NEUTRON AND X-RAY REFLECTOMETRY STUDIES OF PLANAR INTERFACES FOR LITHIUM POWER SOURCES

Ye.N. Kosiachkin[1,2,3], M.V. Avdeev[1,4], I.V. Gapon[1,5], D.I. Boronin[4,1] and L.A. Bulavin[2]

[1]*Frank Laboratory of Neutron Physics, Joint Institute for Nuclear Research, Dubna, Russia*
[2]*Physics Department, Taras Shevchenko National University of Kyiv, Kyiv, Ukraine*
[3]*Institute for Scintillation Materials of NAS of Ukraine, Kharkiv, Ukraine*
[4]*Faculty of Physics, Moscow State University, Moscow, Russia*
[5]*Institute for Safety Problems of Nuclear Power Plants, NAS of Ukraine, Chornobyl, Ukraine*

E-mail: kosiachkin@jinr.ru

Nowadays, rapid development of technologies leads to abundance of the most diverse electronic devices. As well, green energy and low-carbon economy development is not less important, while we have drastically high level of Earth pollution. Both of these trends lead to the need of reliable and safe accumulators with high capacities and low pollution risks. Today, the highest specific capacity in industrial batteries is achieved for lithium-ion accumulators of the 'intercalating type'. The prospects are foreseen for the batteries with metal electrodes, especially lithium anodes. However, the processes on electrochemical interfaces with liquid electrolytes are not fully understood, which slows the progress in this area. In particular, this concerns the controllable formation of a passivating layer − solid electrolyte interphase (SEI), as well as the inhomogeneous lithium deposition on metal electrodes, which both affect performances and safety operation of such kind of batteries.

The given work reports about the applications of neutron (NR) and X-ray (XRR) reflectometry to study planar interfaces related to the lithium power sources. Firstly, XRR is applied for controlling and optimizing substrates for neutron experiments. It is well suited for determining the initial comparatively simple structures with thin (thickness ~50 nm) metal electrodes deposited (magnetron spattering) on crystalline silicon. More complicated heterostructures including multilayers with regulated mean scattering length density in quasihomogeneous approximation are also tested in the frame of the general task of optimizing NR experiment [1,2]. This problem appears, since the changes of the working electrochemical interfaces are small, and certain steps are to be done to enhance relative reflectivity changes during interface evolution. The application of NR makes it possible to in situ investigate the influence on the interface evolution of the environmental parameters, anode initial characteristics, electrolyte composition, current density, overvoltage and so on. For this purpose, electrochemical cells for simultaneous monitoring of voltage/current at the interface under study is designed [3]. The results of the adaptation of the NR experiment to study the structure of electrochemical interfaces are summarized.

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[2] V.I. Petrenko, Ye.N. Kosiachkin, L.A. Bulavin, M.V. Avdeev (2020). Optimization of the initial interface configuration for in-situ neutron reflectometry experiments. J. Surf. Investigation. 14, 215–219.
[3] Ye.N. Kosiachkin, I.V. Gapon, A.A. Rulev, E.E. Ushakova, et al. (2021). Structural studies of electrochemical interfaces with liquid electrolytes using neutron reflectometry: experimental aspects. J. Surf. Investigation. 15, 787–792.