phantom setup around a vertical axis. However, this method does not adequately account for bottom-to-top radiation exposures which are common in real-world situations such as radiation scattered by a patient reaching medical staff.

This study examines oblique radiation exposure conditions using a typical eye lens thermoluminescent dosemeter (TLD), Eye-D, placed on a cylinder phantom (according to ISO 4037-3) to determine the dose response at different angles of radiation incidence and photon energies. The study employs both low-energy (N-30 radiation quality with a photon mean energy of 25 keV) and medium-energy (N-100 radiation quality with a photon mean energy of 83 keV) X-rays at irradiation angles of $\alpha = -60°$, $\alpha = 0°$, and $\alpha = +60°$, measured along the vertical and horizontal rotation axes of the dosemeter-phantom set-up.

The results show no significant difference between the dose response measured at the selected irradiation angles with horizontal and vertical rotation of the dosemeter-phantom setup: recorded relative doses stayed well within ± 1 %, i.e., by far within the attributed combined uncertainty of ± 2 %. Therefore, it was concluded that it is sufficient to carry out type tests of eye lens dosemeters that are rotationally symmetric in the typical, vertical phantom orientation. These findings make additional tests in a horizontal dosemeter-phantom setup unnecessary – at least for rotationally symmetric dosemeters.

A peer-reviewed article describing the details of this study is available in Journal of Radiological Protection (*https://doi.org/10.1088/1361-6498/adaaff*).

From dosemeter development to routine use – Standards and uncertainties

Rolf Behrens*, Oliver Hupe

Physikalisch-Technische Bundesanstalt (PTB), Braunschweig, Germany

https://doi.org/10.21175/rad.abstr.book.2025.37.7

The concept for dose limitation in radiation protection consists of the protection quantities (doses in the human body, not measurable) and the operational quantities (for measurements) to (conservatively) estimate the protection quantities.

Standardization ensures the quality of dose measurements. For this,

- the International Electrotechnical Commission (**IEC**), committee IEC/TC45/SC45B on radiation protection instrumentation, issues standards on **performance requirements for type-tests** while
- the International Organization for Standardization (**ISO**), committee ISO/TC85/SC2 on radiological protection, issues, among others, standards on **reference radiation fields**.
- Regional standardization organizations are
    - the European Committee for Standardization (CEN) CEN/TC430 on nuclear energy, nuclear technologies, and radiological protection, adopting ISO standards, and
    - the European Electrotechnical Committee for Standardization (CENELEC) CLC/TC 45B on radiation protection instrumentation, adopting IEC standards; likewise
    - further regional organizations such as the GCC in the Gulf region, the SARSO in the South Asian region, and the ARSO in the African region, adopt ISO and/or IEC standards.

For photon **dosemeter type-tests** the narrow spectra (N-series) photon reference radiation fields described in ISO 4037 are used to **determine the dosemeters' (extreme) responses to (nearly) mono-energetic radiation**. (ISO 6980 describes beta-particle and ISO 8529 neutron reference radiation fields.) **Further influence quantities** such as angle of radiation incidence, dose and dose rate, ambient conditions (temperature etc.), electromagnetic immunity etc. are, e.g., dealt with by

- IEC 62387 for dosimetry systems with integrating passive detectors and
- IEC 61526 for active personal dosemeters.

The ranges of influence quantities that a dosemeter is tested for must cover the ranges of the workplaces the dosemeter will be used in. The dosemeter should be calibrated at its reference energy (if used at different workplaces) or the mean energy of the foreseen workplace (if used at only one workplace).

The overall uncertainty of a dosemeter is determined by combining the uncertainty contributions for the different influence quantities – deduced from the extreme values of the response values obtained in a previous type-test. The underlying procedure is described in IEC TS 62461 which contains many examples. Its updated version as of 2025 also outlines the determination of the decision threshold and detection limit.

The overall performance of dose measurements should be checked regularly by comparison measurements according to ISO 14146, a standard on performance limits for individual monitoring services (IMS). This standard describes the so-called trumpet curves, i.e., the allowed response limits depending on the dose. Its updated version as of 2024 now covers comparison measurements from the European Radiation Dosimetry Group (EURADOS).

Neutron activation in GANIL facilities: Quantification and safety issues

Manssour Fadil*, Fabienne Lemaire, Nicolas Ménard, Bertrand Rannou, Christelle Stodel, Yoann Trehudic

GANIL, Caen, France

https://doi.org/10.21175/rad.abstr.book.2025.37.8

Neutrons are produced in several areas in GANIL by the interaction of the ion beams with different materials (targets, beam-lines, diagnostics instruments, radiological protections, air ...). The spectrum of produced neutrons depends on several factors: the accelerated ion, its energy, the nature of the targets, the environment ... It is important to know the characteristics of these spectra and their intensities for nuclear safety reasons, for the radiation protection studies and also for the quantification of potential environmental impacts of the air activation.

The simulation work, based on both Monte-Carlo method and the nuclear data, allows to calculate the neutron spectra in different configurations of GANIL nuclear facilities. Simulation codes (like PHITS, MCNP and FLUKA) are used in these studies with theoretical models and nuclear data libraries. Evolution codes (like FISPACT and DARWIN PEPIN) are used to calculate the activation of materials that are under irradiation of these neutron spectra.

The simulation studies are often completed by a benchmark work, both theoretical and experimental. Several experiments are driven to confirm or improve the calculation modelling.

In this talk we will mainly present the methodology used to perform these calculation studies. We will give some examples in physics studies with the actinide targets station and in the accelerators environments.

Package classification in IAEA safe transport regulation: review change history and performance in Republic of Korea

Dae Hyung Cho*, Hyun Suk Yoon

Korea Institute of Nuclear Safety, Daejeon, South Korea

https://doi.org/10.21175/rad.abstr.book.2025.37.9

A variety of radioactive materials are transported by land, sea and air. In Korea, various types of radioactive materials are transported very frequently from research institutes, industries, and hospitals, including nuclear power plants. Moreover, in Korea, as the disposal facilities for medium and low-level radioactive waste are in operation, the transport of radioactive waste sources is gradually increasing. The transport of radioactive materials is receiving increasing attention and concern as radioactive materials are exposed to the general environment outside their managed areas.

When considering the movement of radioactive materials between countries, international harmonization of related regulations as well as ensuring transportation safety are very necessary. The IAEA published "Regulations for the Safe Transport of Radioactive Materials" in 1961 as Safety Series No. 6 to ensure safe transport of radioactive materials. Since then, it has been revised more than 10 times to date, reflecting technical reviews and operational inspections by international organizations and expert groups. The graded approach applied in the initial report of the IAEA transport regulation has not changed so far, which can be said to prove the soundness of the regulation. On the other hand, it has developed by adding, deleting, and changing some technical standards.

The classification of radioactive materials and packages has changed significantly since the publication of the first regulations. The classification of radioactive materials changed from three groups in the first edition to eight groups in the 1964 revised edition, based on radioactive toxicity and physical form, and the package loading limits for each group were presented. When the radioactivity was above a certain amount, it was classified as "large radioactive source", and low-radioactive materials were classified as "low specific activity material". In addition, in consideration of physical characteristics, "Pyrophobic or Explosive material" and "Fissile material" were separately classified. However, the packaging was not specifically presented, only “packed in strong, industrial, leak-proof packages or loaded in vehicles or compartments specially designed to ensure that there will be no leakage under conditions normally incident to transport”was required. The concept of A value was introduced in 1973 edition, and after 2009 edition, a section called "activity limitations and classification" was established to emphasize the classification of package type. The introduction of A value reflecting the Q system was 1996 edition, and at that time the 10 types of transport types were designated.

Korea's safety transport technology standards were established in 1985 reflecting the IAEA Regulations for the safe transport. The peculiarity is that the Exempted package is defined and applied as Type L because it can be misunderstood as a linguistic problem, that is, it is not included in any regulations. Transportation performance for sealed radioactive materials carried out in 2023 and 2024 in Korea are 10,563 and 9,917 cases. The number of cases by package Type, Type B/Type A/Type IP/Excepted/Special Arrangement, is 4,338/5,560/539/539/5 in 2023 and 4,045/5,261/97/512/2 in 2024.

Quality control assessment for different X-ray fluoroscopy units in Albania

Luljeta Disha[1], Irena Mucolari[2], Florinda Cfarku*[2]

[1] Institute of Applied Nuclear Physics, University of Tirana, Tirana, Albania
[2] University of Tirana, Tirana, Albania

https://doi.org/10.21175/rad.abstr.book.2025.37.10

Fluoroscopic examinations can increase the potential for a high radiation dose to the patients and staff, consequently as a prerequisite to guarantee patient safety and the quality of examinations these X-ray fluoroscopy devices require the application of a rigorous quality control program. Quality control (QC) of radiological medical devices in Albania has started during the last decade and is applicated for the first time by the Institute of Applied Nuclear Physics (IANP) according to Decision No.404 – "For basic rules of radiologic installations in medicine" emphasizing that all healthcare institutions that use radiological equipment are obliged to pass in the process of QC not less than once in three years. Except IANP these QC tests are also carried out by other licensed private companies. The purpose of this work was to evaluate the operating conditions of fluoroscopic equipment in use in various health care institutions in Albania comparing the obtained data with those defined in the actual national radiation regulation. We present the results of some primary QC tests evaluation for 10 different fluoroscopy systems. Measurements of radiation exposure were performed using a calibrated Radcal (AGMS - DM+) solid-state multi sensor. For the Image Intensifier (II)Entrance Dose Rate measurements the detector was placed at a focus to II distance of 100 cm directly on the entrance surface of the image intensifier. For the Patient Entrance Surface Dose Rate, the detector was placed on the entrance surface of the 20 cm PMMA body phantom. The units were switched to auto mode with both kV and mA automatically set for field sizes 20-25 cm. From the analysis of the results it was found that: the kilovoltage (kVp) accuracy was between 1.4 - 5%, kVp consistency was between 1-3.1%, tube output for 70 - 80kV operation was between 26.1- 60μGy/mAs,The output variation with change of mAs was between 1 - 4%. Total filtration at 70 kV and higher was between 2.6 – 4.5 mm Al. The Patint Entrance Surface dose rate ranged from 11.2 to 23.2 mGy/min in the continuous mode of operation while Image Intensifier dose rates ranged from 0.29 to 0.69 μGy/s. Based on these findings, this study showed clearly that all the fluoroscopic devices, subject of routine QC tests were in a very good compliance with the national radiation protection acceptable criteria. Such measurements are important both for the optimization of image quality and for radiation protection purposes.

Keywords: quality control, fluoroscopy system, kilovoltage, filtration, dose rate, image quality

Radiation brainscreen protector/interface

Vojislav Antic*

University Clinical Center of Serbia, Beograd, Serbia

https://doi.org/10.21175/rad.abstr.book.2025.37.11

The growing demand for high-quality real-time diagnostics, increased awareness among professionals and technical workers, as well as the improvement of ionizing radiation protection measurements, along the increasing number of medical institutions where interventional procedures are performed (six times more than 10 years ago, UNSCEAR), are contributing to the expansion of the market for ionizing radiation protection equipment.

Lead transparent screens for ionizing radiation protection have been used in medical practice for over 100 years. The shape, dimensions, movement mechanisms, materials and final product processing have been perfected, but currently, the screen is still manually positioned, and its position remains unchanged during the intervention, regardless of potential change in working conditions (as there is no communication between the screen and the relative C-arm X-ray device).

With still unparalleld patented solution (P-2020/0462, The Intellectual Property Office of the Republic of Serbia) for the semi-automatic positioning of the ceiling-suspended screen for radiation protection in interventional radiology, the shield always places itself into the position considering the lowest possible staff exposure against ionizing radiation. Health centers benefit as well, having their staff protected, healthier and less absent.

For the purpose of business and technical implementation, two types of products are defined:

1. Radiation Brainscreen Protector (Total Model) - RBP
2. Radiation Brainscreen Interface (Basic Model) - RBI

The first is intended in synergy with new C-arm X-ray devices, and the second for existing ones.

A machine learning algorithm was created, which uses patent-defined input parameters, for optimal positioning of the protective screen in real time. To that end, a test model was created in the Tensorflow working environment in the Python programming language.

It is envisaged that the assessment of staff radiation exposure will be recorded in the Radiation Structured Dose Report (RDSR).

Radiation protection calculations in the design of the AB-BNCT facility for the PNC-PNRR-ANTHEM Project

Setareh Fatemi*[1], Ricardo Luis Ramos[1], Silva Bortolussi[2,1], Laura Bagnale[3,4], Giovanni Garini[1], Barbara Marcaccio[2,1,5], Cristina Pezzi[2,1], Ian Postuma[1], Lorenzo Airoldi[1], Umberto Anselmi Tamburini[2], Valerio Italo Vercesi[1]

[1] Italian National Institute for Nuclear Physics, Pavia, Italy
[2] University of Pavia, Pavia, Italy
[3] University od Campania L. Vanvitelli, Caserta, Italy
[4] Italian National Institute for Nuclear Physics, Naples, Italy
[5] Instituto Dan Beninson, Universidad Nacional de San Martin, Buenos Aires, Argentina

https://doi.org/10.21175/rad.abstr.book.2025.37.12

In the framework of the PNC-PNRR ANTHEM project, a new Accelerator-Based Boron Neutron Capture Therapy (AB-BNCT) research and clinical facility will be built in Caserta, Italy. The ANTHEM clinical facility neutron production will be based on a Radio Frequency Quadrupole proton accelerator coupled with a beryllium target. Both the accelerator and the target are designed and manufactured by the Italian National Institute of Nuclear Physics (INFN). This machine delivers 5 MeV protons with a 30 mA current in continuous wave, producing at the target a neutron flux of the order of 10^{14} neutrons per second.

The radiation protection aspects of the facilities have been studied for the design of the biological shield and to be able to guarantee operational safety for the clinical and technical staff and for the patients.

In particular, using the Monte Carlo transport codes PHITS and DCHAIN, we have calculated the dose-rate at different times after the accelerator shutdown. We have considered the neutron activation of the Beam Shaping Assembly (BSA) and the neutron activation of the walls in the treatment room. The obtained results allowed us to know the principal radioactive isotopes in the BSA and in the walls as a function of time. For each time, we have also calculated the ambient equivalent dose rate. Additionally, we have investigated the residual specific activity of air within the irradiation room, giving special attention to the neutron activation of Ar-40, that produces the beta-emitter Ar-41 with a half-life of approximately 109 minutes. In this case the specific concentration of the Ar-41 as a function of time was calculated considering also the recirculation of air.

The studies performed in this work, together with additional radiation protection studies carried out by our research group were pivotal in defining the design of the ANTHEM facility and will be fundamental for the management of the future patients after the BNCT treatment.

Scientific activity of the Arab Atomic Energy Agency in 2024-2025

Oksana Morozova*

All-Russian Research Institute for Civil Defense and Emergencies of the EMERCOM of Russia, Moscow, Russia

https://doi.org/10.21175/rad.abstr.book.2025.37.13

Introduction

Arab Atomic Energy Agency (AAEA) - a specialized Arab scientific organization working within the framework of the League of Arab States and dealing with nuclear science and its peaceful applications. The actual work of AAEA began on April 15, 1989. The permanent official headquarters is located in Tunis, Tunisian Republic. The number of Member States is fourteen: Bahrain, Egypt, Jordan, Iraq, Yemen, Kuwait, Lebanon, Libya, Mauritania, Palestine, Saudi Arabia, Sudan, Syria, Tunisia. AAEA strives to develop joint Arab scientific work, as well as to be involved in international scientific and technological progress in this field. AEEA is interested in raising the scientific and technical awareness of Arab citizens in the field of nuclear sciences and their peaceful uses. In 2024, AAEA in cooperation with the Atomic Energy Agency, organized the XVI Arab Conference on the Peaceful Uses of Atomic Energy. Speaking at the conference, the Secretary General of the League of Arab States, Ahmed Aboul Gheit, said that the Middle East and North Africa region needs to increase electricity generation capacity by 70% by 2050 to meet the growing demand. Nuclear power is the solution to meet such needs, as a single nuclear power plant can provide energy to countless homes at minimal cost and with low environmental impact.

Department of Scientific Activity of AAEA: The Department of Scientific Activity of AAEA includes the work of three divisions and an information and training center. The Division of Nuclear Energy and Nuclear Safety is the key one. The Head of the Division of Nuclear Energy and Nuclear Safety is Professor Dr. Firas Al-Ali.

The Division is interested in cooperation on the following issues: protection of people and the ocean from the effects of radiation, reducing the likelihood of accidents, setting standards for the safety and security of nuclear installations and radioactive sources, safe transportation of nuclear materials, creation of a regulatory and legislative framework, radioactive waste management, training and development of specialists, providing expertise and advice to Member States in the field of international treaties. The Department of Scientific Activities also includes the Division of Nuclear Technology and the Division of Life and Environmental Sciences.

Scientific and practical activities AAEA for 2025: Arab Atomic Energy Agency and Jordan Atomic Energy Commission in Cooperation with the League of Arab States will hold The Seventh Arab Forum on the Prospects of Nuclear Power for Electricity Generation and Seawater Desalination in December 2025. The importance of the seventh forum comes at a time when some Arab countries, such as the Arab Republic of Egypt, United Arab Emirates, Kingdom of Saudi Arabia, and the Hashemite Kingdom of Jordan, have made significant progress in establishing their nuclear power programs, while many other Arab countries are considering introducing nuclear energy into their energy diversification strategies. The previous six forums have had a clear and positive impact on raising awareness of nuclear power at both public and decision-making levels. The present forum will enhance Arab cooperation and public understanding on key issues related to nuclear energy. One of the key objectives of the forum is information and experience exchange on national methodologies for the study of nuclear fission and fusion energy to qualify and develop human resources. AAEA also organizes annual training courses. In June 2025, AAEA in cooperation with the Egyptian Atomic Energy Agency, will organize a training course on «Preparedness and response to nuclear and radiation emergencies».

Conclusion

AAEA is interested in the work on creating a qualitative scientific and technological leap. This fact must be taken into account by specialists in the field of radiation safety of humans and the environment, as this implies the expansion of further cooperation between all stakeholders.

The Virtual Radioactive Source System (VRSS)

Karoly Bodor*

EK, Centre for Energy Research, Budapest, Hungary

https://doi.org/10.21175/rad.abstr.book.2025.37.14

What is VRSS:

- The developed virtual gamma system is a true radiation-free, real action (i.e., not computer-run) simulation system using electronic hardware and software tools. The system is intended for creating any kind of radiation detection condition implemented without real radiation, real source, real measuring detector.

  It includes a ("virtual") hardware/electronic source and detector, as well as a software measurement scenario and user interface display on a computer. A user performs/experiences the simulation, which is controlled by the operator. The system can be also programmed for alpha, beta, neutron; dose, dose-rate, count-rate, spectra identification detection and surface contamination (alpha, beta) detection. The system can be programmed for any kind of shielding object and its factors to the source and map (e.g.: concrete wall, barrier, packaging). Shielding objects and factors can be represented virtually on the simulation operation area.

- Operator can see dose rate map and manipulate the simulation by adding/removing shielding. Initial software components and hardware prototypes have been implemented as the first phase of the project. These developments were mainly intended to assess the possibilities and boundaries of the simulations.

Biological treatment plan optimization: A novel computational solution

Silvia Vargas-Castrillon*, Francisco Cutanda Henriquez

UNED, Madrid, Spain

https://doi.org/10.21175/rad.abstr.book.2025.38.1

Current state of the art treatment planning allows the achievement of very complex goals under given constraints. A complex set of parameters has to be evaluated when an irradiation plan is to be assessed, instead of the conventional minimum and maximum doses figures of merit that were used two decades ago. The biological approach is based on different radiobiological indices, linking the plan to specific clinical goals. In order to enhance the plan and get values of the indices close enough to the prescribed goals, a tool to assess plans may be very helpful, so that the planner can be certain that a set of plan parameters delivers a biological value similar or better than another set. Hence, when optimizing a treatment plan, it is very useful to be able to characterize treatment plans, according to the closeness of their indices to a reference value (a goal or a previous result that should be improved).

A measure of closeness to the objective dose distribution was designed, in terms of the values of the indices. We have designed an algorithm that implements a type of distance between dose volume histograms that can be used to optimize biologically a treatment plan. Given a DVH curve, the function F(z)=1-DVH can be considered a probability distribution random variable (absorbed dose for random points inside the tumour in this case). Common biological indices, such as Tumour Control Probability (TCP), act as operators on the set of distribution functions, and we can define a Lévy distance between the distribution functions F and G, dL(F,G). The problem to be considered is whether or not two DVHs within a specified Lévy distance would result (through the TCP operator) in tumour control probabilities within a given interval of values. And the inverse problem is to establish the maximum Lévy distance that can be allowed between two DVHs (and thus, the set of plans) in order to comply with constraints on TCP. If T is an operator (a biological index), and it is continuous, an upper and lower bound can be found on its values for distribution functions at a Lévy distance of R_0 from F_0. Therefore, given a tolerance level on TCP, a set of constraints on plan parameters (for instance, on DVH) can be found ensuring that tolerance is fulfilled. Any functional on distribution functions (DVH) can be modelled through this new theoretical framework, at least if it shows minimum good analytical properties of continuity and differentiability, as it is typically the case with radiobiological indices.

