Project report "A system for neutron *operando* monitoring and diagnostics of materials and interfaces for electrochemical energy storage devices at the IBR-2 reactor"

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At present, the continuous growth of the use of electrochemical energy storage devices requires the development of special approaches for studying the processes taking place inside these devices, including electrodes and hidden boundaries of charge separation, during their functioning (*operando* mode). This project was aimed at a wide adaptation of neutron scattering methods (diffraction, reflectometry, small angle scattering) and sample environment systems to study the evolution of the structure of electrochemical interfaces and electrode materials in *operando* mode.

The project objectives were to develop approaches for the effective use of neutron scattering methods for various types of electrochemical interfaces and electrodes, to create specialized experimental cells, as well as to adapt sample environment systems for *operando* research. The high penetrating power of thermal neutrons makes it possible to study complex systems that are closest in conditions to real batteries, fuel cells and other electrochemical devices. Neutron scattering experiments required the development of special approaches to the creation of electrochemical cells for simultaneous monitoring of voltage/current at the interface/electrode under study together with the organization of the neutron beam passing through the interface/electrode, followed by the detection and analysis of scattering. The application of common approaches to solving problems for different types of interfaces/electrodes in the scattering methods used has significantly improved the quality and level of structural information in the study of electrochemical processes.

The neutron scattering experiments were carried out at the IBR-2 reactor of FLNP JINR using HRFD, RTD diffractometers, GRAINS reflectometer, and YuMO small-angle diffractometer. The work was done at the Frank Laboratory of Neutron Physics, JINR, in collaboration with the Department of Chemistry of Moscow State University and Dubna State University.

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