RESEARCH OF ELECTRIC PROPERTIES OF HYDRATABLE CRYSTAL MnSe-$CuInSe_2$ PROMISING FOR USING IN RENEWABLE ENERGY

Didenko E.A.[1,2], Doroshkevich A.S.[2,3], Samedovaa[2,9] U. F., Kirillov A.K.[2], Vasilenko T.A.[4], Oksengendler B.L.[5], Nikiforova N.N.[5], Balasoui M.[2,6], Stanculescu A.[7,8], Mardare D.[9], Mita C.[9]

[1]*Dubna State University, Dubna, Russian Federation, 19 Universitetskaya street, Dubna, Moscow region,141982;*
[2]*Joint Institute for Nuclear Research, Dubna, Russian Federation;*
[3]*Donetsk Institute for Physics and Engineering named after O.O. Galkin, Kiev, Ukraine,*
[4]*Saint-Petersburg Mining University, St.-Petersburg, Russian Federation;*
[5]*Ion-plasma and laser technologies Institute after U.Arifov, Uzbekistan, Tashkent;*
[6]*Horia Hulubei National Institute for R&D in Physics and Nuclear Engineering (IFIN-HH), Bucharest Romania;*
[7]*Alexandru Ioan Cuza" University of Iasi, Faculty of Physics, Bld. Carol I, No. 11, Iasi 700506, Romania;*
[8]*National Institute for Materials Physics (NIMP) StradaAtomiştilor 405, Măgurele 077125, Romania;*
[9]*Institute of Physics, National Academy of Sciences of Azerbaijan, pr. Dzhavida 33, Baku, AZ1143 Republic of Azerbaijan.*

E-mail: dea.21@uni-dubna.ru

At present time problem of renewable energy sources is actual due to depletion of traditional energy sources [1, 2]. In this respect put attention on development of converter of solar energy in electro form [3, 4]. New technologies based on the new physical mechanisms are made. Unique results were received in the area of adsorptive electrical energy industry [5, 6].

Projects of mechanisms converting chemical energy of adsorption of atmosphere moisture into electric form by electrostatic charge capture of microscopic water droplet [7] with help electrostriction caused by water adsorption [8] etc. [9, 10, 11].

In this respect materials of system MnSe-$CuInSe_2$ are interesting due to their high adsorptive ability to moisture and photovoltaic conversion. It's a possible to practical realization of hybrid energy sources converting photon energy and energy of adsorption of atmosphere moisture into electric form based on the new materials.

Purpose of the work is research of electric properties of system MnSe-$CuInSe_2$.

Researched object is crystals 10mol%MnSe-90mol%$CuInSe_2$, what have 9 mm length, 3 mm highness, 5 mm width. System MnSe-$CuInSe_2$ were obtained with help the chemical technology [12]. Voltamperograms were obtained in the lineal evolute regime (from -2000 mV to +2000 mV, stereotype amount – 1800 mV, final amount 1800 mV, maximum potential 2000 mV, minimum potential -2000 mV) by device R-20 ("Elinns") in moisture saturation regime in four point (85, 75, 35 и 26% ±5%). Research was carried out in closeted container with 350 ml volume, also this container owns controlled moisture by salts KCl (85%), NaCl (35%) and NaCl (75%) [13].

VAC, what were obtained in conditions of different moisture of atmospheric air, were showed on the figure 1. VAC, what were obtained in conditions of different moisture of atmospheric air and light as additional factor, were showed on the figure 2. All VAC have close to linear form what testifies about carrying-out of Ohm's law in researched object. Straight and reverse traces site in first and fourth quadrant respectively. Both traces are almost symmetrical relatively of coordinates starting. Righting qualities weren't observed. Leap of current is at the null voltage value. This leap testifies to availability of barrier potential about 0,3 V at low moisture and about 0,4-0,5 V at high moisture. It means that barrier potential value is proportionally of quantity of moisture in crystal pores. On the

figure 2 illumination results in lowering of barrier potential (about 1 mV) and more sharp than in «dark» regime lowering resistance of material (curve lean to X-axis). Lowering resistance in the first and second variant was caused generation of charge free-carrier. Moisture and illumination are additive. Conclusion: making of hybrid energy sources based on the researched materials is possible.

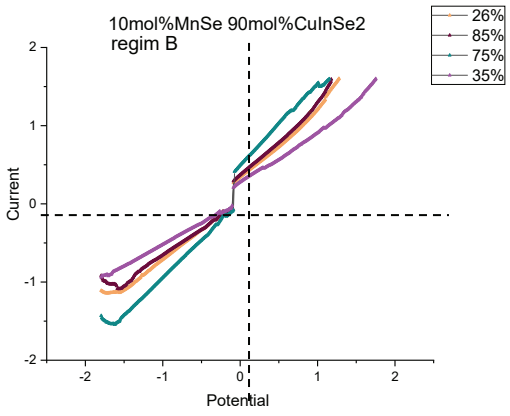

Fig 1. The VAC pattern family owing to atmosphere moist.