This approach speeds up and formalises the decision making process, and allows for flexibility when comparing different treatment strategies. In this work, this approach has been made operational (based on objective conditions) and has been algorithmically implemented.

Development and validation of a dose-response calibration curve for the cytokinesis-block micronucleus assay in peripheral blood lymphocytes for radiation dose assessment

Oldřich Zahradníček*, Katarína Bláhová, Irina Danilova, Hasanul Banna, Alena Davídková

Nuclear Physics Institute of the Czech Academy of Sciences, Prague, Czech Republic

https://doi.org/10.21175/rad.abstr.book.2025.38.2

Biological dosimetry is a technique used to assess exposure to ionizing radiation and quantify the radiation dose received by individuals or populations, particularly in the context of radiation accidents or astronaut missions in space. Ionizing radiation has genotoxic effects, resulting in genetic instability and chromosomal aberrations. One of the key assays employed in biodosimetry for estimating absorbed doses from peripheral blood lymphocytes is the cytokinesis-block micronucleus (CBMN) assay. Micronuclei are round cellular structures composed of chromatin and can originate from chromosomal fragments or whole chromosomes. These micronuclei remain in the cytoplasm after cell division. In this assay, Cytochalasin B plays a crucial role during lymphocyte cultivation. This chemical inhibits cytokinesis during cell division, leading to the formation of binucleated lymphocytes, with micronuclei present, if any. The number of micronuclei within these binucleated cells is then scored. In the present study, we developed a dose-response calibration curve. The presence of micronuclei in cells undergoing mitosis serves as a reliable indicator for estimating the absorbed radiation dose. To develop the calibration curve, blood samples from four healthy donors, aged 20 to 46 years, were irradiated with gamma radiation from a ^{60}Co source. Doses of 0, 1, 2, 3, 4, and 5 Gy were administered using a water phantom. The calibration curve was subsequently validated through a blind experiment, where blood samples from two different donors were irradiated with three doses of X-rays (1.4 – 1.5 MeV) using a TrueBeam linear accelerator (Varian) at Motol University Hospital. After irradiation, the calibration samples were incubated at 37 °C for two hours to simulate DNA repair before being transferred to culture medium. In the blind experiment, the samples were incubated at 37 °C for two hours, stored overnight at room temperature, and then transferred to culture medium. Both sets of cultures were incubated at 37 °C for 72 hours in a CO_2 incubator. At 26 hours post-irradiation, Cytochalasin B was added to the culture medium. After the incubation period, cells were treated with cold KCl and fixed with three washes of methanol/acetic acid, followed by centrifugation. After the final fixation, the cell suspension was dropped from a height onto cold, wet microscopic slides. The slides were then dried, stained with Giemsa-Romanowski nuclear stain, and analyzed under a microscope. A minimum of 800 binucleated cells were analyzed by visual inspection using ImageJ and Zen software, and micronuclei were counted. The relationship between dicentric frequency and radiation dose was described using the linear-quadratic model: $\lambda = C + \alpha D + \beta D^2$. In the blind experiment, relative deviations between measured and reference doses ranged from -11.5 % to 49 %. Dose estimation using our calibration curve was found to be less accurate than the dicentric chromosome test. However, it remains useful for triage purposes in the event of a radiation accident, as the analysis is faster than the dicentric assay, which also requires more experienced analyzers for accurate interpretation.

Improvement of biodosimetry and radiation dose assessment: Future challenges

Tijana Stojanović*, Miroslava Stanković

Public Company "Nuclear Facilities of Serbia", Belgrade, Serbia

https://doi.org/10.21175/rad.abstr.book.2025.38.3

Biodosimetry is a method that assesses the radiation dose received by an organism using biological markers, such as chromosomal aberrations, particularly dicentric chromosomes in peripheral blood lymphocytes. This technique is essential in situations where radiation exposure is unknown, such as nuclear accidents or medical procedures. The first step in biodosimetry involves collecting blood samples from individuals exposed to radiation. In the laboratory, chromosomal analysis is performed using microscopy to identify and count dicentric chromosomes, which are chromosomal structures with two centromeres formed due to chromosome damage from ionizing radiation. The results of this analysis are compared to established dose-response calibration curves based on samples exposed to known radiation doses. Creating calibration curves for different radiation energy levels is important and is defined using Linear Energy Transfer (LET). High LET radiation, such as neutrons, is more efficient at causing chromosome damage, while low LET radiation, such as X and gamma rays, acts differently and is less efficient. For low LET radiation, the dose-response curve can be described using a linear-quadratic equation:

$$Y = A + \alpha D + \beta D^2$$

where, Y is the yield of dicentrics, A is the background frequency, D is dose, and α and β are the linear and dose squared coefficients.

The calibration curve was established in the cytogenetic laboratory of the PC "Nuclear Facilities of Serbia" for four radiation levels: 0.5 Gy, 0.8 Gy, 1 Gy, and 2 Gy. The goal is to enhance this type of radiation measurement by adding several more points to the existing calibration curve. Following the recent updates to laboratory standards, there are plans to improve the existing calibration curves according to new regulations, allowing for more accurate determination of radiation doses. The same protocol used previously will be followed, which involves the use of plexiglass specifically designed for blood irradiation. This plexiglass has a certain thickness that mimics tissue and can hold vacuum containers with blood. Blood samples were taken from three healthy male participants involved in the study. The blood is irradiated using a ^{60}Co gamma radiation source. The maximum irradiation time was ten minutes, and the distance was calculated based on the applied dose. After irradiation, a protocol was followed to measure chromosomal aberrations. For each radiation dose, dicentrics were counted in 200 metaphase cells. After obtaining the results, calibration curves were constructed.

In the future, the experiment will be conducted in the same manner, with plans to add new results to the existing calibration curves to enhance their accuracy. Recognizing the importance of standardization and continuous improvement in methodology, expanding calibration curves and incorporating modern analytical techniques will significantly enhance the precision of dose assessments. The laboratory is dedicated to following established protocols to maintain consistency and accuracy in results. Moving forward, the integration of new knowledge and methods, combined with collaboration among various institutions, will further advance biodosimetry as a reliable tool for protecting the health of individuals exposed to radiation.

Isolation of radiation resistant bacteria from radon rich freshwater and uptake assay

Enis Çam*[1], Rumeysa Çelik[1], İlayda Sapmaz[2], Sinan Hoca[3], Mutlu İçhedef[2], Yasemin Parlak[4], Ajda Turhan[5], Emine Serra Kamer[3], Mustafa Ateş[6], Fazilet Zümrüt Biber Müftüler[1]

[1] Ege University Nuclear Sciences Institute, Nuclear Applications Department, İzmir, Turkey
[2] Ege University Nuclear Sciences Institute, Nuclear Sciences Department, İzmir, Turkey
[3] Ege University Medicine Faculty Hospital, Radiation Oncology Department, İzmir, Turkey
[4] Manisa Celal Bayar University Medicine Faculty Hospital, Nuclear Medicine Department, Manisa, Turkey
[5] Ege University Medicine Faculty Hospital, Blood Center Laboratory, İzmir, Turkey
[6] Ege University Faculty of Science, Fundamental and Industrial Microbiology Department, İzmir, Turkey

https://doi.org/10.21175/rad.abstr.book.2025.38.4

Recent studies on radiation-resistant microorganisms have integrated classical culture techniques with molecular-level investigations. The isolation and characterization of these microorganisms have gained significant interest in the subfields of medical, evolutionary, environmental, and agricultural microbiology. Radiation-resistant microorganisms can be used as bioremediation agents thanks to their microbial metabolism and resistance mechanisms, such as bioadsorption and bioprecipitation, in contaminated areas or for evolutionary studies. In this study, the activity of Radon-222 (^{222}Rn) in groundwater was measured using special glass bottles designed for this purpose. The Durridge RAD7 electronic radon detector and the RAD H2O system were used for radon measurements in groundwater. The radon concentration in the analyzed groundwater sample was 17.6 Bq/L. The ^{222}Rn concentrations measured in this study exceed the maximum contaminant level of 11.1 Bq/L set by the United States Environmental Protection Agency for groundwater. The physicochemical parameters of ^{222}Rn-enriched water were also studied. A total of 60 pure bacterial isolates were obtained using membrane filtration from ^{222}Rn-enriched freshwater, collected from a groundwater source in the Agora Ancient City, İzmir, Turkey. The isolated microorganisms were transferred into 96-well microplates at their stationary phase in Reasoner's 2A (R2A) broth and subsequently exposed to a Cs-137 point source of gamma and X-ray radiation. Following irradiation, the cultures were incubated for 24 hours, and gamma-resistant isolates were selected for further analysis. Additionally, the selected gamma-resistant isolates were exposed to Tc-99m (^{99m}Tc) at an activity level of 50 mCi, and the doses they received were measured using a real-time dosimeter. The isolates were incubated for 24 hours and subsequently plated on R2A agar using the spread plate technique. After an additional 24-hour incubation, colony-forming unit (CFU) counts were determined, providing quantitative data on the toxic effects of ^{99m}Tc on bacterial survival. After determining the minimum inhibitory concentration of ^{99m}Tc for the gamma-resistant bacteria, microbial uptake experiments were performed in R2A broth at both stationary and logarithmic growth phases. ^{99m}Tc uptake was measured at 0, 1, 3, and 6 hours using a Cadmium Telluride (CdTe) detector, allowing for a comparative analysis between the two growth phases. This study aims to elucidate the dose-dependent effects of ^{99m}Tc on bacterial survival and growth and to enhance our understanding of radionuclide uptake mechanisms related to microbial metabolism, such as bioadsorption and biomineralization, in gamma radiation-resistant bacteria exposed to ^{222}Rn in their natural microbiota. Following this study, we will evaluate the effects of an Sr-90 beta source, UV-C, and I-131 on the selected resistant bacterial isolates.

Keyword: ^{222}Rn enriched water, Bacterial gamma resistance, Bacterial ^{99m}Tc uptake, Gamma irradiation, Radioresistant bacteria

Molecular markers for cancer risk assessment, biodosimetry, and optimizing radiotherapy

Igor Belyaev*, Pavol Kosik, Matus Durdik, Lukas Jakl, Sachin Gulati, Eva Markova, Milan Skorvaga, Volodymyr Vinnikov, Lucian Zastko, Dominika Kochanova, Katarina Vigasova, Karol Martinka, Armin Rebernig, Lea Tomasova, Diana Seresova

Department of Radiobiology, Cancer Research Institute, Biomedical Research Centre, Slovak Academy of Sciences, Bratislava, Slovakia

https://doi.org/10.21175/rad.abstr.book.2025.38.5

Our department elaborates effects of ionizing and non-ionizing radiations on genetic instability in human cells with focus on hematological stem cells. An effect of radiations on origination of leukemia, molecular mechanisms in etiology of leukemia and new approaches in prevention, treatments, and diagnostics of leukemia are being investigated. DNA damage response, circular and microRNA, gene and chromosome rearrangements, gene expression, and apoptosis are the main endpoints studied by the state-of-the-art techniques including automated fluorescent and imaging microscopy, DNA repair foci and comet assays, chromosomal aberrations, micronuclei, FISH, RT-qPCR, DNA cloning and sequencing, standard and imaging flow cytometry, and cell sorting. New emerging possibilities of using non-ionizing radiation in medicine, on one side, and increasing health risks from exposures to low doses of ionizing radiation and low intensity non-ionizing radiation, from another side, are in focus of research projects. We contributed to development of new approaches for inhibition of cancer cell growth with extremely low frequency magnetic fields, mapping of magnetic fields from mobile communication devices in human body, and radiobiological studies for implementation of therapeutic proton complex at Ružomberok. Special efforts are given to establishing biomarkers for assessment of individual radiosensitivity of cancer patients, reduction of side effects of radiotherapy and health risks from exposure to radiofrequency radiation of mobile communication. The RT has also contributed to biological dosimetry, i.e. in medical radiologists and patients. We found higher accumulation of chromosomal damage in the radiological workers in comparison to the control group. In addition, long-term low-dose exposure to IR resulted in amplification of the MLL gene segment what could potentially contribute to malignant transformation. We also compared genetic instability in people leaving in proximity to 3G/4G mobile phone base stations (BS). Statistically significant correlation chromosomal aberrations with distance to BS/intensity of radiofrequency radiation (RFR) was established and the equal dose of ionizing radiation was estimated based on dicentrics according to the IAEA recommendations. The work in progress is to: (i) evaluate possible genetic instability induced by MRI investigations, (ii) shield RFR in order to reduce symptoms of burn-out syndrome, and (iii) evaluate clinical effects of phytochemicals during radiotherapy of cancer patients.

This work is supported by the IAEA Research Contract No: 24714, APVV and VEGA (2/0012/23) Agencies of Slovak Republic, and Kompetenzinitiative, Germany

Potential radioprotective effects of natural antioxidants on testicular tissue exposed to ionizing radiation

Alina Elena Andone*, Speranta Radu, Ana Maria Catrina, Cerasela Haidoiu, Oana Voinea, Lucia Elena Ionescu, Octavian Calborean, Sonia Maria Spandole-Dinu

"Cantacuzino" National Military Medical Institute for Research and Development, Bucharest, Romania

https://doi.org/10.21175/rad.abstr.book.2025.38.6

Ionizing radiation poses a significant risk to male reproductive health, as the testes are highly sensitive to DNA damage. Phosphorylation of histone H2AX (γH2AX) serves as a key biomarker for radiation-induced double-strand breaks, while histopathological changes reflect broader tissue damage. Our objective was to evaluate the potential radioprotective effects of Natural SOD®, a green barley-derived antioxidant, in mitigating testicular damage following ionizing radiation exposure.

Male Wistar rats (n=15) were divided into three groups: control, X-ray exposed without pretreatment (sham), and X-ray exposed with Natural SOD® pretreatment. Whole-body irradiation was performed using a single X-ray dose of 6 Gy at a dose rate of 1 Gy/min. Testicular tissue samples were analyzed for γH2AX expression and histological changes.

Following irradiation, γH2AX foci were observed in all layers of the seminiferous tubules, indicating widespread DNA damage. In the Natural SOD®-pretreated group, γH2AX expression was reduced and primarily localized to primary spermatocytes, suggesting a protective effect. Histological analysis of irradiated sham rats revealed interstitial edema, germinal epithelium disorganization, and nuclear abnormalities in primary spermatocytes, indicative of early apoptotic changes. These effects were less pronounced in Natural SOD®-pretreated rats, which exhibited more preserved testicular architecture.

Our findings suggest that Natural SOD® may help reduce radiation-induced DNA damage and preserve spermatogenesis. This highlights the potential role of natural antioxidants in protecting male reproductive health from ionizing radiation. The methods developed for investigation γH2AX foci have also been used in studies on ex vivo irradiated blood samples. Future research should explore long-term effects and clinical applications.

Keywords: testicular damage, γH2AX, natural antioxidants, spermatogenesis, radioprotection

Acknowledgments: This work was carried out through the Core Program within the National Research, Development and Innovation Plan 2023-2026, with the support of Ministry of Research, Innovation and Digitalization, project no. 23 44, and project "Development of new radioprotection strategies after exposure to ionizing radiation" granted by Cantacuzino National Military Medical Institute for Research and Development.

Preliminary study on the radiobiological effect of Ce-134 therapy using TOPAS-nBio

Sangho Lee[1], Youngho Seo[2], Kondapa Naidu Bobba[3], Robert Flavell[2], Wonku Kim[1], Gyohyeok Song[1], Jaehyun Park[1], Hyunbin Yun[1], Deokseong Kim[1], Gyuseong Cho*[1]

[1] Department of Nuclear and Quantum Engineering, Korea Advanced Institute of Science and Technology (KAIST), Daejeon, South Korea
[2] Department of Radiology and Biomedical Imaging, University of California, San Francisco, San Francisco, United States
[3] Department of Nuclear Engineering, University of Tennessee, Knoxville, Knoxville, United States

https://doi.org/10.21175/rad.abstr.book.2025.38.7

Introduction: It has been recently suggested that Ce-134 can serve as an imaging surrogate for targeted alpha therapy using Ac-225. Ce-134 emits Auger electrons when decaying to La-134 via electron capture, and the decay of La-134 to Ba-134 makes Ce/La-134 pair an imaging surrogate due to the emission of positrons that makes PET imaging possible.

Auger electrons from the decay of Ce-134 were given less attention compared to positrons from La-134 decay when discussing Ce-134/La-134 pair, due to their extremely short range and low energy compared to other radiation types. However, their high linear energy transfer (4-26 keV/μm) they may be employed radionuclide therapy.

We show the feasibility of Ce-134 therapy by using the TOPAS-nBio simulation package, which allows radiation simulations on cellular and subcellular levels.

Methods: The "TsNucleus" cell nucleus model was used for geometry provided by TOPAS-nBio. It consists of uniformly distributed DNA in a sphere with a radius of 4.65 μm. The DNA is modeled with a series of stacked cylinders, which further consist of subdomains within the nucleus. The parameters which control DNA fractal recursion inside the nucleus, (HilbertCurve3DRepeat and HilbertCurveLayer) were set to 30 and 4, respectively and approximately 6 billion DNA base pairs were formed.

Our study used TOPAS-nBio simulated Ce-134, Cu-64, Ga-67, I-131, In-111 and Sb-119 for comparison. For each radionuclide type, 100 radionuclides were randomly distributed in the cell nucleus, with 10 runs each. Not only physical processes but chemical processes were also considered to include indirect damages from hydroxyl to derive the mean absorbed dose to the nucleus.

Result: The mean absorbed dose per 100 radionuclides to the nucleus was: 6.78 ± 0.29 Gy for Ce-134, 2.45 ± 0.09 Gy for Cu-64, 5.13 ± 0.15 Gy for Ga-67, 1.92 ± 0.09 Gy for I-131, 5.45 ± 0.16 Gy for In-111 and 5.09 ± 0.16 Gy for Sb-119.

Conclusion: Our preliminary studies using TOPAS-nBio showed the feasibility of Ce-134 for radionuclide therapy in an absorbed dose manner compared to other beta emitters already exploited for radionuclide therapy. These initial results will be expanded by encompassing parameters such as the scavenging effect, DNA repairs, and cell cycle to further investigate DNA strand breaks.

Concentration of Sr-90 and Cs-137 in selected herbs from two regions of Poland

Małgorzata Kazimierowicz*, Małgorzata Kardaś

Central Laboratory for Radiological Protection

https://doi.org/10.21175/rad.abstr.book.2025.39.1

Radionuclides such as Sr-90 and Cs-137 are artificial products of nuclear fission introduced into the environment primarily through atmospheric nuclear tests and nuclear accidents.

In Poland, their presence is largely attributed to the Chernobyl accident in 1986. Due to their long half-lives (approximately 29 and 30 years, respectively), these isotopes persist in the environment and pose potential radiological risks by entering the food chain. Strontium and cesium exhibit chemical similarity to essential elements: calcium and potassium therefore can mimic them, respectively, in biological systems. Strontium, as a chemical analog of calcium, can be incorporated into bones and teeth, whereas cesium, resembling potassium, is distributed within soft tissues and muscles.

This study focuses on the determination of Sr-90 and Cs-137 activity concentrations in commonly used medicinal plants: Mentha piperita (peppermint), Hypericum perforatum (St. John's wort), Tanacetum vulgare (tansy), Equisetum arvense (horsetail), and Urtica dioica (nettle). Samples were collected from two regions in northeastern Poland—Podlasie and Kurpie. The analysis of Sr-90 was performed using radiochemical separation followed by low-level beta counting (Riso GM-25-5), whereas Cs-137 was measured by high-resolution gamma spectrometry using a Tennelec AL.30 HPGe detector and GENIE 2000 software.

The measured concentrations of Sr-90 ranged from 1.01 to 8.89 Bq/kg, while Cs-137 concentrations ranged from 0.50 Bq/kg to 7.37 Bq/kg. No consistent geographic trend was observed for Sr-90; however, horsetail and nettle showed higher accumulation potential. Elevated levels of Cs-137 were detected in Kurpie samples, particularly in St. John's wort, horsetail, and nettle. Despite the presence of these radionuclides, all measured values were below levels considered hazardous to human health.

Keywords: Sr-90, Cs-137, medicinal plants, herbs, Poland

Radioactive concentrations of Sr-90 and Cs-137 in the diet of Polish residents over five years: 2020 – 2024

Małgorzata Kazimierowicz*, Małgorzata Dziubałtowska, Małgorzata Kardaś

Central Laboratory for Radiological Protection, Warsaw, Poland

https://doi.org/10.21175/rad.abstr.book.2025.39.2

The nuclides examined in this study, Sr-90 and Cs-137, are artificial radioactive isotopes, and their presence in the European environment is primarily associated with radioactive fallout from the 1986 Chernobyl disaster. Since ingestion is one of the main pathways for the intake of radioisotopes into organisms, the radioactive concentrations of Sr-90 and Cs-137 in the diet of Polish residents were studied. To estimate the intake of Sr-90 and Cs-137 through food, their levels in daily meals were measured annually in Warsaw, capital city of Poland. The radioactive concentrations measured ranged from 0.03 to 0.07 Bq/day for Sr-90 and from 0.06 to 0.23 Bq/day for Cs-137. The combined effective doses from Sr-90 and Cs-137 varied between 0.69 and 1.60 μSv/year.

