Proposal for opening a new project

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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The performance characteristics of modern electrochemical energy storage devices (energy capacity, power, stability of operation, service life) are largely determined by the processes occurring at charge separation interfaces and by corresponding chemical reactions, as well as evolution of the structure, composition and chemistry of electrodes and electrolytes. The project is aimed at developing neutron scattering techniques that would allow studying the structure of electrochemical interfaces and electrode materials of different types in the course of their operation (*operando* mode) and monitor the influence of various factors on it. High penetrating power of neutrons makes it possible to study complex systems that are closest to real batteries. Neutron scattering experiments require the development of specialized approaches and the creation of electrochemical cells for simultaneous monitoring of voltage/current at an interface/electrode under study and the formation of a neutron beam passing through the interface/electrode, followed by detection and analysis of scattering. At the same time, for various types of interfaces/electrodes and the scattering methods used (diffraction, reflectometry, small-angle scattering), it is possible to formulate common tasks that allow one to some extent to combine approaches to their solution and thus improve the efficiency of obtaining structural information and enlarge the scope of investigations of various aspects of electrochemical processes. Thus, the purpose of this project is to develop approaches for the effective use of neutron scattering methods for various types of electrochemical interfaces and electrodes, with the subsequent creation of specialized experimental cells and a sample environment system for operando research.

Neutron scattering experiments will be carried out at the IBR-2 reactor at FLNP JINR on HRFD and RTD diffractometers, GRAINS reflectometer, and YuMO small-angle instrument. The long-term experience in electrochemical studies of a wide range of interfaces at the Chemical Faculty of Moscow State University (Moscow) and the experience in diffraction studies of electrodes in lithium-ion batteries at FLNP JINR will be used to develop new cells. Facilities and equipment for electrochemical testing of the cells, as well as application of additional methods (spectroscopy, microscopy, etc.), will be available in specialized laboratories at the Engineering Centre of Dubna University. The infrastructure developed during the project implementation will be employed in the framework of the User Program at the IBR-2 reactor for a wide range of tasks related to materials and interfaces for electrochemical energy storage.

The project cost is estimated to be about 450 k$ for 3 years.