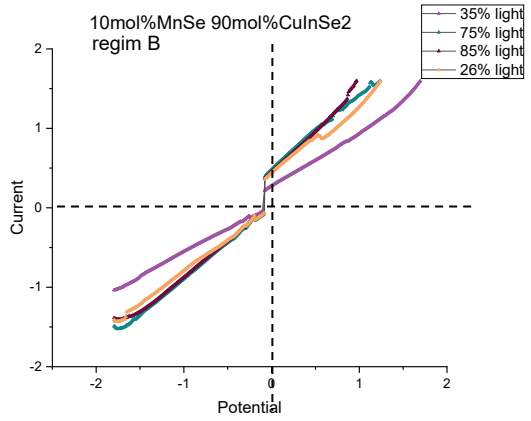

Fig 2. The VAC pattern family owing to atmosphere moist in the present of light as additional factor.

The study was performed in the framework of the JINR-Romania cooperation program in 2022 (topic 03-4-1128-2017/2022).

[1] Lyubarskaya M. A. Review of trends in innovative development of renewable energy technologies //Russian Economic online magazine. – 2019. – №. 3. – p. 54-54.
[2] Chernyshev A. S., Mordvinov S. E. Review of renewable energy sources //Youth and knowledge-a guarantee of success-2019. – 2019. – p. 146-149.
[3] Strebkov D. S. Et al . Solar energy: state and prospects of development //Machinery and equipment for the village. – 2019. – №. 3. – p. 43-47.
[4] Tychkov A. Yu. Et al. Alternative energy at military facilities: a literary review //Bulletin of the Penza State University. – 2020. – №. 4 (32). – p. 101-106.
[5] S. Doroshkevich, A. I. Lyubchyk, A. V. Shilo, T. Yu. Zelenyak, V. A. Glazunovae, V. V. Burhovetskiy, A. V. Saprykina, Kh. T. Holmurodov, I. K. Nosolev, V. S. Doroshkevich, G. K. Volkova, T. E. Konstantinova, V. I. Bodnarchuk, P. P. Gladyshev, V. A. Turchenko, S. A. Sinyakina Chemical-Electric Energy Conversion Effect in Zirconia Nanopowder Systems. Journal of Surface Investigation: X-ray, Synchrotron and Neutron Techniques, 2017, Vol. 11, No. 3, pp. 523–529. DOI: 10.1134/S1027451017030053
[6] S. Doroshkevich, A. I. Lyubchyk, A. V. Shilo, T. Yu. Zelenyak, V. A. Glazunovae, V. V. Burhovetskiy, A. V. Saprykina, Kh. T. Holmurodov, I. K. Nosolev, V. S. Doroshkevich, G. K. Volkova, T. E. Konstantinova, V. I. Bodnarchuk, P. P. Gladyshev, V. A. Turchenko, S. A. Sinyakina Chemical-Electric Energy Conversion Effect in Zirconia Nanopowder Systems. Journal of Surface Investigation: X-ray, Synchrotron and Neutron Techniques, 2017, Vol. 11, No. 3, pp. 523–529. DOI: 10.1134/S1027451017030053
[7] N.Miljkovic, D. Preston, R. Enright, and E. Wang. Jumping-droplet electrostatic energy harvesting // APPLIED PHYSICS LETTERS. 2014. V. 105, P.013111.
[8] Georgen B., Nienhaus H., Weinberg W. H., Mc Farland E. Chemically induced electronic excitations at metal surfaces // Science. 2001. V.294. P. 2521–2523.
[9] Leandra P. Santos, Telma R. D. Ducati, Lia B. S. Balestrin, and Fernando Galembeck* Water with Excess Electric Charge // J. Phys. Chem. C 2011, 115, 11226 –11232. Dx. Doi.org/10.1021/jp202652q.

[10] Rubia F. Gouveia and Fernando Galembeck Electrostatic Charging of Hydrophilic Particles Due to Water Adsorption // J. AM. CHEM. SOC. 2009 , 131 , 11381–11386 9 11381.
[11] Rubia F. Gouveia, Carlos A. R. Costa, and Fernando Galembeck* Water Vapor Adsorption Effect on Silica Surface Electrostatic Patterning // J. Phys. Chem. C 2008, 112, 17193–17199.
[12] Sh. M. Gasanlya , A. A. Abdurragimovb, and U. F. Samedovaa The Electric and Thermoelectric Properties of cuinse2based Chalcopyrite // Surface Engineering and Applied Electrochemistry, 2012, Vol. 48, No. 5, pp. 439–443, 1068-3755, DOI 10.3103/S106837551205004.
[13] Relative humidity of air above saturated solutions / A.G.Tereshchenko – Tomsk, 2010. – p. 22.