Rare earth elements patterns of uranium ore concentrate using ICP-MS technique - application in nuclear forensics

Ilijana Zelić*[1], Greg Brennecka[2], Derek Hoffman[2], Ivan Grujanac[1], Danijela Soldatović[1], Jovana Nikolov[3], Dalibor Arbutina[1]

[1] Public Company Nuclear Facilities of Serbia, Belgrade, Serbia
[2] Lawrence Livermore National Laboratory, Livermore, United States
[3] University of Novi Sad, Novi Sad, Serbia

https://doi.org/10.21175/rad.abstr.book.2025.39.3

Nuclear materials, particularly those early in the fuel cycle, can contain important trace elements that can give clues to their source. One clue can be the rare earth element (REE) pattern, which can be used as the effective signature for provenance assessment. Prior work has shown that the REE pattern of a source rock can survive chemical and physical processing of material processed into the early stages of the fuel cycle, making REE patterns a very useful tool. The goal of this study is to compare the results obtained by two methods of measuring REEs in uranium ore concentrates (UOCs). The first method is done by first separating the REEs from the uranium matrix prior to analysis, whereas the second method involves measuring the REEs directly in the uranium-rich matrix. We will compare these measurements on multiple different UOC standard materials and report our findings to which method can provide the most accurate and precise REE patterns results. This information will be able to be used in future studies of REEs in nuclear materials with a high uranium matrix.

Analysis of methodological approaches and guidelines to define the radiological stress on the components of natural ecosystems when setting up NPP in the republic of Kazakhstan

Pavel Krivitskiy*, Natalya Larionova, Assan Aidarkhanov, Almira Aidarkhanova, Andrey Panitskiy, Vyacheslav Bozhko, Assiya Kunduzbayeva, Yuliya Baklanova

Branch office 'Institute of Radiation Safety and Ecology' of RSE NNC RK, Kurchatov, Kazakhstan

https://doi.org/10.21175/rad.abstr.book.2025.40.1

The world currently tends to switch to the green power by increasing the fraction of power sources assuming the lowest or no releases of greenhouse gases. Kazakhstan, in accordance with the carbon neutrality strategy of the Republic of Kazakhstan until 2060, also considers nuclear power plants as a stable source of energy. An increase in utilizing the fraction of nuclear power will be accomplished by commissioning new NPP power units. This will reduce the amount of greenhouse gas emissions into the atmosphere, but will entail higher emissions of radionuclides into the environment. The input of radionuclides into the environment, which are produced during the operation of nuclear power plants, may lead to their accumulation by environmental compartments and, as a consequence, to a higher radiation burden in the impact zone of plants. In this regard, it is relevant to determine the content of the major dose-forming radionuclides produced by the operating nuclear power plants in compartments of natural ecosystems.

According to the specific safety requirements of the IAEA No. SSR-1, before any commissioning operations concerning a nuclear installation, the levels of initial (background) radioactivity in environmental compartments (atmosphere, hydrosphere, lithosphere and biota) must be determined. Research into background dose levels before the construction and commissioning of NPP is of key importance for ensuring safety and creating a transparent radiation situation in the region. Radiation monitoring prior to the NPP operation makes it possible to assess the content of radionuclides in ecosystem components, as well as to assess the human radiation burden at the background level (the so-called 'zero level'). The determination of background values serves as a starting point for subsequent impact assessments providing basic information for monitoring and controlling future exposure levels. This approach contributes to safety and ensures that the impact of energy projects on health and the environment will be thoroughly studied and presented to the society transparently.

Accordingly, a priority first step for assessing the radiation burden on the components of natural ecosystems is to determine the list of dose-forming radionuclides. To make up the list of radionuclides to be determined, when assessing the 'zero' background of radioactive contamination, it is necessary to account for the fact that radioactive contamination of the main ecosystems is generated by radionuclides of natural and man-made origin. The main natural radionuclides that produce radioactivity in the soils are ^{40}K, ^{238}U, ^{232}Th, and ^{226}Ra, the content of which depends on the type of parent rocks involved in soil formation, the mineral fertilizers in use, the migration processes of radionuclides in the soil cover and other factors. To make up the list of man-made radionuclides, it is necessary to account for both atmospheric emissions during the operation of nuclear power plants and global fallout after nuclear weapon tests and accidents at NPP, as well as the consequences of previous human activities. In this regard, the analysis of long-term data characterizing atmospheric emissions of NPP has been carried out. It was found that the list of controlled radionuclides has extended over time. For example, the content of radioecologically significant radionuclides ^{14}C and ^{3}H in emissions were not detected for most NPP until after 2018. Test calculations showed that it is these radionuclides that are able to make the main contribution to the public radiation burden in the regions of NPP locations. In addition, the assessment of the 'zero' background necessitates the determination of ^{90}Sr, ^{137}Cs, since these radionuclides are specific to all past incidents and nuclear weapon tests and, accordingly, are on the background of global fallout.

Application of Po-210 measurements in aerosol to assess emissions of the Núi Pháo Masan Mine

Hue Nguyen Thanh Kim[1,2], Van-Hao Duong[3], Trung-Tien Chu[3], Thanh-Xuan Pham-Thi[3], Duc-Thinh Ta[4], Obid Tursunov[5,6,7], Mohamed Saiyad Musthafa[8], Thomas Onumah[9], Anita Csordas[9], Tibor Kovacs*[9]

[1] Environment and Sustainable Development Research Group, Dong Nai Technology University, Bien Hao, Vietnam
[2] Faculty of Technology, Dong Nai Technology University, Bien Hao, Vietnam
[3] VNU School of Interdisciplinary Sciences and Arts, Vietnam National University, Hanoi, Vietnam
[4] Hanoi University of Mining and Geology, Hanoi, Vietnam
[5] Department of Power Supply and Renewable Energy Sources, National Research University TIIAME, Tashkent, Uzbekistan
[6] Bioenergy and Environment Science & Technology Laboratory, College of Engineering, China Agricultural University, Haidian District, Beijing, China
[7] College of Mechanical and Electrical Engineering, Shihezi University, Shihezi, China
[8] Unit of Research in Radiation Biology & Environmental Radioactivity (URRBER), P.G. & Research Department of Zoology, The New College (Autonomous), Affiliated to University of Madras, Tamil Nādu, India
[9] Institute of Radiochemistry and Radioecology, University of Pannonia, Veszprém, Hungary

https://doi.org/10.21175/rad.abstr.book.2025.40.2

The radioisotope content of aerosols can be influenced by multiple natural and anthropogenic sources, however this influence can be used to monitor emissions and the impacted area as well. Vietnam's economical growth relies not only on its robust manufacturing sector, but also by leveraging its natural resources, including mining. The open pit polimetallic mine and its ore processing facilities at the Núi Pháo Masan Mine complex is one of the world's major source of tungsten is a potential source of dust emissions that can feasibly influence air and soil quality in the area if not properly managed. Po-210 activity concentrations were determined by alpha spectrometry in aerosol collected at 34 different sampling points in and around the mine and in residential areas in the direction of the prevalent winds. The observed values ranged from 18.1 to 1950 µBq/m^3 with an average of 160 µBq/m^3, with the elevated values mostly concentrated in the 1 km vicinity of the mining site. The approximately 24 times higher ^{210}Po value of the aerosol in the processing plant area compared to the surrounding regions indicates that mineral processing significantly increases ^{210}Po levels in the air. Results indicate that dust emissions from the mine are limited to the vicinity of the mine possibly due to the climate and topography of the area and the relatively short half-life of ^{210}Po (138.4 days). ^{210}Po content in aerosols tends to be 2-3 times higher in the immediate vicinity (<1km), compared to areas far from the factory. Local residents and especially factory workers might be exposed to elevated ^{210}Po levels in aerosol, however the resulting inhalation doses are expected to be less than 60 µSv/year.

Assessment of fission and activation products in the fish from the waters of the Semipalatinsk Test Site

Andrey Panitsky[1], Symbat Baigazy[1], Zhanat Baigazinov[2,3], Ivan Alexandrivich[1], Togzhan Baiserkenova[1], Serwaa Adjei-Kyereme*[4], Miklos Hegedus[4], Tibor Kovacs[4]

[1] Institute of Radiation Safety and Ecology, NNC RK, Kurchatov, Kazakhstan
[2] Park of Nuclear Technologies, Kurchatov Kazakhstan, Kurchatov, Kazakhstan
[3] Alikhan Bokeikhan University, Semey, Kazakhstan, Semey, Kazakhstan
[4] University of Pannonia, Department of Radiochemistry and Radioecology, Veszprem, Hungary, Veszprem, Hungary

https://doi.org/10.21175/rad.abstr.book.2025.40.3

The Semipalatinsk Test Site is a home of various contaminated water resources including lakes and rivers hosting fish, caught for personal consumption and for sale in adjacent communities also used to water livestock by farmers. There is limited data available on the contamination of freshwater biota for multiple radionuclides. The presence of ^{137}Cs, ^{90}Sr, ^{241}Am, $^{239+240}$Pu, and ^{3}H at various levels in the different water bodies offers a unique opportunity to study the uptake of radionuclides in fish as well as assuring public safety. Additionally, information on the migration processes of cesium and strontium can be applied to other pollutants that exhibit similar behavior in the environment. The observed radionuclides showed mostly a similar pattern to various other marine and freshwater species, with ^{137}Cs concentrated in the muscle, ^{90}Sr in the bones, however only Crater No. 101 showed the gastrointestinal tract high pattern for Pu isotopes. Crater No.101 could serve as an outstanding site for future experimental investigations into radionuclide transfer and dynamics for fish and other freshwater biota, while other, less contaminated sites show a potential for commercial utilization as hosts for fisheries based on internationally accepted levels of radionuclides in food.

Assessment of natural radionuclides and associated radiation indices in beach sand in Binh Thuan province, Vietnam

Hue Nguyen Thanh Kim[1,2], Duong Van-Hao[3], Chu Trung-Tien[3], Pham-Thi Thanh-Xuan[3], Nguyen Thanh-Nam[4,5], Khai M. Nguyen[6,7], Thomas Onumah*[8], Miklos Hegedus[8], Tibor Kovacs[8]

[1] Environment and Sustainable Development Research Group, Dong Nai Technology University, Bien Hoa City, Vietnam, Bien Hoa, Vietnam
[2] Faculty of Technology, Dong Nai Technology University, Bien Hoa City, Vietnam, Bien Hoa, Vietnam
[3] VNU School of Interdisciplinary Sciences and Arts, Vietnam National University, Hanoi, Vietnam, Hanoi, Vietnam
[4] Faculty of Biology, University of Science, Vietnam National University, Hanoi, Vietnam, Hanoi, Vietnam
[5] Biological Museum, University of Science, Vietnam National University, Hanoi, Vietnam, Hanoi, Vietnam
[6] Faculty of Environmental Science, University of Science, Vietnam National University, Hanoi, Vietnam, Hanoi, Vietnam
[7] University of Science, Vietnam National University, Hanoi, Vietnam, Hanoi, Vietnam
[8] University of Pannonia, Department of Radiochemistry and Radioecology, Veszprem, Hungary, Veszprem, Hungary

https://doi.org/10.21175/rad.abstr.book.2025.40.4

Naturally occurring radionuclides can be a health hazard due to their inequal distribution in the earth's crust. Beach sand is not only valuable as a potential recreational area, with the Binh Thuan coast being a popular tourist destination, it can also be a valuable mineral deposit (for example zircon near Ham Tan) or an important raw resource for building material. To assure public safety, the assessment of natural radionuclides can be a necessary precaution, for example Guarapari or Kerala has significant natural radionuclide concentrations in monazite sand. Accordingly, ^{226}Ra, ^{232}Th (^{228}Ra) and ^{40}K concentrations were determined in beach sand samples obtained along the Binh Thuan coast by gamma-spectrometry, and the associated radiation indices were calculated to assess the potential risk. The activity concentration values obtained in the current study ranged from 3.7±0.5 to 235±6.6 for ^{226}Ra, from 5.0±1.0 to 187±4.1 for ^{232}Th and from 26±2.2 to 292±8 for ^{40}K, respectively. With the exception of a single point, the sand was evaluated to be a suitable building material, however most locations show elevated radionuclide levels compared to the population weighted world average. There was a strong correlation found between ^{226}Ra and ^{232}Th (^{228}Ra) values indicating similar origin, and these are the determining factors in the dose rate and radiation hazard indices in the area.

Concentrations of ^{137}Cs in cereal plants intended for animal feeding

Paweł Czerski*, Magdalena Gembal

National Veterinary Research Institute, Department of Chemical Research of Food and Feed, Pulawy, Poland

https://doi.org/10.21175/rad.abstr.book.2025.40.5

Introduction. Cereal plants constitute a large group of cultivated plants that are widely used as fodder or feed additives for feeding farm animals. In Poland, after 1986 (the Chernobyl accident), areas are still contaminated with radioactive caesium-137, whose half-life is 30.2 years. As an emitter of gamma radiation, 137Cs persists in the soil for a long time and plays an important role in the toxicity of radioactive contamination. As a result of migration, 137Cs may penetrate between individual elements of the environment and contaminate, among others, cereal plants, posing a threat to animals fed with plant feed.

Objective. The aim of the study was to estimate the concentration of 137Cs in cereal plants used to feed animals.

Material and methods. In order to assess contamination of cereal plants, grains of corn, wheat, barley and rye were tested, among others. A total of 50 feed samples were analyzed as part of the scientific task in 2023. After grinding and unification the samples, they were transferred to Marinelli-type measuring containers (450 cm3), while maintaining the geometry of the multinuclide calibration source used to calibrate the detectors. Measuring containers with samples were placed on detectors (HPGe, NaI) protected with lead covers, and determinations were made using the gamma radiation spectrometry method. The measurement time of each sample was 20 hours (72,000 seconds). The collected gamma-ray spectra were analyzed using Genie 2000 software.

Results and discussion. The tested samples of cereal plants showed very low concentrations of 137Cs (average 0.61 Bq/kg), the vast majority of which did not exceed the MDA (Minimum Measurable Activity) value. In the case of only two samples of cereal plants, activities were found (2.29 ± 0.23 Bq/kg and 1.01 ± 0.37 Bq/kg) slightly exceeding the MDA value.

Conclusions. The assessment of contamination of cereal plants with the radioactive isotope 137Cs showed that this type of feed products are safe to feed farm animals. The measured concentrations were at very low levels and therefore did not pose a radioactive threat. The obtained low concentrations of 137Cs of the first element of the food chain also indicate greater safety for animals and humans.

Keywords: ^{137}Cs, feed, contamination, cereal plants

Concentrations of ^{137}Cs in forest mushrooms from the region of Eastern Poland

Magdalena Gembal*, Paweł Czerski

National Veterinary Research Institute, Department of Chemical Research of Food and Feed, Pulawy, Poland

https://doi.org/10.21175/rad.abstr.book.2025.40.6

Introdution. The nuclear accident in Chernobyl caused radioactive caesium-137 contamination of the area of Poland. As a result of radioactive fallout, the main biotic elements, such as vegetation and fungi, were unevenly contaminated. The distribution and migration of 137Cs between individual elements of the environment influences the circulation of 137Cs in the food chain through its uptake by animals.

Objective. The aim of the study was to determine the levels of 137Cs in mushroom samples collected in the forest region of Eastern Poland.

Material and methods. The research material consisted of mushroom samples obtained from a forest area. A total of 12 samples of edible mushrooms were tested (Leccinum scabrum (Bull.) Gray, Suillus luteus (L.) Roussel, Tricholoma batschii Gulden, Agaricus sylvaticus Schaeff.) and inedible mushrooms (Amanita muscaria (L.) Lam., Amanita citrina Pers., Lepiota cristata). In the conducted research, the entire mushroom and its individual elements (stem and cap) were analyzed. The crushed and homogenized samples were transferred to special measuring containers, suitably calibrated, Jar type (125 cm3). For detection, gamma radiation spectrometry was used using a semiconductor detector (HPGe high-purity germanium detector). The collected gamma-ray spectra were analyzed using Genie 2000 software.

Results and discussion. The concentrations of caesium-137 activity varied greatly (from MDA values to over 60 Bq/kg). Most often, they ranged from several to a dozen or so Bq/kg. The average concentration of 137Cs in the whole mushroom was 13.17 Bq/kg, in the stem 15.63 Bq/kg and in the cap 16.96 Bq/kg. The highest concentration of 137Cs concerned an inedible mushroom (Amanita citrina Pers.) and amounted to 62.7 +/- 7.73 Bq/kg in the whole mushroom, 53.5 +/- 6.72 Bq/kg in the stem, and 63.5 +/- 7.83 Bq/kg in the cap.

Conclusions. Forest areas create very good conditions for conducting research on 137Cs migration within the fungus itself and in the natural environment. Radiocesium contamination of the forest environment is unevenly distributed, so the concentration of 137Cs varies greatly in mushroom samples. The occurrence of higher concentrations of 137Cs in mushrooms is related to their ability to accumulate artificial radionuclides originating from nuclear explosions and accidents, present in the environment (soil, air, water).

Keywords: ^{137}Cs, Chernobyl, contamination, forest mushrooms.

Correlations between soil's physical properties and radon exhalation rates in Hungarian soil samples

Anita Csordás*, Edit Tóth-Bodrogi, Tibor Kovács

Department of Radiochemistry and Radioecology, University of Pannonia, Veszprém, Hungary

https://doi.org/10.21175/rad.abstr.book.2025.40.7

The natural background radiation to humans comes both from outside the Earth (cosmic radiation) and from radioactive isotopes found on Earth (terrestrial radiation). Radionuclides of terrestrial origin are partly external exposure and partly internal exposure via ingestion and inhalation. One of the most important sources of external terrestrial radiation is soil, where the most significant isotopes found are uranium-238, uranium-235 and thorium-232, members of the decay series, and potassium-40.

The samples can be classified into different soil types and therefore have a wide range of physical and chemical properties. These properties can influence the movement and possible accumulation of radionuclides in different soil layers.

In this study, soil samples were collected from the Transdanubia region (Hungary), based on the grid network used by the JRC (European Commission's Joint Research Centre). The radon exhalation capacity of the soil was measured by closed accumulation technique using AlphaGUARD radon monitor. Other physical and chemical properties (pH, conductivity, porosity, etc.) of the soil samples were also determined.

The aim of the study is to investigate the possible effects of physico-chemical properties on the radon exhalation characteristics of soils.

Funded by the Research Fellowship Programme (Code: 2024-2.1.1-EKÖP) of Ministry of Culture and Innovation from the National Fund for Research, Development and Innovation

Distribution of radionuclide contamination in water bodies at the excavation explosions areas at the territory of the Semipalatinsk test site

Almira Aidarkhanova*, Natalya Larionova, Ainur Mamyrbayeva, Zhanna Tleukanova, Rinata Yermakova

Institute of Radiation Safety and Ecology of NNC RK, Kurchatov, Kazakhstan

https://doi.org/10.21175/rad.abstr.book.2025.40.8

Excavation explosions are underground nuclear tests with the ejection of soil. At the Semipalatinsk Test Site (STS), excavation explosions carried out between 1965 and 1968 resulted in the formation of reservoirs with water. These include the "Telkem-1" and "Telkem-2" craters at the "Telkem" test site, the crater (borehole 1003) at the "Sary-Uzen" test site, and the "Atomic" Lake at the "Balapan" test site. As a result of the excavation explosions, the vegetation in these areas was destroyed and currently is represented by various stages of restoration of some plant communities.

To conduct research on the selected craters, several research sites were laid out, where combined sampling of water, sediments, coastal soil and plants was carried out. Plants belonged to 3 ecological groups depending on their place of growth: aquatic, air-water and coastal. The ^{137}Cs, ^{90}Sr, ^{241}Am and $^{239+240}$Pu contents were determined in all taken samples.

According to the obtained data, all water bodies have a high anthropogenic radionuclides content in sediments, on average at a level from n*10^{2} to n*10^{4} Bq/kg, with the exception of the site in the western part of the "Atomic" lake, where the radionuclides content is an order of magnitude lower than in other sites.

In the water of these craters, the ^{241}Am and ^{137}Cs content is < Detection limit (DL) (< 0.01 Bq/L for both radionuclides). Numerical values of the ^{90}Sr and $^{239+240}$Pu content in all craters water were recorded and vary within the range: for ^{90}Sr from n*10^{-2} to n*10^{2} Bq/L, for $^{239+240}$Pu from n*10^{-4} to n*10^{-1} Bq/L.

In plants, the maximum radioactive contamination is observed for aquatic plants (pectinate pondweed (*Potamogeton pectinatus*) and vallisneria (*Vallisnéria vulgaris*)) growing in the "Telkem-1" crater: for ^{241}Am and ^{137}Cs at a level from n*10^{2} to n*10^{3} Bq/kg, ^{90}Sr – n*10^{3} Bq/kg and $^{239+240}$Pu – n*10^{4} Bq/kg.

High values of ^{90}Sr content were also recorded in samples of the coastal plant tamarisk (*Tamarix ramosissima*) at a level of 8000 Bq/kg, growing in the "Telkem-2" crater. This is probably due to the fact that tamarisk is a shrub, so the radionuclides content in samples of this plant can characterize long-term accumulation.

The soils, as well as the sediments, are characterized by high values of the content of anthropogenic radionuclides at a level from n*10^{2} to n*10^{3} Bq/kg, with the exception of the site in the western part of the "Atomic" lake. At the same time, the $^{239+240}$Pu content in the soil of the "Telkem-2" area reaches n*10^{5} Bq/kg.

Based on the obtained data, the concentration ratio (F_V) for the system "sediments / coastal soil – plants" was calculated. According to the results, the F_V for aquatic plants is 1-2 orders of magnitude higher than for air-water and coastal plants. The exception is ^{90}Sr, for which the F_V are at the same level for all 3 groups of plants (n*10^{-1}). The descending series of radionuclides by their ability to accumulate for air-water and coastal plants is as follows: F_V ^{90}Sr > F_V ^{137}Cs > F_V $^{239+240}$Pu > F_V ^{241}Am.

As the obtained data show, despite the fact that excavation explosions at the territory of the STS were carried out more than 55 years ago, a high level of radioactive contamination of water bodies still remains for sediments, soil and plants (^{137}Cs, ^{241}Am, ^{90}Sr and $^{239+240}$Pu), and for water (^{90}Sr). Thus, although excavation explosions were carried out for "peaceful" purposes, in ecological terms it represents a significant hazard to the environment and humans, since it is still a source of radioactive contamination.

Equilibrium of uranium recovery with ion-exchange resins from the uranium-containing solution simulated groundwater in the radioactive waste tailing site

Vadym Korovin*, Yurii Pohorielov, Yurii Shestak, Aleksandr Valiaiev

M.S. Poliakov Institute of Geotechnical Mechanics of the National Academy of Sciences of Ukraine, Dnipro, Ukraine

https://doi.org/10.21175/rad.abstr.book.2025.40.9

The paper deals with uranium sorption from the solution that simulated uranium-polluted groundwater formed inside Centraly Yar tailing facility at the former Production Union Pridneprovsky Chemical Plant (Ukraine). Nine tailing sites were formed within the factory and in the neighboring area over the plant operation period (1948 to 1991) with a total activity of $2.7 \cdot 10^{15}$ Bq.

Centralny Yar tailing facility was operated from 1950 to 1954; it accumulated $0.22 \cdot 10^{6}$ tons of uranium ore processing waste with a total activity of $1.04 \cdot 10^{14}$ Bq. It is located in a ravine of Dniper terrace; there is no bottom clay barrier. The wastes accumulated in the tailing site feature acidic reaction (pH = 2.5 to 4.0), possibly, due to insufficient neutralization of the sludge after ore processing. Previously, it was concluded that active uranium leaching occurs from the tailing site massif, and its migration into groundwater.

Uranium sorption equilibrium was studied from the solution that simulated the uranium-contained groundwater formed in the Centralny Yar tailing site.

Uranium equilibrium distribution was studied by the different portion technique in batch mode. Uranium concentration in the aqueous phase was measured by photocolorimetry with Arsenazo III.

Ion exchange resins were used during the research manufactured by Smoly JSC (AM-p, AM-p-2, AMP), Lanxess (Lewatit MDS TP 208, Lewatit CNP 80, Lewatit MonoPlus M 500), Purolite (Purolite C115, Puromet MTS9300, Puromet MTA6002PF, Purolite A530E), and DuPont (Ambersep 920U). Experimental data on uranium sorption equilibrium were processed by Freundlich, Langmuir, Sips, and Dubinin-Radushkevich fits. We used determination factor (R^2) as a criterion for selecting the best fit. Based on the data processing, the main parameters of equilibrium uranium recovery (model constants, maximum capacity, heterogeneity factor) were calculated. Characteristic sorption energy indicated the ion exchange mechanism with chemosorption for the recovery process.

HTO uptake by vegetable crops by aerial and root pathway

Yelena Polivkina*, Yelena Zhanuzakova, Yelena Syssoeva, Ludmila Nemytova

Institute of Radiation Safety and Ecology, Kurchatov, Kazakhstan

https://doi.org/10.21175/rad.abstr.book.2025.40.10

The development of the nuclear industry contributes to the increase in discharges and emissions of tritium oxide (HTO) into the environment. This is characterized by its over-migratory capacity due to its similarity with ordinary water, which forms the basis of all vital processes in organisms. Plants play a special role in HTO migration. Plants are able to absorb HTO through both aerial and root pathways. In the case of contamination of agricultural ecosystems, there is a risk of human exposure to ^{3}H. In this regard, it is important to understand the patterns of absorption and incorporation of ^{3}H by vegetable crops, both in the case of emergency discharge and emergency release. The purpose of this work was to compare the incorporation of ^{3}H by vegetable crops during root and aerial uptake HTO. Common beans (*Phaseolus vulgaris*) were used as the subject of the study. The plants were grown to the fruiting stage in plastic containers on a background of soil, into which complex fertilizers were added before sowing to ensure normal growth and development. The plants were watered with distilled water, maintaining optimal humidity at a level of 60-70% of the total moisture capacity of the soil. A phytolighting system was used as a source of light.

The simulation of the aerial intake of HTO was carried out in the field in an area with a high concentration of ^{3}H in the surface air. Air vapor samples were taken by cryogenic freezing with an interval of 2 hours. Plant sampling was carried out during exposure with an interval of 2 hours in three repetitions. The last sampling of plants took place a week after the exposure.

The simulation of the root intake of HTO was carried out under semi-open conditions with tritiated water. The plants and soil samples were selected a day later and a week later.

The specific activity of tritium in the samples was determined by liquid scintillation spectrometry. Quantitative parameters of tritium incorporation by common bean during aerial and root absorption of HTO have been determined. The distribution of “tissue free water tritium” (TFWT) and organically-bound ^{3}H (OBT) into the plants had a different character depending on the pathway of HTO intake. The minimum rate of ^{3}H loss (TFWT and OBT) in the post-exposure period is noted for beans, the maximum for leaves and stems, regardless of the HTO uptake pathway of and the level of tritium content in the environment. It was found that with root uptake of HTO, the value of translocation index of the OBT into beans is 1.5 times higher than with aerial uptake.

This research has been funded by the Science Committee of the Ministry of Education and Science of the Republic of Kazakhstan (Grant No. AP19675034).

Radionuclides in the land cover at hydronuclear test locations of the Semipalatinsk test site

Natalya Larionova*, Anna Toporova, Pavel Krivitskiy, Lubov Timonova, Assan Aidarkhanov

Branch office 'Institute of Radiation Safety and Ecology' of RSE NNC RK, Kurchatov, Kazakhstan

https://doi.org/10.21175/rad.abstr.book.2025.40.11

The Semipalatinsk Test Site (STS) is one of the largest nuclear test sites. 1949 through 1962, atmospheric and ground tests were mostly conducted at the Experimental Field site, but after the International Nuclear Test Ban Treaty took effect, tests came to be conducted underground at the Degelen, Balapan and Sary-Uzen test locations. For specific experiments, the Telkem site was used – the site of two excavation nuclear blasts, 4 and 4a sites – for tests of radiological warfare agents, as well as the Aktan-Berli site – for hydro-nuclear experiments. The hydro-nuclear tests at the Aktan-Berli site are known to be conducted in boreholes underground at a depth of 5-30 meters. Any information on the locations of these experiments (coordinates or layouts) is totally missing. The purpose of this work was to study the content of natural (^{40}K, ^{232}Th, ^{226}Ra) and artificial (^{137}Cs, ^{90}Sr, ^{241}Am, $^{239+240}$Pu, ^{3}H) radionuclides in the land cover of the Aktan-Berli site.

The field work included measurements of radiometric parameters and duplicate sampling of the soil (0-5 cm) and plants (most often a mixed sample of steppe motley grasses). The content of ^{3}H in plants was determined in free water (TFWT) and organic matter (OBT) by liquid scintillation spectrometry using a QUANTULUS 1220 spectrometer (Perkin Elmer, USA). The activity concentrations of ^{40}K, ^{232}Th, ^{226}Ra, ^{137}Cs, and ^{241}Am in soil and plant samples were determined using a Canberra GX-2020 gamma spectrometer, those of ^{90}Sr and $^{239+240}$Pu – by radiochemical isolation followed by being measured with a TRI–CARB 2900 TR beta spectrometer and an Alpha Analyst alpha spectrometer, respectively.

The field measurements showed that the β-particle fluence in the study area is <0.10 part/(cm^2 ×min), the equivalent gamma dose rate on the soil surface varies from 0.10 to 0.26 μSv/h. According to the laboratory results, the content of ^{3}H in the vegetation cover was found to be below the detection limit of the methodological hardware in use: TFWT – <8 Bq/kg, OBT – <7 Bq/kg. The content of naturally occurring ^{40}K, ^{232}Th and ^{226}Ra in plants does not exceed their content in the soil, and the maxima in the soil (^{40}K – 1,100, ^{232}Th – 77, ^{226}Ra – 34 Bq/kg) are typical of the Kazakhstani soils (^{40}K – 1,200, ^{232}Th – 220, ^{226}Ra – 120 Bq/kg). This, in turn, indicates the absence of any geochemical anomalies. The range of ^{90}Sr activity concentration in plants varies from <0.7 to 6.7 Bq/kg, that of ^{137}Cs – <0.6 to 1.1 Bq/kg, the content of ^{241}Am and $^{239+240}$Pu in plants in the absolute majority of cases turned out to be below the detection limit of the methodological hardware in use (<0.2 Bq/kg). That said, proceeding from the assessment findings on the exposure dose rate of plants, one can say that the values are within the lower threshold level of the 'dose limit' according to various literature data. And as the calculated dose rates for plants are lower than the accepted international criteria, the reported result indicates no threats (hazard) to the ecosystem conditions. As a whole, the content of radionuclides in the vegetation cover of the Aktan-Berli site is essentially lower than the maximum permissible levels of radioactive contamination for forage plants posing no hazard to the study area if used for economic needs.

Transfer of ^{137}Cs from radioactively contaminated soils to potato and its subcellular distribution in tubers

Tatiana Paramonova*[1,2], Alexander Zhernenkov[1,2], Maria Godyaeva[1,2], Natalia Kuzmenkova[1,3], Leonid Turykin[4]

[1] Lomonosov Moscow State University, Faculty of Geography, Laboratory of Geochemistry of Natural Waters, Moscow, Russia
[2] Lomonosov Moscow State University, Soil Science Faculty, Moscow, Russia
[3] Lomonosov Moscow State University, Chemistry Faculty, Moscow, Russia
[4] Lomonosov Moscow State University, Faculty of Geography, Moscow, Russia

https://doi.org/10.21175/rad.abstr.book.2025.40.12

Potatoes are one of the most popular foods in the world and are the leading crop of many agricultural rotations. After the large-scale radioactive contamination of terrestrial ecosystems in Europe following the 1986 Chernobyl accident, which affected thousands hectares of agricultural land, there was some concern about the possibility of potato cultivation, since its edible tubers directly contact with ^{137}Cs-containing soil. The transfer factor (TF) for tubers was also found to be 5.6×10^{-2}, which is lower than the TF for the group of leafy vegetables, but higher than the radionuclide uptake parameters of other crops. However, the regulatory agencies responsible for monitoring the radiation and environmental safety of agricultural products do not usually detect quality defects in potatoes from post-Chernobyl areas. Does this mean that potato cultivation on radioactively contaminated land is definitely possible?

In order to independently assess the acceptability of growing potato cv. Gala on arable Luvic Chernozems (Tula region of Russia) with contamination level of ≈170 kBq/m^2 (≈5-fold excess of the permissible level of 37 kBq/m^2) and to identify general patterns of ^{137}Cs root uptake by potato, a study was carried out in 2024 to determine the parameters of the radionuclide accumulation in tubers, roots, stems and leaves, and fruits of the crop. Soil and plant sampling was carried out on a fixed area of 0.625 m^2 in a 3-fold repetition. Insignificant mass fractions of potato (fruits, roots, stolons) were additionally sampled throughout the study area.

Total ^{137}Cs in the soil was relatively evenly distributed over 10-cm sample layers within the plough horizon due to regular agroturbation: specific ^{137}Cs activity ranged from 517 to 564 Bq/kg with a mean value of 537±140 Bq/kg. Specific ^{137}Cs activity in potato biomass was significantly lower and averaged 14.4±1.7 Bq/kg. At the same time, a characteristic feature of the processes of biological ^{137}Cs accumulation in plants was the contrasting distribution of radionuclide in organs and tissues. The highest activity concentrations of ^{137}Cs per unit organ weight were observed in stolons (162.6±20.9 Bq/kg), the lowest – in tubers (9.1±1.4 Bq/kg). Translocation of consumed ^{137}Cs from roots to shoots was active, with leaves acting as radionuclide accumulators (49.0±8.5 Bq/kg), and the weighted average specific activity of ^{137}Cs in aboveground parts of potato exceeded that in belowground parts by 4 times.

The TF established during field observations for the edible part of the crop, the tubers, was 1.4×10^{-2}, which is in good agreement with the indicative values suggested by the IAEA. In general, tubers served as a deconcentrator of ^{137}Cs among other fractions; however, due to their predominant share in the total biomass, more than 66% of the element transferred to the plant was associated with tubers. In the culinary preparation of tubers, peeling resulted in an even greater reduction in ingestion risks, as the periderm was characterised by higher values of ^{137}Cs specific activity than the tuber pulp (9.5±1.6 and 6.4±0.7 Bq/kg, respectively).

An additional aim of the study was to analyse the subcellular distribution of ^{137}Cs in tuber pulp, since these characteristics directly affect the intake of radiocaesium in humans after culinary processing. Fractions of cell walls, starch, organelles and cytosol (soluble material) were isolated for this purpose. The obtained values of specific activity of ^{137}Cs for the stated subcellular fractions formed the following row: cytosol < cell walls ≈ starch < organelles (1.1, 2.6-3.0, and 33.4 Bq/kg, respectively). The localisation of ^{137}Cs in firmly bound cell components explains the empirically established insignificant change in the value of its specific activity in tubers subjected to cooking.

This work was supported by the grant of the The Government of the Russian Federation (Agreement № 075-15-2024-614 of 13.06.2024).

Progress on the Bristol Proton Accelerator

Yannick Verbelen*, Mahmoud Bakr-Arby, Alicja Szczepanska, Thomas Scott

University of Bristol, Bristol, United Kingdom

https://doi.org/10.21175/rad.abstr.book.2025.41.1

The lack of a domestic research reactor in the United Kingdom (UK) has profound consequences for its ability to source radionuclides for medical applications, relying on the European mainland to satisfy its medical demands. Reactors such as BR2 (SCK, Belgium) and the HFR (Petten, Netherlands) have historically been adequate to meet healthcare needs. However, these reactors are reaching the end of their life, with BR2 scheduled to be decommissioned no later than 2036. Other reactors are likewise reaching the end of their life, which threatens the continuity of large-scale production for critical radionuclides such as Tc-99m and I-131, essential for medical imaging as well as brachytherapy. As global demand increases and the supply chain is expected to contract, scarcity is anticipated for less common radionuclides, potentially putting patients at risk. To counter this problem, the UK is exploring several pathways to increase its domestic production capabilities. Proton accelerators offer a variety of benefits, including the ability to produce many different radionuclides without the high capital investment associated with high-flux reactors or the large inventory of nuclear fuel needed to run them. Protons, as charged particles, are much easier to shield, and the tendency of (p, xn) reactions to dominate greatly reduces nuclear proliferation concerns. The University of Bristol has been working since 2022 on novel proton accelerator technology using nuclear fusion reactions to boost proton energy. This approach potentially enables more compact designs that cost less to operate and maintain, with a substantial decrease in capital investment requirements. Such smaller accelerators could thus be scaled to the needs of individual medical institutions, bringing production closer to the patient. In this talk, Dr. Ing. Yannick Verbelen, project lead on the proton accelerator project, presents the progress made on the prototype, an update on the safety case and regulatory situation, and an outlook for future work.

h-BN as a novel implant material: Monte Carlo simulations of the dose distributions in radiotherapy

Aslı Bozkurt[1,2], Gaye Ö. Çakal[1], Ayşe Kaşkaş Öztepe*[3]

[1] Ankara University Institute of Nuclear Sciences, Ankara, Turkey
[2] Radiation Oncology Clinic, Abdurrahman Yurtaslan Ankara Oncology Training and Research Hospital, Ankara, Turkey
[3] Ankara University, Faculty of Science, Department of Physics, Ankara, Turkey

https://doi.org/10.21175/rad.abstr.book.2025.42.1

In recent years, studies on the use of low atomic number implant materials, such as carbon-based and/or PEEK materials, have been carried out in order to overcome the problem of artifacts that occur during radiotherapy treatment. In this study, hexagonal boron nitride (h-BN), widely used in bone tissue engineering and nanomedicine, was suggested as an implant material owing to being a biocompatible, chemically stable material with an effective atomic number close to the tissue. Due to these properties, h-BN was expected to cause minimal dose perturbations in radiotherapy applications. For this reason, firstly, EGSnrc/DOSXYZnrc Monte Carlo code was used to simulate the percent depth dose (PDD) measurements at SSD 100 cm, and 10x10 cm2 field size using cylindrical h-BN rods inserted into the RW3 phantom delivering 100 MU dose at 6 MV in LINAC. Then, simulation and experimental results of commercially used titanium alloy and stainless steel implants were compared with h-BN material. Secondly, the EGSnrc/DOSXYZnrc Monte Carlo simulation code was used to simulate the lower extremity phantom (LEP), considered as a leg, made of polymethyl methacrylate (PMMA), consisting of two concentric, water-filled, nested cylinders in which an implant with/without bone tissue was placed. The results simulating the experimental conditions were compared with the dose values obtained from the treatment planning system (TPS, Varian Eclipse, AAA algorithm) for titanium alloy, stainless steel and h-BN materials. All the simulation results for PDDs and dose distributions in LEP were in good agreement with the experimental measurements. The incident and exit surface dose distributions increased in metal implants as seen in PDD measurements, whereas h-BN gave a homogeneous dose distribution in radiotherapy. h-BN material behaved as a tissue equivalent material similar to RW3 phantom. To conclude, h-BN material can be recommended as an orthopedic material in radiotherapy applications.

Preliminary assessment of radiosurgical treatment of breast cancer metastases using the Gamma Knife ICON device, taking into account their immunohistochemical features

Vladimir Krasnyuk*, Ksenia Shilova, Roman Goncharov, Komer Sharipov, Anastasia Kakotkina

Dr. Sergey Berezin Medical Institute, Novosibirsk, Russia

https://doi.org/10.21175/rad.abstr.book.2025.42.2

Breast cancer is one of the most studied types of cancer. It is the most common cancer among women, which makes its study extremely relevant. Early diagnosis, timely provision of assistance to patients, the possibility of immunohistochemical examination of the tumor, selection of systemic therapy, have significantly increased the life expectancy of patients. However, an increase in the incidence of breast cancer metastases to the brain has also been noted, especially in the Her2neu positive variant of the tumor. The gold standard for the treatment of multiple metastases in the brain is considered to be radiosurgical treatment using the Leksell Gamma Knife device. Stereotactic radiosurgery of brain metastases allows achieving satisfactory local control rates, reducing the severity of damage to normal brain tissue, and maintaining an acceptable quality of life for the patient with a low risk of developing neurocognitive disorders. Therefore, the study of the response of metastases with different immunohistochemical tumor variants to the prescribed dose of ionizing radiation is of particular interest.

From January 2020 to January 2025, 102 patients (342 lesions) with breast cancer were treated at the Sergey Berezin Medical Institute (Novosibirsk). The statistics included patients with a KPS of at least 70. The average age of the patients was 52 years. Radiosurgical treatment of metastases were performed using the Leksell Gamma Knife device (manufactured in Sweden).

A retrospective analysis of 102 patients with different molecular subtypes of breast cancer after radiosurgical treatment of metastases using the Gamma Knife Icon device confirms satisfactory local control rates and demonstrates a relationship between the response of tumor tissue to radiosurgical doses and the immunohistological variant of the tumor.

Characterization and calibration of a batch of five thousand SSNTD Columbia Resin 39 detectors

Anna Maria Sotgiu*, Naglaa Hazm Hassan Awad, Monica Buchetti

National Inspectorate for Nuclear Safety and Radiation Protection ISIN, Rome, Italy

https://doi.org/10.21175/rad.abstr.book.2025.43.1

The sampling of radon 222 (Rn-222) in confined environments can be performed using solid-state nuclear track detectors (SSNTD) of the Columbia Resin 39 (CR-39) type. The alpha tracks imprinted by radon on the surface of the sensitive material become visible through chemical etching and are subsequently counted to determine the radon activity concentration in the environment. In 2022, the National Inspectorate for Nuclear Safety and Radiation Protection (ISIN) carried out the characterization and calibration of a batch of 5054 CR39 detectors supplied by a British manufacturer and divided into 3 different production lots. The characterization was conducted at the ISIN radon laboratory, while the calibration was performed at the National Institute for Ionizing Radiation Metrology of ENEA (INMRI-ENEA) as part of an ISIN-INMRI ENEA agreement between the two entities. The batch was characterized and calibrated using 106 detectors, corresponding to 2%, and 255 detectors, corresponding to 5% of the total detectors, respectively.

MATERIALS AND METHODS

CR39 Tastrak detectors and RADOSURE measurement chambers from TASL were used. The chemical etching of the CR39 detectors was performed using a 25% P/V NaOH solution. The instrumentation used for reading the radon tracks was an automated TASLImage reader, and the concentration of the NaOH solution was verified using a DL 22 titrator. The validity of the chemical etching process was checked using 54 control samples consisting of CR39 detectors exposed to an 241Am source with known activity. The background track level was measured using 50 CR39 samples taken from the batch stored in a freezer at -30°C. The CR39 detectors for calibration were subjected to 5 exposures in the Radon Chamber of ENEA, within a range of 136±3 kBqhm-3 to 4651±93 kBqhm-3, and transit detectors were also prepared for each calibration group.

The statistical parameters used were mean, standard deviation, coefficient of variation, and variance. The statistical tests applied included the Shapiro-Wilk test for normal data distribution verification; outlier elimination was performed using Dixon's test, Grubbs' criterion for 1 and 2 data points, and Huber's rejection rule. Variance verification was carried out using Hartley's Criterion for comparing groups of results with different sample sizes. The sensitivity of the 3 supply lots was measured as the ratio of the radon tracks read by the TASL reader (after background subtraction) to the reference exposure, while the calibration factor was defined as the ratio 1/Sensitivity.

RESULTS

The application of the Shapiro-Wilk test to all sample groups (backgrounds, 241Am controls, and calibration samples) revealed a normal distribution of data, except for one lot's exposure. The application of statistical tests for outlier elimination across all sample groups identified 9 outliers in the total dataset subjected to evaluation. After removing these outliers, the remaining samples were re-evaluated with the Shapiro-Wilk test, which indicated a normal data distribution. Variance verification using Hartley's criterion indicated that the criterion was met for the 241Am and background samples, whereas for the calibration samples, it was satisfied only after removing a divergent variance. After removing the outliers, the weighted average sensitivity of the three calibration batches was determined to be 2,388 +/- 0,055, and the Calibration Factor was calculated as 0,42 +/- 0,10. The final results, obtained after removing outliers, were used to draft Shewhart Control Charts, which can serve as a reference for future laboratory measurement control procedures.

CONCLUSIONS

Overall, the measurement results indicate the homogeneity of the measurement material, except for the exposure of one lot, which requires further analysis. The laboratory concluded that the measurement material from this batch is suitable for use in measurement campaigns and national and international intercomparison procedures.

Defined solid-angle alpha spectrometry: Geometrical sensitivities in absolute Rn-222 activity measurements

Behnam Khanbabaee*, Stefan Röttger, Anja Honig

Physikalisch-Technische Bundesanstalt (PTB), Braunschweig, Germany

https://doi.org/10.21175/rad.abstr.book.2025.43.2

Radon (Rn-222) is a naturally occurring radioactive gas in the uranium-238 (U-238) decay chain and is a major contributor to natural radiation exposure. Its alpha-emitting progeny attach to airborne particles, posing serious health risks, especially lung cancer. To mitigate these risks, the European Council Directive 2013/59/EURATOM (EU-BSS) mandates monitoring and mitigation actions for indoor radon concentrations exceeding 300 Bq/m³.

Meeting these regulatory requirements presents considerable metrological challenges, especially due to the high uncertainty of low-level radon measurements and the demand for accurate calibration of detection systems. To address this, National Metrology Institutes (NMIs) have developed absolute measurement systems that serve as primary standards for radon activity.

Defined Solid Angle (DSA) alpha spectrometry is a precise technique for absolute radon activity determination. It relies on maintaining a fixed geometry between a solid radon source—created by cryogenic deposition under vacuum—and a detector. The detection efficiency depends solely on the geometrical factor G, defined as $G=\Omega_{eff}/4\pi$, where Ω_{eff} is the effective solid angle. Activity A of the source is then given by $A = Counting\ rate/G$.

First introduced by Picolo et al. (https://doi.org/10.1016/S0168-9002(96)80029-5), this method has since been refined by several NMIs, including LNE-LNHB (https://doi.org/10.1016/j.apradiso.2016.09.009) and IRA-METAS (https://doi.org/10.1016/j.nima.2006.07.055). This study focuses on the optimization and upgrade of PTB's primary system for absolute Rn-222 measurement (https://doi.org/10.1016/j.apradiso.2003.11.046) using the DSA technique.

The aim of this work is to optimize PTB's primary DSA measurement setup by numerically evaluating the dependency of the geometrical factor G on various key parameters, using both the Knoll and Curtis formulations. By systematically varying individual geometrical inputs, the analysis identifies which parameters most significantly influence the accuracy of G. This evaluation enables prioritization of high-precision measurements for the most impactful variables.

Results show a high level of agreement between the Knoll and Curtis extensions under typical operating conditions, confirming their equivalence within standard distance ranges. Among the parameters studied, the diaphragm radius exerts the most substantial influence on the geometrical factor. In contrast, the effect of eccentricity—within the range of 0 mm to 1 mm—is negligible compared to the impact of source and diaphragm radii. These findings support focused improvements in geometrical precision for enhanced accuracy and traceability in absolute Rn-222 activity measurements.

Estimating the contribution of anthropogenic fine particulate matter to urban air pollution using radon and its progeny measurements

Mohammad Alem Sultani*, Martin Bulko, Markus Helej, Ivan Sýkora, Terézia Eckertová, Monika Müllerová, Jozef Masarik

Department of Nuclear Physics and Biophysics, Faculty of Mathematics, Physics and Informatics, Comenius University in Bratislava, Bratislava, Slovakia

https://doi.org/10.21175/rad.abstr.book.2025.43.3

Radon (^{222}Rn), a radioactive noble gas, is widely recognized for its utility as a tracer in environmental studies due to its unique properties. As ^{222}Rn undergoes radioactive decay, it produces a series of short- and long-lived progeny. These airborne decay products readily attach to fine aerosols, predominantly those with aerodynamic diameters between 0.1 and 2 μm. This attachment mechanism renders radon progeny an effective tracer for investigating the dynamics of such aerosols.

In this study, we determined aerosol residence time (T_R), a critical parameter for understanding the transport and fate of airborne pollutants, using three years of radon and its decay products measurement. The calculated T_R values ranged from 0.35 to 6.7 days. Leveraging these results, we developed a simplified model to estimate the contribution of anthropogenic fine particulate matter (PM) to urban air pollution. The model effectively characterizes daily anthropogenic PM emissions and captures distinct differences in pollution levels between weekdays and weekends, demonstrating its utility for air quality assessments.

Acknowledgments: This work was financially supported by the Scientific Grant Agency of the Ministry of Education, Science, Research and Sport of the Slovak Republic and the Slovak Academy of Sciences (VEGA project No. 1/0019/22 and No. 1/0086/22), the Slovak Research and Development Agency (project No. APVV-21-0356) and the Excellent Grant of Comenius University (No. UK/3056/2024). The authors are especially grateful to the Slovak Hydrometeorological Institute for providing data on concentrations of air pollutants (PM2.5).

Radon mitigation and dosimetry

Hugo Corcelle[1], Quentin Rogliardo*[1], Alessandro Curioni[2], Stefano Romano[2], Gilles Triscone[1], Stavroula Pallada[1]

[1] University of Applied Sciences and Arts of Western Switzerland (HES-SO), Geneva, Switzerland
[2] Better Air Quality (BAQ) Sàrl, Geneva, Switzerland

https://doi.org/10.21175/rad.abstr.book.2025.43.4

Radon is a naturally occurring radioactive noble gas present in the environment. Its infiltration into buildings from the ground can lead to indoor air pollution if the rooms are poorly ventilated. High radon concentrations in enclosed spaces pose a significant health risk, as radon is the second leading cause of lung cancer after smoking, contributing to approximately 10% of cases in Europe [1]. The dose received is primarily due to radon progeny (^{218}Po, ^{214}Pb, ^{214}Bi, ^{214}Po), which, being solid in nature, attach to airborne aerosols that are subsequently inhaled.

This research project, focuses on developing an air purification device equipped with a series of filters specifically designed to remove radioactive particles and reduce exposure for individuals in highly contaminated indoor environments, especially in enclosed spaces where the addition of ventilation systems is prohibited.

The first phase of the project involved quantifying the filtration behavior of different filters when exposed to radon progeny-contaminated air. The tested filters included coarse G4 and fine F7 types. A measurement setup was designed to evaluate their performance, consisting of a 200-liter hermetically sealed chamber with an activity of A(^{222}Rn) ≈ 550 kBq/m^3, AlphaGuard and AlphaE radon monitors, and a mechanically driven system fabricated using 3D printing. This system includes a pump to circulate contaminated air through a series of three filters. Two measurement methodologies were implemented to quantify the trapped radioactivity.

The first method relied on measuring the total count rate N.totN.totwith a surface contamination probe, followed by the determination of individual contributions N(218Po), N(214Pb) and N(214Bi) through data fitting using a three-body Bateman equation model. The G4 filters exhibited significantly higher count rates compared to the F7 filters under identical conditions. For both filter types, across the three-filter series, the first filter in the sequence retained 80% of the radioactive particles.

The second method involved Monte Carlo simulations to calibrate the efficiency of an HPGe detector for absolute activity measurement. This approach was validated through comparisons with experimental measurements and reference samples, showing deviations below 5.3%. Using this method, the absolute activity of a G4 filter was determined as A(^{214}Pb) = (1175 ± 76) Bq.

To evaluate its operational performance, the methodology was applied in a 50 m^3 experimental room to assess the effectiveness of the BAQ purification system in reducing airborne radioactive particles. Experimental tests confirmed its efficiency, leading to a significant reduction in the dose rate from 2.4 µSv/h to values below 0.1 µSv/h.

Keywords: Radon, Filter, Radon decay products, gamma spectroscopy, Monte Carlo

Acknowledgements: This project (107.193 IP-ENG) is financially supported by Innosuisse funding.

References:

1. Ligue contre le cancer, Ligue pulmonaire suisse, and OFSP. Radon et cancer du poumon. https://www.liguepulmonaire.ch/sites/default/files/documents/radon_et_cancer_du_poumon.pdf

Time-series analysis of radon monitoring in various underground environments: Case of abandoned Kővágószőlős uranium mine

Szabolcs Tóth*[1], Ákos Horváth[1], László Sajó-Bohus[2]

[1] Eötvös Lóránd University, Faculty of Natural Sciences, Institute of Physics and Astronomy, Department of Atomic Physics, Budapest, Hungary
[2] Óbuda University Alba Regia Technical Faculty, Székesfehérvár, Hungary

https://doi.org/10.21175/rad.abstr.book.2025.43.5

Field uranium research began in Hungary in 1947 under the guidance of Hungarian specialists. After the research period, mining plants were opened one after the other, and an ore processing plant was also established. The ore wealth found in the Mecsek Mountains was less favorable than average, 1 ton of ore contained 1.2 kg of uranium metal. By 1989, Hungarian uranium ore mining had become uneconomical, and a government decision was made to close it down, dating back to 1997. The reculturation process began in 1998. Currently, environmental damage is being eliminated under the title of long-term monitoring. Due to the proximity of inhabited areas, NORM anomalies, and the presence of radon gas, radiation protection played a particularly important role during and after remediation.

The radon monitoring of the abandoned mine cavity system was carried out with active radon monitors placed in different boreholes, closed shafts and adits. In the last three years, a radon soil gas monitoring station has also been operated on a waste rock pile site covered with 1 m of loess cover to check the radon retention capacity of the soil.

For radon detection alpha-sensitive photodiode (sensitive area: 1 cm^2) or PIPS detector (sensitive area: 3 cm^2) are used. The hungarian made Dataqua monitoring system gives one impulse per hour for 140 and 56 Bq/m^3 ^{222}Rn concentration, respectively, for the photodiode and PIPS detector. The multi-channel devices beside the radon detector can include other additional sensors for temperature, pressure, humidity, water level, salinity, etc. measurements to study the relation between the variation of radon concentration and other environmental parameters. The radon concentration together with other environmental parameters are continuously recorded with one measurement per hour sampling frequency for several years.

In closed, underground places extremely high radon concentration (a couple of tens up to hundred kBq/m^3, may occur in the absence of ventilation, even in rocks of average radionuclide content. According to our measurements both the daily and the yearly variation is well recognizable, which originate from the variation of the meteorological and lunisolar parameters. In the case of a few time series, we revealed a strong correlation between the outside temperature and the resulting radon concentrations.

We found the atmospheric pressure also affects radon levels, but extent and only on a smaller scale than temperature.

Comprehensive statistics and Fourier analysis were also carried out in order to examine the dominant frequencies, and we also examined the change of the one day long components as a function of time.

Characterization of a commercial pulse assessment simulator using a custom-developed MXene-based sensor

Stefan D. Ilić*, Marija V. Pergal, Ivan Pešić, Milena Rašljić Rafajilović, Marko Spasenović

Center for Microelectronic Technologies, Institute of Chemistry, Technology and Metallurgy, University of Belgrade, Belgrade, Serbia

https://doi.org/10.21175/rad.abstr.book.2025.44.1

Introduction. The BT-CEAB2 Pulse Assessment Simulator is a commercially available artificial arm designed for medical staff training in pulse measurement. It provides mechanical vibrations that simulate a human pulse at two anatomical locations: the radial and brachial arteries. The device supports heart rate variation between 40 and 140 BPM and offers three operating modes: Palpation, Auscultation, and Palpation → Auscultation. The artificial skin of the simulator closely mimics the tactile properties of human skin.

Experimental setup. This study involved characterizing the mechanical pulse behavior of the BT-CEAB2 simulator during prolonged operation in each of its three modes. For each mode, a one-hour measurement was conducted. A custom-developed flexible resistive sensor was used to detect mechanical pulses. The sensor was based on a polyurethane (PU) matrix with 5 wt% dispersed MXene material. The resistance variation of the sensor, induced by the mechanical deformation from the artificial pulse, was recorded using a Keithley 2450 Source Measure Unit. Data acquisition and interface were managed via custom software developed in C#, which also preprocessed the data for analysis with the HeartPy software package.

Results. To assess long-term consistency, segments from the beginning, middle, and end of each one-hour measurement session were analyzed. No significant variations in pulse frequency or amplitude were observed across the recorded segments, indicating stable operation of the simulator. The set heart rates for each mode were confirmed as follows: Auscultation – 105 BPM, Palpation – 90 BPM, and Palpation → Auscultation – 80 BPM.

Conclusions. The BT-CEAB2 Pulse Assessment Simulator demonstrates stable mechanical pulse performance over prolonged use in all three modes. The custom-developed MXene-based sensor proved effective for detecting pulse characteristics and verifying simulator performance. These results support the simulator's reliability for extended training sessions in medical education.

Acknowledgments: This work was supported by the Science Fund of the Republic of Serbia, #4950, Polymer/graphene heterostructures for physiological sensors—Polygraph and by the Ministry of Science, Technological Development, and Innovation of the Republic of Serbia (Contract No: 451-03-136/2025-03/200026).

Electroconductive polymer-based nanocomposite ink for enhanced electrochemical detection of doxorubicin using modified screen-printed electrodes

Iva Dimitrievska*[1], Katarina Aleksić[2], Perica Paunović[1], Smilja Marković[2], Anita Grozdanov[1]

[1] Ss. Cyril and Methodius University, Faculty of Technology and Metallurgy, Skopje, North Macedonia
[2] Institute of Technical Sciences of SASA, Belgrade, Serbia

https://doi.org/10.21175/rad.abstr.book.2025.44.2

Electrochemical sensor design continues to evolve, with ongoing enhancements in surface kinetics leading to devices offering improved analytical performance, reliability, and wider applicability. Screen-printed electrodes have emerged as a focus of extensive research for sensitive drug determination due to their suitability for surface modification. The combination of carbon nanomaterials, noble metals, and polymers has demonstrated promising advancements in sensor performance, utilizing their distinctive chemical and physical properties to achieve exceptional electrode reactivity.

Our research explores the modification of commercial screen-printed carbon electrodes (SPCE) with a synthesized electroconductive polymer-based nanocomposite ink to enhance sensitivity for detecting low clinical concentrations of doxorubicin in a simulated biological matrix. The ink was prepared using a composite material of reduced graphene oxide and 0.5% wt. gold nanoparticles (rGO + 0.5% wt. Au NPs), synthesized via a two-step process involving graphene oxide reduction and nanoparticle decoration. Electrochemical measurements were performed using cyclic voltammetry in 25 mL of 0.1 M phosphate-buffered saline (pH 7.0) with incremental additions of DOX (Ebewe a.d., 2 mg/mL) ranging from 10 to 150 µL. The modified electrode demonstrated a favorable electrochemical response to DOX, characterized by higher reversibility compared to the unmodified commercial electrode. The evaluations showed that the modified SPCE delivered a much lower limit of detection (LOD) and limit of quantification (LOQ) of 9.263 µM and 30.878 µM, respectively, compared to 16.676 µM and 55.587 µM for the commercial electrode. Moreover, the modification demonstrated a superior sensitivity of 0.219 µA/µM, compared to 0.152 µA/µM for the commercial SPCE. This overall enhanced electrical performance demonstrates the modified electrode's potential for application in sensitive drug analysis.

Green carbon dots developed from biomass for sensing marine biotoxin

Ahmed Dawood[1,2], Beatrice Ercolani[2], Clara Piccirillo[3], Bianca Gustavino[4], Mohsen Ghali[5,6], Medhat Hashem[1], Laura Micheli*[2]

[1] Aquatic Biotechnology, Animal Biotechnology Department, Genetic Engineering and Biotechnology Research Institute (GEBRI), University of Sadat City (USC), Sadat City, Egypt
[2] Department of Chemical Science and Technologies, University of Rome Tor Vergata, Rome, Italy
[3] Institute of Nanotechnology, National Research Council (CNR NANOTEC), Campus Ecotekne, Rome, Italy
[4] Department of Biology, University of Rome Tor Vergata, Via Della Ricerca Scientifica 1, Rome, Italy
[5] Department of Energy Materials, Basic and Applied Science Institute, Egypt-Japan University of Science and Technology, Borg El-Arab, Alexandria, Egypt
[6] Department of Physics, Faculty of Science, Kafrelsheikh University, Kafrelsheikh, Egypt

https://doi.org/10.21175/rad.abstr.book.2025.44.3

INTRODUCTION: Biomass waste has a lot of promise for creating inexpensive carbon-based nanomaterials for electrochemical sensing applications. This study presents the preliminary results of an immunosensors for a seafood biotoxin detection using Screen Printed Electrodes (SPEs) modified with green nanostructures to enhance their electrochemical performances. With this goal, two green CDs compounds, derived from fish and cork powder, were used to modify the graphite SPEs. These electrodes provide an economical and sustainable way to create carbon-based sensors using biomass sources.

OBJECTIVE: The purpose of this study is to assess the development of an electrochemical immunosensor for saxitoxin (STX) based on SPE modified with green carbon dots (CDs) made from Cork powder and Fish scales (poster by Gustavino - Cytogenotoxicity studies on green carbon dots developed from biomass for biosensing applications) with label free approach. Saxitoxin is one of the most lethal non-protein toxins (LD50 9 mg Kg-1)1,2 and is known as one of the "Paralytic Shellfish Poisons" (PSP), produced by several marine dinoflagellates and freshwater algae. Contamination of shellfish with saxitoxin has been associated with harmful algal blooms throughout the world. In humans, PSP causes dose-dependent perioral numbness or tingling sensations and progressive muscular paralysis, which may result in death through respiratory arrest3. For these reasons it is very important to develop an innovative nanosystem integrating ultrasensitive saxitoxin (STX) detection with sustainable bionanomaterials. This system enables rapid, ultrasensitive monitoring of marine biotoxins to safeguard seafood safety and marine ecosystems, while valorizing industrial byproducts to reduce waste and align with circular economy goals—bridging environmental stewardship with cutting-edge analytical science and aquatic biotechnology.

MATERIALS AND METHODS: Preparation of green carbon dots from Fish Scale & Gill (FSG-CDs) and cork (C-CDs): FSG-CDs & C-CDs prepared by the hydrothermal method – using just water as green solvent – of the FSG powder of the Nile tilapia (Oreochromis niloticus) & cork powder by applying the heating programs in a Teflon-based autoclave at 200°C for 12 h. Preparation of label-free electrochemical immunosensor for STX detection: The green FSG-CDs & C-CDs are used to modify by drop casting the surface of screen-printed electrodes (SPEs). Electrochemical characterisation using cyclic voltammetry and square wave voltammetry are used in order to optimise the amount of the deposition, the solvent, the better green material and the storage.

RESULTS: In this work, a disposable, simple and low-cost platform for immunosensing applications is reported using SPE modified with green CDs. The serigraphic sensor exhibited a low detection limit, good sensitivity, reproducibility, selectivity and storage stability with both proposed materials, paving the way for its potential exploitation for the detection of STX in a wide range of real matrix samples, such as water or mussel.

Keywords: Biomass, Carbon Dots, Hydrothermal, Screen Printed Electrode, Marine Biotoxin, Biosensing

Acknowledgments: The research leading to these results has received funding from the Project P2022CZA3P “Dress The future: novel combined wearable integrated systems”, funded by EU in the NextGenerationEU through the Italian Bando PRIN 2022 PNRR, D.D. n. 1409 del 14.9.2022, by MUR (2023-2025). Post-Graduate Scholarship [Borsa post-laurea, Borsa di ricerca, Upcycling di microfibre in nanodiamanti - CUP: E83C23001310001, D.R. n. 1649 del 23/05/2024

1. Brower DJ et al. (1981) Clin Toxicol 18:813-865
2. Supplemento alla Gazzetta Ufficiale della Repubblica Italiana (10/9/1990), serie generale 21, decreto 256.
3. Uslber E. et al. (1995) Food Addit Contam 12(3):405-413
4. Micheli L. et al., Anal Bioanal Chem (2002) 373:678–684

Polymer-modified screen-printed gold electrode for sensitive electrochemical detection of doxorubicin

Iva Dimitrievska*[1], Katarina Aleksić[2], Perica Paunović[1], Smilja Marković[2], Anita Grozdanov[1]

[1] Ss. Cyril and Methodius University, Faculty of Technology and Metallurgy, Skopje, North Macedonia
[2] Institute of Technical Sciences of SASA, Belgrade, Serbia

https://doi.org/10.21175/rad.abstr.book.2025.44.4

Screen-printing technology has proven to be an effective approach for fabricating highly sensitive and accurate electrochemical sensors, offering applications across diverse fields. The method's inherent benefits, including improved sensitivity, selectivity, and stability, coupled with its capacity for miniaturization, portability, and on-site real-time detection, have established screen-printed electrodes as essential tools in sensor development. These features have made them particularly valuable for pharmaceutical and biological analyses, especially for detecting trace levels of biomolecules.

Our study introduces a novel electrochemical sensor based on a polymer-modified screen-printed gold electrode for detecting doxorubicin at clinically relevant concentrations. The modification involved a nanocomposite comprising reduced graphene oxide decorated with gold nanoparticles embedded within a Nafion matrix — a configuration not previously reported in the literature for DOX sensor construction. The sensor demonstrated precise quantification of doxorubicin using cyclic voltammetry, achieving a wide linear concentration range from 1.5 to 22.1 μM and a low detection limit of 11.462 μM under optimized conditions. Its high surface area, functionalization capability, excellent sensitivity, and rapid response underscore its potential for practical applications in anticancer drug monitoring.

Sensor nanostructures for the detection of toxic gases

Olena Aksimentyeva*[1], Bohdan Tsizh[2,3], Yuliia Horbenko[1], Roman Holyaka[4]

[1] Ivan Franko National University of Lviv, Lviv, Ukraine
[2] Kazimierz Wielki University in Bydgoszcz, Bydgoszcz, Poland
[3] Stepan Gzytskyi National University of Veterinary Medicine and Biotechnologies of Lviv, Lviv, Ukraine
[4] National University "Lviv Polytechnics", Lviv, Ukraine

https://doi.org/10.21175/rad.abstr.book.2025.44.5

The development of portable detectors for the control of organic and explosive vapors by creating organic-inorganic nanosystems that can quickly respond to the action of gases by changing optical and electrical parameters is an important current problem [1]. The creation of sensor structures based on polymer-semiconductor hybrid nanosystems makes it possible to combine the sensitivity of semiconductors on the action of gases with the flexibility, lightness of organic (polymer) semiconductors, their high selectivity and reproducibility of properties, with the possibility of operation of the sensor element without additional heating in wide temperature ranges.

We investigated several organic and inorganic materials and their composites to select sensitive elements of resistive and optical sensors for gaseous substance recognition and detection [2, 3]. For this purpose, composite structures of electrically conductive polymers (polyaniline, polytoluidine, polyanisidine, poly-3,4-ethylendioxithiophene) with inclusions of graphene oxide nanoclusters and nanoparticles TiO_2, ZnO, SiO_2 were synthesized. According to optical and electron microscopy results, the introduction of inorganic nanoclusters into the polymer matrix with the formation of core-shell structures was confirmed. The influence of the toxic vapors (ammonia, aromatic amines, hydrogen sulfide, nitrogen dioxide, nitrobenzene, and toluene) on the optical absorption, specific resistance, and structure of conducting polymer-semiconductor nanostructures has been studied. It was found that by introducing the semiconductor clusters in the polymer nanocomposites, the gas sensitivity of the detectors increases from 2 to 10 times, and the response time decreases to 30-60 seconds.

The proposed structures are planned to be used in gas sensors for the rapid detection of toxic substances in contaminated territories because of military operations, as well as in public practice for the manufacture of portable sensors for monitoring the freshness of food products, the gas atmosphere near enterprises, landfills, and chemical warehouses.

Acknowledgment: The research results presented in this abstract were obtained with grant funding from the National Research Foundation of Ukraine under the competition «Science for strengthening the defense capability of Ukraine» within the framework of the project 2023.04/0133 "Development of detectors for express control of toxic substances in polluted areas" (2024-2025).

1. Ismail A.H., Sulaiman Y. *Synthetic Metals*. **280,** 116860 (2021).
2. Tsizh B., Aksimentyeva O., Horbenko Y., Holyaka R. *Molec. Cryst. & Liq. Cryst.*, **767,** 159 (2023).
3. Tsizh B., Aksimentyeva O. *Sens. Actuator A. Physics*. **315,** 112273 (2020).

Modelling of heat transfer in helically coiled tube

Renoldas Zujus*, Povilas Poškas, Robertas Poškas

Lithuanian Energy Institute, Kaunas, Lithuania

https://doi.org/10.21175/rad.abstr.book.2025.45.1

This study presents a numerical modelling analysis of heat transfer in a helically coiled tube at the conditions of the experiment. The investigations were performed for a turbulent flow regime in the hydrodynamically and thermally stabilized region at $50 < x/d < 100$ (x – heated tube length, d - tube inside diameter). The air through the unheated hydrodynamic stabilization section ($x/d \approx 150$) entered the heated thermal section ($x/d = 100$). The geometric parameters of the stainless-steel coil: coil diameter D = 0.39 m, tube diameter d = 0.017 m (D/d=23), tube wall thickness = 0.0005 m, and coil pitch h = 0.07 m. The simulations were performed for a Reynolds number Re = 11 900 at the inlet using two turbulent transfer models: the standard k-ε model (k - turbulent kinetic energy and ε - dissipation) and the k-ω SST (Menter) model (ω - specific dissipation and SST - turbulent shear stress). To ensure the accuracy of the modelling results, the sensitivity analysis was performed using three different meshes. Finally, a 51 million computational nodes mesh was selected for modelling. The modelling results of both turbulent transfer models were compared with experimental data. In the case of the k-ε turbulent transfer model, simulated results showed an unsatisfactory agreement with the experimental data: the modelled Nusselt number (Nu, averaged over the tube perimeter) was about 60 % larger than the one obtained in the experiments. This was caused by an overestimation of the turbulent transport in the model, which resulted in the decrease in the average wall temperature around the perimeter of the tube; however, the relative local temperature variation around the perimeter was like the experimental one. In the case of the SST k-ω turbulence model, the comparison showed that the modelling results reasonably well agree with the experimental data in the thermally stabilized region ($50 < x/d < 100$). Here averaged over the perimeter Nu being only 5 - 10% smaller than the experimental one. The relative local temperature variation around the perimeter was close to the experimental one. The methodology and results presented here can serve as a reference for future wider research of heat transfer in helically coiled tubes of different geometric variations.

Trials on the reduction of zinc content in Romanian blast furnace slag for use in the steel industry

Camelia Traista[1], Eugen Traista*[2], Tiberiu Rusu[1], Ciprian Danciu[2], Tudor Andrei Rusu[1]

[1] Technical University of Cluj-Napoca, Cluj Napoca, Romania
[2] Petrosani University, Petrosani, Romania

https://doi.org/10.21175/rad.abstr.book.2025.45.2

Blast furnace slag is a by-product of the smelting process. It consists of a complex mixture of fine particles of metal oxides, carbon, sulphur and other impurities with specific physico-chemical characteristics. The exact composition of blast furnace slag varies according to the raw material used (iron ore, coke, fluxes) and the specific metallurgical process technology. The main components are: iron oxides (Fe_2O_3, Fe_3O_4, FeO) - 30-50%, calcium and magnesium oxides (CaO, MgO) - 5-15%, silicon dioxide (SiO_2) - 5-15%, aluminum oxides ($Al_2O_2O_3$) - 2-8%, carbon (C) and sulfur compounds (S) - 5-20%, zinc oxides (ZnO, $ZnFe_2O_2O_4$) - 1-5%, lead oxides (PbO) - 0.1-3%. The presence of zinc in blast furnace slag mainly originates from the recycling of secondary materials containing this element, metallurgical dusts, metal scrap or contaminated ores. The presence of zinc in blast furnace slag creates multiple technological difficulties, negatively affecting both metallurgical processes and recycling possibilities. In order to allow the efficient re-use of blast furnace slag and to avoid the problems caused by it in metallurgical processes, it is necessary to apply technologies for the separation and recovery of this metal. The methods used can be classified into three main categories: pyrometallurgical, hydrometallurgical and physico-mechanical. This paper presents the research carried out by the authors in order to reduce the zinc content in Romanian blast furnace slurries with a view to the disposal and valorization of this waste. Physico-mechanical methods are less efficient, but can be used as pre-treatments to reduce the zinc content prior to recycling the blast furnace slag. As zinc is present as light oxides, it can be separated from the denser components using hydraulic classifiers or jigging. Tests show that the efficiency of this process is limited as zinc is often finely dispersed. The use of magnetic separators can also remove the iron-rich fraction, thus concentrating the zinc for further treatment. This method could be useful as a preliminary process, but does not completely remove zinc. In the tests carried out, inconclusive results were obtained (zinc content reduction below 28%) explained by the fact that franklinite ($ZnFe_2O_4$) exhibits ferromagnetism, but with a lower intensity than magnetite (Fe_3O_4), due to the presence of zinc, which does not contribute to the magnetic moment. In alkaline leaching (NaOH, NH_44OH) zinc can be extracted with alkaline solutions (e.g. NaOH) as a soluble complex. This method is more selective than acid leaching, avoiding dissolution of other metals such as iron. Zinc can be further recovered by precipitation or electro-deposition. This method is more environmentally friendly but requires precise control of the pH and precipitation process. In acid leaching tests, zinc is selectively dissolved using strong mineral acids such as sulphuric acid (H_2SO_4), hydrochloric acid (HCl). Tests with sulfuric acid showed higher reductions of zinc content up to 56%, but the residual zinc content in the slurry (0.69% ZnO) is much higher than the requirement of the processors (0.30% ZnO).These results explain that franklinite is resistant to weak acids and very stable in alkaline solutions, because $ZnFe_2O_4$ is not soluble in common bases such as NaOH or KOH at low temperatures. The use of concentrated acid solutions is excluded due to acid losses when filtering the treated slurry. Pyrometallurgical pyrometallurgical methods involve heating the slurry at high temperatures to volatilize zinc, which can then be captured and recovered as zinc oxide (ZnO). The process is carried out by heating to 1000-1200°C in the presence of a reducing agent (coal). The zinc volatilizes, is oxidized in the flue gas, and collected as a ZnO-rich powder (~60-70% Zn). Experimental tests gave the best results, i.e. a zinc content in cast iron below the detection limit.

Universal cryogenic pelletized moderator for research neutron sources of any power and intensity

Maksim Bulavin*

Joint Institute for Nuclear Research, Dubna, Russia

https://doi.org/10.21175/rad.abstr.book.2025.45.3

For the first time, the author proposed the concept of a new direction in the field of cold (cryogenic) neutron moderators for research neutron sources of low, medium and high power and intensity, which is based on the use of a universal cryogenic pelletized neutron moderator based on hydrocarbons. It is shown that the successful development of fundamentally new methods, installations, instruments and devices in the field of this direction will make it possible to create high-intensity sources of cold neutrons based on any research neutron source.

Clay-based matrices for chloride- and fluoride-containing radioactive wastes

Anna Matveenko*[1], Anna Basova[1], Vladimir Petrov[1,2,3], Yin Yihang[1]

[1] Lomonosov Moscow State University, Moscow, Russia
[2] MSU-BIT University, Shenzhen, China
[3] Belozersky Institute MSU, Moscow, Russia

https://doi.org/10.21175/rad.abstr.book.2025.46.1

Nowadays countries operating nuclear power plants have an ambitious goal – closing the nuclear fuel cycle. One of the major tasks is the spent nuclear fuel (SNF) management. Due to the continuous development of fourth-generation nuclear reactor technologies there are some significant issues. For example, with the processing of mixed nitride uranium-plutonium SNF from fast-neutron reactors (FNR) that suggests the use of LiCl-KCl electrolyte in pyrochemical or combined technology [1]. In addition, eutectic mixtures of lithium, sodium and potassium fluorides (FLiNaK) are of interest for possible use as media in molten-salt reactors (MSR) [2]. Thus, the forms of radioactive waste (which by the way are high-level, HLW) are becoming increasingly complex and turn a key challenge requiring urgent solutions. However, industrial applications of pyrochemical processing cannot be implemented until immobilization methods of the resulting RW are developed.

Studies with glass composite materials show that for reliable fixation of a significant amount of alkali chlorides they must be preliminary converted into the form of phosphates or oxides, i.e. conventional technological operation forms [3 – 5]. Ceramic or glass-ceramic matrices are more reliable alternatives to vitrified matrices. To reduce the release of radionuclides from the matrix into the biosphere, the matrix material should be as close as possible to the surrounding host rocks in its chemical and phase composition. Therefore, in this work, we propose using clays as a possible material for manufacturing matrices for specific RW generated during the pyrochemical processing of SNF from MSR and FNR. These finely dispersed materials, consisting of more than 70% of the layered minerals montmorillonite and kaolinite have a large specific surface, become very durable after annealing and are able to retain alkali metal ions due to their layered structure.

Specific compositions and temperature-time regimes were chosen in our earlier works empirically for immobilization of the spent LiCl-KCl electrolyte with addition of fission products [6]. As a result, strong ceramic samples based on bentonite clay with an electrolyte content of up to 30 wt. % were synthesized. Furthermore, three new clay samples with contrasting mineralogical and chemical profiles are analyzed for their ability to immobilize fluoride wastes from MSR and chloride wastes from FNR. The studied characteristics include mechanical strength, thermal and frost stability, phase composition, morphological structure, resistance to leaching and radiation loads. A set of modern analytical and physicochemical methods are used to support the results: X-ray diffraction, ICP-OES and ICP-MS, mercury porosimetry, X-ray fluorescence analysis, etc. Thus, the fundamental possibility of using clays as a material for immobilizing the spent chloride and fluoride electrolyte from pyro-processing of SNF and MSR is demonstrated. Moreover, comparative data on the correlation between the characteristics of the obtained matrices and the type of clay used are presented.

References:

1. Shadrin A.Y., Dvoeglazov K.N., Maslennikov A.G. et al. Radiochemistry. 2016. Vol. 58. № 3. P. 271-279.
2. Ignatiev V.V., Feynberg O.S., Zagnitko A.V. et al. Atomic Energy. 2012. Vol. 112. № 3. P. 157-165.
3. Ahn, Soo-Na et al. Journal of the Nuclear Fuel Cycle and Waste Technology. 2012. Vol. 10. P. 27-36.
4. Day D.E. et al. J. Non. Cryst. Solids. 1998. Vol. 241. № 1. P. 1–12.
5. Donald I.W. et al. J. Nucl. Mater. 2007. Vol. 361. № 1. P. 78–93.
6. Matveenko A. V. et al. Sustainability. 2021. Vol. 13, № 19. P. 10780.

Determination of the internal structure of electronic waste items using a combination of neutron and X-ray radiography

Noémi Anna Buczkó*[1,2], Mariann Papp[1], Boglárka Maróti[1], Zoltán Kis[1], László Szentmiklósi[1]

[1] HUN-REN Centre for Energy Research, Institute for Energy Security and Environmental Safety, Budapest Neutron Centre, Budapest, Hungary
[2] ELTE Eötvös Loránd University, Hevesy György PhD School of Chemistry, Budapest, Hungary

https://doi.org/10.21175/rad.abstr.book.2025.46.2

The amount of waste electrical and electronic equipment (e-waste or WEEE) is increasing year by year in modern society. Nowadays, the proper collection, separation, and reprocessing of e-waste have become one of the key environmental problems. The WEEE are typically highly complex products that may contain several valuable and critical elements; thus, they could become a valuable secondary raw material resource for industry with proper recycling. In this work, the applicability of neutron and X-ray-based imaging techniques, and their combination were examined to identify the internal structure of different types of WEEE. The e-waste we investigated included, among others, a mobile phone and components of personal computers, such as a memory card, a sound card, and a hard disk. We envision that volume-representative information obtainable with these methods could be a valuable input for future intelligent waste sorting and decomposition technologies, which could be applied even industrially.

It was concluded that both X-ray and neutron radiography are capable of revealing the inner structure of different types of e-waste and identifying their main components. However, some limitations were observed for both techniques. One of the main limitations of X-ray radiography was that components that were thin or contained elements with low atomic numbers did not provide sufficient contrast, however, were often clearly visualized by neutron radiography. The other drawback was the limited penetration of the X-rays into metallic parts with considerable thickness. These components were typically much more transparent to neutrons so that the structures underneath could be examined well with neutron radiography. On the contrary, limited applicability was identified for the investigation of WEEE containing thick polymer coating, due to the significant neutron scattering of the hydrogen present in the plastic. The detailed structure of such waste was much better identifiable by X-ray radiography, as the polymer matrix has a high transmission capability to X-rays. Also, the ability of the identification of primarily small metallic components was limited with the neutron-based method, due to the small contrast difference of these parts and even typically poorer spatial resolution of the neutron radiography. They were typically visible with much better contrast on the X-ray radiograms.

We found that solely the combination of the two radiography techniques provided adequate information on the inner structure of the investigated e-waste types and enabled appropriate material segmentation. Furthermore, the combined interpretation of the two radiograms allowed the identification of components whose elemental compositions significantly differed from the nearby structures which would otherwise not have been possible by either method alone.

Environmental and regulatory challenges in organic radioactive waste management

Edda Baek*, Olav Kalvig

Norwegian Radiation and Nuclear Safety Authority, Oslo, Norway

https://doi.org/10.21175/rad.abstr.book.2025.46.3

Norway currently has no solution for proper management of radioactive waste containing > 10% total organic carbon (TOC). This is because Norwegian regulations prohibit the disposal of waste with high organic content, as it results in significant greenhouse gas emissions and environmentally harmful leachate.Typical sources of radioactive waste with high TOC content may include: peat and stone masses from construction work, such as road and railway development, sludge from treatment plants and precipitation ponds,sample materials from laboratories, such as food and environmental samples, especially in the event of a nuclear incident, contaminated organic matter after a nuclear incident, such as milk, grain/vegetable crops, meat from grazing animals, etc.),waste from the petroleum industry. The Norwegian strategy for the safe, secure and environmentally sound management of radioactive waste also addresses this issue.

The process so far: Alternative solutions for management of waste containing > 10 % TOC have been considered, including incineration and anaerobic decomposition. From these methods there can be extracted resources in the form of energy production and biogas. The selected methods are chosen based on the fact that disposal of biodegradable waste leads to large emissions of greenhouse gasses and production of environmentally harmful leachate [1-4]. Incineration is particularly interesting, since this process allows for good emission control and reduces the volume of the waste. With effective filtration and purification technologies it could be possible to contain radionuclides and reduce emission associated with incineration. The development has happened within the framework of existing Norwegian regulations which prohibits the disposal of waste with TOC > 10 %, which makes incineration and purification technologies a potential solution. As of today, there is no implemented solution. Incineration is still considered the most feasible solution, but there is still need for continuous development of technology and handling. There is a lot of different waste fractions that fall under the category of biodegradable or have high TOC content while also being radioactive, making it even more challenging.

Further Research: There is great potential in the development of new technologies and methods which can: stabilize, remove, separate or transform the high organic content to safe materials, identify, extract and utilize valuable resources in the waste. There should be an inter-disciplinary approach to future research, with collaboration between environmental science, chemistry, industrial sciences and nuclear fields to develop innovative solutions to reduce the environmental impact and improve the safety in radioactive waste management.

References

1. Nordahl, S. L., Devkota, J. P., Amirebrahimi, J., Smith, S. J., Breunig, H. M., Preble, C. V., Satchwell, A. J., Jin, L., Brown, N. J., Kirchstetter, T. W., & Scown, C. D. (2020). Life-cycle greenhouse gas emissions and human health trade-offs of organic waste management strategies. *Environmental Science & Technology, 54*(15), 9200-9209. https://doi.org/10.1021/acs.est.0c00364
2. Buzby, J. (2022, January 24th). Food waste and its links to greenhouse gases and climate change. *U.S. Department of Agriculture*. https://www.usda.gov/about-usda/news/blog/2022/01/24/food-waste-and-its-links-greenhouse-gases-and-climate-change
3. Abdel-Shafy, H. I., Ibrahim A. M., Al-Sulaiman A. M., & Okasha R. A. (2024). Landfill leachate: Sources, nature, organic composition, and treatment: An environmental overview. *Ain Shams Engineering Journal*, 15(1). https://doi.org/10.1016/j.asej.2023.102293
4. European Environment Agency. (2025, March 3rd). Emission from waste management facilities. *European Zero Pollution Dashboards*. https://www.eea.europa.eu/en/european-zero-pollution-dashboards/indicators/emission-from-waste-management-facilities

Machine learning and transfer functions to characterise radioactive waste for particle accelerators

Maria Elisso Stamati*, Andrea Gomes, Matteo Magistris, Raphael Neugebauer, Christian Theis

CERN, Geneva, Switzerland

https://doi.org/10.21175/rad.abstr.book.2025.46.4

CERN (European Organisation for Nuclear Research) is a laboratory which operates a complex network of particle accelerators. During their maintenance, upgrades or dismantling, radioactive waste is generated and must be radiologically characterised before disposal. This characterisation is performed through radiological measurements but it also requires extensive calculations, given the wide range and complexity of the activation scenarios.

Developed in 2011, the ActiWiz software uses particle fluence spectra and other user-defined input parameters such as material composition, irradiation and waiting time, in order to compute quantities related to the activation of an object inside a particle accelerator. In particular, it solves the Bateman equations with a dedicated decay engine and it produces a full radionuclide inventory, including the estimated dose-rate and radiotoxicity.

In this work, we present how we employ ActiWiz within a Monte Carlo framework in order to characterise radioactive waste at CERN. This framework allows us to account for the inherent variability in irradiation scenarios, enabling the generation of statistically representative virtual waste items. By simulating over 100000 activation scenarios for different types of metals and their alloys, we established one set of transfer functions that relates dose rate with the complete radionuclide inventory, for all metallic radioactive waste produced at CERN with mass greater than one ton. This approach allows us to avoid time-consuming and costly destructive analyses or complicated experimental measurements without compromising the quality of our characterisation results.

Moreover, by using different data sets for training and testing, we can compare different models and quantify their performance. The techniques of machine learning presented here are so versatile and robust that they allow us to extract a unique set of transfer functions for waste items originating from different machines, with proton energy from 50 MeV 7 TeV and with waiting times spanning over 2 decades.

Modeling of the flow features in the burners air supply channel

Kęstutis Račkaitis*, Robertas Poškas, Povilas Poškas

Lithuanian Energy Institute, Kaunas, Lithuania

https://doi.org/10.21175/rad.abstr.book.2025.46.5

This study presents a comprehensive numerical modeling analysis of a non-symmetrical duct designed to evenly distribute airflow between two outlets while having only one inlet. The primary goal of the research was to evaluate duct performance under varying airflow conditions using computational fluid dynamics (CFD). A series of simulations were conducted to investigate the flow characteristics within the duct, with a particular focus on the difference between the flow rates in both outlets and to identify any potential pulsations or instabilities that could affect the system's efficiency.

Simulations were performed using both transient and steady state solvers. Steady state simulations were performed using ANSYS Fluent software. ANSYS Discovery was used to perform transient simulations. These simulations were performed for a range of inlet airflow rates to replicate operating conditions. Turbulence was modeled using the k-ε turbulence model, which is widely recognized for its reliability in simulating internal flows. The mesh generation process was carefully optimized to ensure accuracy, with particular attention paid to resolving boundary layers and regions of potential flow separation.

The results of the simulations demonstrated that the duct performs as intended, with the airflow evenly distributed between the two outlets across all tested conditions in steady state simulations. Transient simulations showed non-significant pulsations or instabilities with magnitude reaching up to 10% of mass flow at the outlet. The time scale of pulsations decreases with an increase of incoming flow rate. These findings highlight the robustness of the numerical modeling approach and provide valuable insights into the design and optimization of flow distribution systems.

This study not only investigates the air flow in the duct but also underscores the importance of numerical modeling in engineering applications. The methodology and results presented here can serve as a reference for future research and development of similar systems, particularly in applications where balanced flow distribution is critical. Future work could explore the impact of additional geometric variations or the use of alternative turbulence models to further refine the design to reduce flow rate pulsations to a minimum.

Modelling of radionuclide release from a near-surface repository taking into account sorption changes due to concrete barriers degradation

Dalia Grigaliuniene*, Povilas Balcius

Lithuanian Energy Institute, Kaunas, Lithuania

https://doi.org/10.21175/rad.abstr.book.2025.46.6

Countries dealing with decommissioning of nuclear power plants have to find a solution for safe disposal of large amounts of radioactive waste. Near-surface repositories (NSR) are considered as an appropriate disposal option for short-lived low and intermediate level radioactive waste. The safety of such repositories is based on a multi-barrier system, which ensures the isolation and containment of radioactive waste and prevents migration of radionuclides into environment. Cement-based materials play a significant role in the NSR barrier system due to their longevity, ability to maintain mechanical stability and retain radionuclides. However, the engineered barriers undergo a negative environmental impact and are subject to degradation. One of the detrimental phenomena that lead to concrete barrier degradation is rainwater infiltration. The infiltrated water reacts with cementitious materials and can cause their chemical degradation (e.g. decalcification, dissolution/precipitation of minerals, leaching of cement components) as well as changes in the ability to retard radionuclides migration into the surrounding environment. When performing a safety assessment of the radioactive waste disposal facility, these changes have to be considered. A common approach to model radionuclide sorption in cement is based on a ratio of the concentration of sorbed contaminant with respect to the concentration in solution (Kd concept). Therefore, the chemical changes in concrete can be introduced by selecting the appropriate Kd value for each radionuclide under consideration.

The aim of this work is to investigate radionuclide release from a near-surface repository, taking into account sorption changes due to concrete barriers degradation, applying different conceptual models, and compare the results. In general, four concrete degradation stages can be distinguished, and each stage can be characterized by a distinct pH value. Taking into account that radionuclide sorption is pH-dependent, the variation of Kd values in this work is based on pH changes in the repository. There are several approaches how to model the changes in the Kd values. The first conceptual model in this work is constructed assuming concrete degradation stages as four discrete periods of time and the changes in Kd values are modelled in a step-wise manner. The other model takes into account gradual changes in the Kd values that follow the changes in the pH in the repository and more accurately represents the nature of the degradation process. Weakly sorbed and well-sorbed radionuclides are considered. As the output variable, radionuclide flux into the environment is selected. Chemical processes will be modelled with the geochemical solver PHREEQC. The applicability of these approaches for complex system will be discussed.

Purification of acidic condensate using a reverse osmosis test unit

Jurgis Jankauskas*, Arūnas Sirvydas, Robertas Poškas, Povilas Poškas

Lithuanian Energy Institute, Kaunas, Lithuania

https://doi.org/10.21175/rad.abstr.book.2025.46.7

Many industrial processes generate various types of contaminated liquid streams. Before discharge into the sewage system, they must be treated to remove pollutants that pose risks to human health and the environment, in line with sustainability standards. This study, conducted as part of the EU Horizon 2020 project iWAYS (Innovative WAter recoverY Solutions through recycling of heat, materials, and water across multiple sectors"), focuses on the purification of diluted condensate (up to the pH value of ≈2.2) formed during the condensation of simulated humid industrial gas at temperatures of 200–250 °C. This condensate, containing hydrochloric acid (HCl), was obtained by passing the gas through a condensing economizer made from corrosion-resistant materials, such as alloys 400 and 904L, and stainless steel 304L. The resulting condensate, which contained dissolved HCl as well as corrosion products from the economizer and piping, was collected and treated using a laboratory-scale multi-stage filtration unit equipped with a reverse osmosis (RO) membrane. This treatment process produced two separate streams: concentrate and permeate. The pH and electrical conductivity (EC) of the raw condensate, concentrate and permeate were measured. The results showed that the reverse osmosis filtration significantly reduced the total dissolved solids in the permeate, as evidenced by a drop in conductivity from 5.59 mS/cm to 0.67 mS/cm. Additionally, the permeate's pH slightly increased, indicating retention of acidic ions in the concentrate and resulting in a less acidic treated stream. While metal concentrations slightly increased in the concentrate, the RO system effectively reduced metal content in the permeate, regardless of its initial level. These findings demonstrate that the lab-scale multi-stage filtration unit, including reverse osmosis, is a suitable and efficient method for the purification of industrial condensate, particularly for the removal of dissolved metals.

Transformation of food waste by green synthesis: Radiolabelled Ch/AgNP-C for infection control

Rumeysa Çelik*[1], Enis Çam[1], Duygu Tuğçe Baran[1], İrem Kaya[1], Didem Hepağuşlar[2], Emre Uygur[3], Fazilet Zümrüt Biber Müftüler[1]

[1] Institute of Nuclear Sciences, Ege University, İzmir, Turkey
[2] Department of Biology, Celal Bayar University, Manisa, Turkey
[3] Soma Vocational School, Manisa Celal Bayar University, Manisa, Turkey

https://doi.org/10.21175/rad.abstr.book.2025.46.8

As the increasing accessibility of ready-to-eat and packaged foods, rapid consumption habits have intensified the negative environmental impact of food waste, highlighting the need for sustainable recycling methods. The utilization and recycling of food waste represent a crucial approach to promoting environmental sustainability. In this context, the utilization of food waste is crucial for combating microorganisms surrounding infected wounds or tissue, ranging from minor scratches to deep tissue injuries. Since the resistance mechanisms of microorganisms against active agents used in conventional treatment methods contribute to delayed wound healing, there is a growing need for novel, sustainable, and cost-effective alternative approaches. This study focuses on the use of organic waste, specifically carrot peels, in the synthesis of nanoparticles via an environmentally friendly "Green Synthesis" method, providing a sustainable biotechnological solution such as use chitosan and silver nanoparticle. Chitosan, a natural biopolymer, is known for its biocompatibility, biodegradability, and wound-healing properties. Additionally, it supports cell proliferation, accelerates tissue regeneration, and maintains moisture balance, thereby contributing positively to the wound healing process. Silver nanoparticles (AgNPs), on the other hand, exhibit antibacterial, antifungal, and anti-inflammatory properties, making them valuable biomaterials for the treatment of infected wounds. In this study, AgNPs derived from carrot peels (C) were combined with chitosan to synthesize Ch/AgNP-C, and their potential as antimicrobial wound-healing materials was investigated. To evaluate the interaction of nanoparticles with microorganisms around deep wounds or infected tissues using nuclear methods, Ch/AgNP-C were labelled with Iodine-131 ([^{131}I]I) and analysed using a radioiodination method to determine labelling efficiency. The microbial uptake of the radiolabelled nanoparticles was examined using a Cd(Te) detector. The characterization of Ch/AgNP-C synthesized was performed using High-Performance Liquid Chromatography (HPLC), Dynamic Light Scattering (DLS), Zeta Potential Measurement. The hydrodynamic diameter of Ch/AgNP-C was determined to be 223.8 nm, with a zeta potential of -30.9 mV. Antimicrobial activity was evaluated in methicillin resistant *Staphylococcus aureus* (MRSA), *S. aureus*, *E. coli* and *Candida sp.* strains. The radiolabelling quality control of [^{131}I-I]-Ch/AgNP-C was conducted using Thin-Layer Radiochromatography (TLRC), with labelling efficiency calculated to exceed 95% (n=3). This study presents a model for repurposing food waste for biotechnological and healthcare applications. The findings support the antimicrobial efficacy and wound-healing potential of Ch/AgNP-C. Furthermore, by investigating the distribution of radiolabelled nanoparticles on microorganisms, an innovative approach to the diagnosis and treatment of infectious diseases has been proposed. Sustainable approaches based on food waste recycling, such as this, can significantly contribute to combating climate change and advancing innovative biomaterial applications in healthcare.

Keyword: Green synthesis, food waste, antimicrobial activity, iodine-131

Application of nitrogen-doped biomass-based activated carbon catalysts modified with Co and Cu crystallites for hydrazine-hydrogen peroxide fuel cells

Virginija Ulevičienė*[1], Aldona Balčiūnaitė[1], Daina Upskuvienė[1], Galina Dobele[2], Aleksandrs Volperts[2], Ance Plavniece[2], Aivars Zhurinsh[2], Loreta Tamašauskaitė-Tamašiūnaitė[1], Eugenijus Norkus[1]

[1] Department of Catalysis, Center for Physical Sciences and Technology, Vilnius, Lithuania
[2] Latvian State Institute of Wood Chemistry, Riga, Latvia

https://doi.org/10.21175/rad.abstr.book.2025.47.1

Biomass-derived carbons have emerged as promising alternatives to conventional carbon-based catalysts, offering sustainable solutions for energy storage and conversion technologies. Biomass serves as an ideal precursor for carbon-based catalysts due to its renewable nature, abundance, low cost, and intrinsic heteroatom content (e.g., N, P, S). In this study, we propose a straightforward method for synthesizing a non-noble metal-based carbon catalyst designed for low-temperature alkaline fuel cells. Activated wood carbon (AWC) was derived from birch wood and doped with cobalt (Co) or copper (Cu) and nitrogen in a one-step synthesis using 10% Co^{2+} or Cu^{2+} ions relative to AWC, along with dicyandiamide (DCDA) in dimethylformamide (DMF). The mixture was subjected to heat treatment at 800 °C for 60 minutes after evaporation of DMF. A comprehensive physicochemical characterization was performed using various techniques, including ICP-OES, XRD, XPS, SEM-EDS, BET surface area analysis, and Raman spectroscopy. The synthesized AWC-Co-N catalyst contained 1.29 at. % Co and 98.71 at. % C, while AWC-Cu-N contained 1.19 at. % Cu and 98.81 at. % C. The performance of a direct hydrazine fuel cell (DHFC) was evaluated using 1 M N_2H_4 + 1 M KOH as the fuel and 5 M H_2O_2 + 1.5 M HCl as the oxidant, with AWC-Co-N or AWC-Cu-N catalysts employed as the anode and cathode catalysts, respectively. Peak power densities of up to 30 mW cm^{-2} were achieved at 25 °C using the AWC-Co-N catalyst. Both catalysts demonstrated high electrocatalytic activity, stability, and power output in DHFC tests, highlighting their potential for efficient energy conversion technologies.

Inulin as an innovative ingredient in inks for 3-D printing in the production of dressings

Marta Konieczka*, Joanna Skopińska-Wiśniewska

Nicolaus Copernicus University, Toruń, Poland

https://doi.org/10.21175/rad.abstr.book.2025.47.2

Inulin is a linear fructan formed from D-fructose molecules linked by β-2,1-glycosidic bonds and is obtained from plant roots. It exhibits biological activity, e.g., as a prebiotic, antioxidant, and inhibits the expression of inflammatory factors. Research into the use of inulin in 3D printing opens up new possibilities in the field of biomaterials engineering, pointing to the potential benefits of using this natural polysaccharide in modern dressings.

Our study aims to develop an innovative hydrogel that can be used for 3D printing containing inulin and potentially could find application in the production of modern dressing materials. The hydrogel must exhibit appropriate physico-chemical and mechanical properties to ensure the functionality and effectiveness of the dressing and support the wound healing process. So, the tensile strength and water absorption capacity of the obtained materials were analyzed.

The influence of the addition of 10-30% inulin to the alginate-gelatine mixture on the ability of a hydrogel to water absorption was tested. Adequate regulation of moisture in the wound environment influences the healing process by, among other things, preventing the wound from drying out. The dressing should provide an optimal balance between fluid absorption and maintaining adequate moisture, promoting tissue regeneration and reducing the risk of complications. Based on our results, we can conclude that the inulin-containing hydrogels retained moisture more effectively. With increasing inulin content in the material, the time required to dry the hydrogel is longer. It was also observed that the hydrogels could absorb around 60-120% additional liquid, which led us to expect that it would be a good wound exudate absorber.

Mechanical properties are also crucial for the application of hydrogels in wound healing. Dressings should be durable and resistant to mechanical damage during application and provide an adequate level of wound protection. A tensile test was performed, and it was found that inulin addition decreased the tensile strength and elongation at the breaking point of the hydrogels. However, the elasticity represented by the Young Modulus value is modified to a much lesser extent. Despite reduced strength parameters, materials containing up to 20% inulin are still useful as potential dressings.

The results of the analyses will help determine whether inulin can be a valuable component, improving the efficiency and comfort of wound treatment. Furthermore, the data obtained may contribute to the further development of personalized 3D-printed biomaterials tailored to individual patient needs and the requirements of modern regenerative medicine.

Application of amino acid–based adsorbents for the extraction of antisense oligonucleotides

Kseniya Sasim*, Sylwia Studzińska

Chair of Environmental Chemistry and Bioanalytics, Faculty of Chemistry, Nicolaus Copernicus University in Toruń, Toruń, Poland

https://doi.org/10.21175/rad.abstr.book.2025.47.3

Oligonucleotides are short, single-stranded nucleic acid fragments, typically 13–25 nucleotides long, capable of hybridizing with complementary sequences in DNA or RNA. Antisense oligonucleotides (ASOs) are widely used in molecular biology and therapeutic applications due to their ability to regulate gene expression by binding to target mRNA and preventing protein synthesis. The efficiency of ASO isolation and purification is critical for their analytical and biomedical applications.

This study explores the use of amino acid-functionalized adsorbents for the selective extraction of ASOs. Adsorption, a key process in solid-phase extraction, involves the interaction of ASOs with adsorbent surfaces via electrostatic and hydrophobic interactions. Three silica adsorbents, modified with alanine, glycine, and phenylalanine, were evaluated. The goal of the study was to develop the complex extraction procedure, therefore various adsorption and desorption conditions were tested. Final experimental procedure included conditioning the adsorbents with methanol, water, and ammonium acetate (pH 4), followed by ASO adsorption. The washing step utilized a 10/90 % v/v methanol/ammonium acetate mixture. The desorption was tested using ammonium acetate solutions at different pH values (9.5, 10.5, and 11) to determine optimal elution conditions. The adsorption and desorption process was controlled by the quantitative determination of ASO using ultra high performance liquid chromatography in ion-pair mode. The results of this study may contribute to the development of more effective methods for ASO purification, offering a selective and efficient approach for nucleic acid separation. Moreover, the developed extraction procedure may find application for isolation of ASO and their metabolites from serum samples of patients treated with nucleic acid drugs. This will be the goal of the next steps of the studies.

Acknowledgements: The authors are grateful to National Science Centre (Cracow, Poland) for financial support under Opus project (2023/51/B/NZ7/00537).

CO_2 high temperature adsorption over C@C nanocomposites – Mechanistic studies

Julia Moszczyńska*, Marek Wiśniewski

Nicolaus Copernicus University, Toruń, Poland

https://doi.org/10.21175/rad.abstr.book.2025.47.4

Introduction

The dynamic technological growth has led to the fact that the main environmental protection problem is the huge emission of greenhouse gases. Thus the reduction of anthropogenic carbon dioxide emission is one of the most important goals of sustainable development. Recently, lots attention has been paid to carbon capture, utilization and storage (CCUS) approach. It is holistic attitude which allows to remove CO2, that has already been released into the atmosphere, and reuse it to produce chemicals and green fuels. This makes it possible to simultaneously eliminate past mistakes and prevent the creation of new contaminants. Carbon dioxide adsorption over carbon nanostructures and nanocomposites is very promising and ecological strategy.

Chitosan is a biopolymer obtaining from organisms' shells. Due to deacetylation of chitin it is soluble in water solutions. Such ability let easily form (i) composites; (ii) thermosetting polymer films, which after carbonization form carbon film. Chitosan, thus seems to be the perfect matrix and incorporation of the different reinforcement. To increase the CO2 adsorption capacity we applied two kind of reinforcement: graphene oxide and melamine. Both materials form 2D structures during carbonization process affecting so the porosity and surface chemistry of obtained compounds.

Another important question is utilization or recycling of capturing CO2. Designing bifunctional catalysts, i.e. materials which could be simultaneously adsorbents and catalysts fits perfectly with the CCUS idea.

Materials and methods

In this research chitosan-derived-carbon-films were synthesized and characterized spectroscopically and microscopically. Then, the adsorption capabilities of carbon dioxide at different temperatures were tested. Adsorption mechanism was also tested with using infrared spectroscopy.

Results

It was proven that all of composites have a great CO2 adsorption capacity up to 3 mmol/g under atmospheric pressure. The investigated adsorption mechanism reveals, the predominance of physisorption as well as the formation of carbonate groups on the surface of the material. After confirming the possibility of using this type of composites as CO2 storage materials, there are plans to test their catalytic properties in the hydrogenation process under non-thermal plasma conditions.

Conclusions

This research presents a comprehensive solution to the problem of too much CO2 in the atmosphere. It focuses on capturing CO2 emitted to the atmosphere, which in itself reduces its amount in the air. In addition it is fully green method to produce ecological fuel in hydrogenation process.

Dyes adsorption from water - Increasing the adsorption capacity of the carbon material by the hydrovoltaic effect

Agnieszka Marczyńska*, Marek Wiśniewski

Nicolaus Copernicus University in Toruń, Faculty of Chemistry, Department of Materials Chemistry, Adsorption and Catalysis, Toruń, Poland

https://doi.org/10.21175/rad.abstr.book.2025.47.5

Freshwater accounts for less than 3% of the planet's total water resources, most of which is stored in glaciers. This small amount of water is still being degraded by pollutants of various origins. We cannot increase our water resources. The only solution is to purify and reuse water.

On the other hand, with global energy demand growing at an alarming rate, currently operating renewable energy sources such as hydropower, wind or solar power are not able to cover global demand. The recently discovered hydrovoltaic phenomenon is a promising avenue to complement more established energy platforms, creating opportunities to harness the hidden power generation potential of many materials when placed in water.[1]

When the surface of a solid is in contact with water, ions will be selectively adsorbed on its surface, forming a tight adsorption layer (Stern layer) due to the action of charge or chemical potential. In the solution, ions with charges opposite to the Stern layer will be attracted to the solid-liquid interface due to the Coulomb force, thus a diffusion layer is formed. Therefore, a region enriched by two different charged ions is usually formed at the interface, which is called the electric double layer (EDL).

The nature and the size of EDL depends on the nature and strength of the interactions of water molecules with surface functional groups. Water flowing, due to the e.g. capillary effect, along the two different substrates, produces differences in chemical potential, and in consequences formation of oppositely charged electrodes. [1] The accumulated charges are not large, but sufficient to amplify the Culombian force responsible for effective adsorption from an aqueous solution.

In the study, surface-modified and neat carbon fibers were used. Adsorption of methylene blue by the carbon fiber and assisted by the hydrovoltaic effect were measured. An increase in the adsorption capacity of the carbon fiber by the hydrovoltaic effect was noted.

The results are very promising for the practical application of the hydrovoltaic effect to purify water. The process emits no CO2 and requires no electricity, making it environmentally friendly.

References

1. Kumar et al., ACS. Appl. Mater Interfaces, 2023, 15, 7511-7517.
2. Beaton et al., Sustainable Energy Fuels, 2022, 6, 4645–4651.

Green hydrogen vs nanomaterials. Electrolysis potential using doped graphene

Agnieszka Marczyńska*, Marek Wiśniewski

Nicolaus Copernicus University in Toruń, Faculty of Chemistry, Department of Materials Chemistry, Adsorption and Catalysis, Toruń, Poland

https://doi.org/10.21175/rad.abstr.book.2025.47.6

Freshwater accounts for less than 3% of the planet's total water resources, most of which is stored in glaciers. This small amount of water is still being degraded by pollutants of various origins. We cannot increase our water resources. The only solution is to purify and reuse water.

On the other hand, with global energy demand growing at an alarming rate, currently operating renewable energy sources such as hydropower, wind or solar power are not able to cover global demand. The recently discovered hydrovoltaic phenomenon is a promising avenue to complement more established energy platforms, creating opportunities to harness the hidden power generation potential of many materials when placed in water.[1]

When the surface of a solid is in contact with water, ions will be selectively adsorbed on its surface, forming a tight adsorption layer (Stern layer) due to the action of charge or chemical potential. In the solution, ions with charges opposite to the Stern layer will be attracted to the solid-liquid interface due to the Coulomb force, thus a diffusion layer is formed. Therefore, a region enriched by two different charged ions is usually formed at the interface, which is called the electric double layer (EDL).

The nature and the size of EDL depends on the nature and strength of the interactions of water molecules with surface functional groups. Water flowing, due to the e.g. capillary effect, along the two different substrates, produces differences in chemical potential, and in consequences formation of oppositely charged electrodes. [1] The accumulated charges are not large, but sufficient to amplify the Culombian force responsible for effective adsorption from an aqueous solution.

In the study, surface-modified and neat carbon fibers were used. Adsorption of methylene blue by the carbon fiber and assisted by the hydrovoltaic effect were measured. An increase in the adsorption capacity of the carbon fiber by the hydrovoltaic effect was noted.

The results are very promising for the practical application of the hydrovoltaic effect to purify water. The process emits no CO_2 and requires no electricity, making it environmentally friendly.

References

1. Kumar et al., ACS. Appl. Mater Interfaces, 2023, 15, 7511-7517.

Beaton et al., Sustainable Energy Fuels, 2022, 6, 4645–4651.

Influence of hard and soft corona on the catalytic activity of proteins immobilized on modified carbon fibers

Marita Samburska*, Marek Wiśniewski

Nicolaus Copernicus University in Toruń, Faculty of Chemistry, Department of Materials Chemistry, Adsorption and Catalysis, Toruń, Poland

https://doi.org/10.21175/rad.abstr.book.2025.47.7

The ability to modify nanomaterials and optimise their surfaces to improve physicochemical properties is an innovative research area, bringing many opportunities for medical and materials science applications. Among the most easily modifiable materials, carbonaceous materials are undeniably in the lead. The ability of incorporation of acidic or basic groups on the surface is unusual among other solids. The chemical nature (oxidation state) of the surface of the material is of great importance in the process of immobilization of proteins and enzymes. It affects not only the size of the adsorbed phase, but also its quality – activity in the case of enzymes.

Alkaline phosphatase (ALP) is an enzyme widely used in biotechnology and medicine, and its stability and interaction with different substrates is an important area of research. The enzyme acts as a homodimer, consisting of two identical subunits. Each monomer contains an active site with three metal ions, usually two Zn 2+ ions and one Mg 2+ ion. The presence and arrangement of metals plays a key role in the binding of substrates to terminal phosphate groups.

The present work focuses on the analysis of ALP adsorption and activity on the surface of carbon fibres with different degrees of chemical modification. Experiments were performed on pristine and oxidised fibres. The aim was to determine the stability of the enzyme after adsorption and its catalytic activity on the different surfaces.

An important part of the study was to determine the effect of the hard and soft protein corona on the stability and activity of the enzyme. A hard corona, consisting of strongly bound enzyme molecules, can affect the stability of ALP, while a soft corona, formed by more loosely bound proteins, can promote the dynamic exchange of the enzyme with the solution and modulate its catalytic activity.

The research process involved assessing the degree of ALP adsorption after incubation on the fibres, as well as analysing the enzymatic activity of the adsorbed ALP. P-nitrophenyl phosphate was used as a substrate to determine the initial rate of the enzymatic reaction.

The results obtained indicate that the degree of oxidation of the carbon fibres and the degree of protein packing on their surface affect the adsorption efficiency of ALP and its catalytic activity. Chemical modifications of the fibre surface lead to changes in their adsorption properties, which in turn affect the stability of the enzyme. The results obtained may be relevant for future applications of carbon materials in biotechnology and biomaterial engineering.

Kappa-carrageenan as a potential, vegan alternative to gelatine hard capsules

Marta Kozub*, Joanna Skopińska-Wiśniewska

Laboratory for Functional Polymeric Materials, Faculty of Chemistry, Nicolaus Copernicus University in Toruń, Toruń, Poland

https://doi.org/10.21175/rad.abstr.book.2025.47.8

One of the most popular ways to administer drugs by oral route is by taking medicine in the form of capsules. Depending on the type of substance that the medicine contains, capsules can be either soft or hard. Soft capsules are applied to medications in liquid or semisolid form. As their name suggests, they are soft to the touch and quite elastic. Hard capsules are used as shells for solid medications, such as powders or microcapsules. A hard capsule is composed of two put-together parts that are definitely less elastic than a soft capsule. Irrespective of the type of capsules, the main material that is used in their production is gelatine – an animal-derived protein. In the food, cosmetic, or pharmaceutical industry, gelatine is obtained from partial hydrolysis of collagen extracted from the skin, bones, or connective tissues of animals – mainly from cattle or pigs.

Gelatine, being of animal origin, and what follows it, a non-vegan form of medicine, causes problems for people who, due to their ethical or religious beliefs, do not consume products containing animal-derived ingredients. A potential alternative for gelatine-made capsules could be capsules made of κ-carrageenan, which is a plant-derived polysaccharide. Carrageenans are obtained from red algae, and depending on their degree of sulfation and number of galactose molecules, three types can be distinguished: kappa, iota, and lambda. Kappa-carrageenan is the one with the best gelling properties that are valued/prized when it comes to working on new material for hard, vegan capsule shells.

K-carrageenan-only based films are quite fragile, and to change this, a plasticizer must be added. Studies have shown that adding sorbitol as a plasticizing agent to 2% or 3% carrageenan solutions makes the finished films more flexible. The plasticizing effect is confirmed by a decrease in Young's modulus with increasing sorbitol content and a higher value of relative elongation at break. However, the tensile strength of films modified with sorbitol addition is lower.

Materials based on polysaccharides enriched with plant extract as potential wound dressing

Daria Gwiazda*, Dorota Chełminiak-Dudkiewicz

Nicolaus Copernicus University in Toruń, Faculty of Chemistry, Department of Biomedical Chemistry and Polymers, Toruń, Poland

https://doi.org/10.21175/rad.abstr.book.2025.47.9

Polysaccharides are widely used in various industrial sectors, including developing biopolymeric sponges and films with potential medical applications. They are emerging as a promising alternative to traditional dressings. This study investigates using a mixture of pullulan and chitosan to create sponges and films enriched with an extract from *Dipsacus fullonum*, which could serve as novel dressing materials. The obtaining structures exhibit good physicochemical (such as mechanical properties) and biological properties. The anti-inflammatory properties of the *Dipsacus fullonum* extract further enhance the potential of these materials to support wound healing and protect the skin from infections.

The dressing materials underwent a series of tests, including ATR-FTIR spectroscopy, scanning electron microscopy (SEM), mechanical strength testing, and evaluation of antioxidant, antibacterial, and swelling properties. The results demonstrate that the materials possess biocompatibility, adequate mechanical strength, and significant antioxidant and antioxidant activity. Additionally, these materials exhibit swelling properties, which are crucial for practical dressing functionality.

These findings suggest that the developed biopolymeric materials could provide an effective alternative to traditional dressings, offering potential benefits in wound care and infection treatment.

NIR emission in sol-gel glass-ceramic materials singly- and doubly-doped with RE^{3+} ions

Joanna Śmiarowska*[1], Natalia Pawlik[1], Bartosz Handke[2], Maciej Sitarz[2], Wojciech Pisarski[1]

[1] University of Silesia, Institute of Chemistry, Katowice, Poland
[2] AGH University of Science and Technology, Faculty of Materials Science and Ceramics, Kraków, Poland

https://doi.org/10.21175/rad.abstr.book.2025.47.10

Due to the rapid development of telecommunication technologies, there is currently significant interest in materials exhibiting ultra-broadband near-infrared emission, which could be used as optical amplifiers. The optical properties of Nd3+ ions have been widely investigated considering their efficient emission in the NIR spectral range. Co-doping with rare-earth ions (RE3+) is one of several strategies to improve the luminescent performance of optical materials due to the possibility of energy transfers between them. Systems doubly-doped with Nd3+ and Pr3+ ions could be predisposed to be used as elements of optical amplifiers covering O- (1260-1360 nm), E- (1360-1460 nm), and S-bands (1460-1560 nm) ranging in the NIR spectral scope [1,2]. Additionally, materials which exhibit irradiation within I (700–950 nm), II (1000 - 1700 nm), and III (1550–1870 nm) biological windows are promising candidates for bioimaging applications. This type of emitter is currently highly in demand as the use of NIR radiation instead of UV-Vis provides the possibility of deep-depth tissue penetration and relatively high transparency toward biological matter [3].

In this work, the series of sol-gel oxyfluoride glass-ceramic materials singly-doped with Nd3+ ions and doubly-doped with Nd3+ and Pr3+ ions, containing LaF_3 nanocrystals were synthesized. The fluoride phase crystallization was confirmed using X-ray diffraction analysis (XRD). The luminescent behavior of the obtained materials was characterized based on excitation (Nd3+: 1063 nm, Pr3+: 636 nm) and emission (Nd3+: 793 nm, 579 nm, Pr3+: 444 nm) spectra as well as decay analysis from the excited states of certain dopant ions (Nd3+:4F3/2; Pr3+:1D2). The performed studies evidenced the occurrence of energy transfers between Nd3+ and Pr3+ ions. Furthermore, luminescence lifetimes as well as energy transfer efficiencies were estimated. The influence of Nd3+ and Pr3+ concentration on the overall luminescent performance was studied. The results indicate that the fabricated materials are promising candidates for the NIR luminescence applications.

References

1. X. Shein, L. Xia, Y. Zhang, J. Li, G. Yang, Y. Zhou, Structural, thermal and broadband NIR emission properties of Nd3+/Pr3+/Ag NPs co-doped tellurite glass, Optics Express 28 (2020) 14186.
2. O. Bezkrovna, P. Zdeb, O. Bezkrovnyi, R. Lisiecki, P.J. Dereń, Micro and Nanocrystalline $LuPO_4$(Ln3+: Nd, Pr) - Morphology, Luminescence and Inter-ionic Interplays, ACTA PHYSICA POLONICA A 4 (2023) 263.
3. L.R.R. Nunes, H.P. Labaki, F.J. Caixeta, R.R. Gonçalves, Yb3+ influence on NIR emission from Pr3+-doped spherical yttria nanoparticles for advances in NIR I and NIR II biological windows, Journal of Luminescence 241 (2022) 118485.

Self-assembling styrylpyridinium compounds forming liposome nanoparticles for near-infrared photodynamic therapy

Reinis Putrālis*[1,2], Kristapts Krims Dāvis[1,2], Meldra Ķemere[3], Anatolijs Šarakovskis[3], Aleksandra Gluščenko[1], Kārlis Pajuste[1], Aiva Plotniece[1]

[1] Latvian Institute of Organic Synthesis, Rīga, Latvia
[2] Rīga Stradiņš University, Rīga, Latvia
[3] Institute of Solid State Physics, University of Latvia, Rīga, Latvia

https://doi.org/10.21175/rad.abstr.book.2025.47.11

Introduction: Cancer remains a leading cause of death worldwide. Although chemotherapy is widely used, it often causes severe side effects that force patients to stop treatment. To address this challenge, there is a need for precisely targeted therapies that can effectively destroy cancer cells while maintaining minimal toxicity to healthy tissues. Promising alternative is Photodynamic therapy (PDT) where light-activated compounds are used to generate reactive oxygen species (ROS) at the irradiation site triggering cancer cell apoptosis. This localized activation results in minimal systemic toxicity and precise control over site of action. For effective PDT, it is essential that the compounds absorb and emit in the near-infrared (NIR) region, which allows deeper tissue penetration. But current NIR photosensitizers face a critical challenge: they usually aggregate in aqueous environments (aggregation caused quenching (ACQ)), dramatically reducing their therapeutic potential. This limitation further results in poor tissue penetration and reduced ROS generation, creating an urgent need for more effective photosensitizing agents. Objectives: Our goal was to develop self-assembling styrylpyridinium compounds with aggregation-induced emission (AIE) properties that form liposome nanoparticles, specifically engineered to overcome the ACQ limitations of conventional photosensitizers through enhanced NIR fluorescence and ROS production as potential PDT agents. Methods: We synthesized novel styrylpyridinium derivatives via Knoevenagel condensation reactions between aldehydes and picolinium salts. Liposomes were formed using the injection method, and their physical characteristics were analyzed using dynamic light scattering (DLS). AIE properties were evaluated by comparing fluorescence spectra in ethanol versus liposomal solutions. In vitro cytotoxicity was evaluated using the MTT (3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide) assay, both with and without light irradiation, on cancer (HeLa) and normal (NIH3T3) cell lines. ROS production was confirmed using cellular ROS assay kit - H2DCFDA, and compound cellular uptake and localization were visualized using confocal microscopy. Results: We successfully synthesized 4 new styrylpyridinium compounds with high yields ranging from 73% to 85%. The obtained compounds demonstrated great fluorescence enhancement in liposomal form, with intensity increases up to 7-fold compared to ethanol solution confirming AIE. The emission maximum was observed at 810 nm, successfully reaching the NIR region. DLS analysis confirmed the formation of stable nanoparticles with a polydispersity index of 0.19–0.32 and an average particle size of 156–225 nm, ideal for cellular uptake, and the solutions remaining stable for at least one month. Cytotoxicity studies showed that light irradiation significantly enhanced the cytotoxicity of the compounds, with an IC50 of 5.5 μM compared to >10 μM without light exposure. ROS release after light irradiation was confirmed using a ROS detection kit. Confocal microscopy demonstrated that the compounds entered cells within 30 minutes and localized near mitochondria. After irradiation, visible mitochondrial damage indicated ROS-induced apoptosis. Conclusion: In this study, we developed novel self-assembling styrylpyridinium compounds with strong AIE properties, effective NIR fluorescence, and the ability to form stable liposomal nanoparticles. These compounds demonstrated efficient cellular uptake, enhanced ROS production upon light activation, and selective phototoxicity towards cancer cells, while maintaining low toxicity in the absence of light. Our results show that these compounds successfully address key limitations of traditional photosensitizers, offering a promising platform for next-generation PDT with improved precision, reduced systemic toxicity.

This work was funded by grant IG-2025-03

UV-visible spectroscopy, atomic force microscopy and transmission electron microscopy analysis of gold nanoparticles exposed to varying doses of ionizing radiation

Filip Marinov*[1,2], Ivo Petrov[2], Tsvetoslav Lazhovski[2], Krum Stoilov[2], Peter Temnishki[1], Silviya Simeonova[3], Peter Georgiev[3], Lyuben Mihaylov[3], Evelina Vassileva[3], Konstantin Balashev[3]

[1] Medical University- Pleven, Pleven, Bulgaria
[2] Heart and Brain Center of Excellence, Pleven, Bulgaria
[3] Sofia University, Sofia, Bulgaria

https://doi.org/10.21175/rad.abstr.book.2025.47.12

Colloidal gold solutions, more commonly referred to as gold nanoparticles (AuNPs), have been utilized for medical purposes for over a century. They are excellent X-ray absorbers, making them valuable in advanced medical applications, particularly in enhancing medical diagnosis and X-ray imaging. Understanding their interactions with ionizing radiation is crucial for their safe and effective use. This study investigates the effects of varying X-ray irradiation doses on the morphology and physicochemical properties of AuNPs. AuNPs were analyzed pre- and post-irradiation using UV-Vis spectroscopy, atomic force microscopy (AFM), and transmission electron microscopy (TEM). The results reveal dose-dependent changes in the optical and structural characteristics of the nanoparticles, providing insights into their behavior under ionizing radiation and implications for their biomedical applications.

TITLE: Book of Abstracts

EDITOR: Prof. Dr. Goran S. Ristić

TECHNICAL EDITING: Aleksandar Ristić, MD

WEB EDITING: Đorđe Ristić, DMD

COVER DESIGN: Aleksandar Ristić, MD

YEAR OF PUBLISHING: 2025

PUBLISHER: RAD Centre, Niš, Serbia

FOR THE PUBLISHER: Prof. Dr. Goran S. Ristić

CD BURNING AND COPYING: RAD Centre, Niš, Serbia

PRINT RUN: Electronic edition - 10 CDs (CD-R)

ISBN: 978-86-901150-8-2

www.rad-conference.org

CIP - Каталогизација у публикацији Народна библиотека Србије, Београд

539.16(048)(0.034.2)
57+61(048)(0.034.2)
502/504(048)(0.034.2)

INTERNATIONAL Conference on Radiation, Natural Sciences, Medicine, Engineering,

Technology and Ecology (13 ; 2025 ; Herceg Novi)

Book of abstracts [Elektronski izvor] / Thirteenth International Conference on Radiation,

Natural Sciences, Medicine, Engineering, Technology and Ecology (RAD 2025) June 16–20,

2025, Herceg Novi ; [editor Goran S. Ristić]. - Electronic ed. - Niš : RAD Centre, 2025 (Niš :

RAD Centre). - 1 elektronski optički disk (CD-ROM) ; 12 cm

Sistemski zahtevi: Nisu navedeni. - Nasl. sa naslovne strane dokumenta. - Tiraž 10. -

Bibliografija uz pojedine apstrakte.

ISBN 978-86-901150-8-2

a) Jонизујуће зрачење -- Дозиметрија -- Апстракти b) Биомедицина -- Апстракти

v) Животна средина -- Апстракти

COBISS.SR-ID 172645385

ISBN 978-86-901150-8-2