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Neutron Imaging of Electrochemical Devices

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Electrochemical storage systems, such as lithium batteries and fuel cells, have become an increasingly important pillar in a zero-carbon strategy for curbing climate change, with their potential to power multiscale stationary and mobile applications. Immense progress has been made in electrochemical storage technology during the past decades, but significant challenges remain and new development strategies are required to improve performance, fully exploit power density capacity, utilize sustainable resources, and lower production costs. Suitable characterization techniques are crucial for understanding, inter alia, 3D diffusion processes, formation of passivation layers or dendrites in batteries or visualize the water management in fuel cells. Studies of such phenomena typically utilize 2D or 3D imaging techniques, offering locally resolved information. Over the last decades neutron imaging has been steadily growing in many disciplines as a result of improvements to neutron detectors and imaging facilities, providing significantly higher spatial and temporal resolutions. The high sensitivity for light-Z elements, in particular hydrogen and lithium, makes neutron imaging to the perfect probe to study inter alia, changes of the media distribution and transport mechanisms in electrochemical components.
All of that provides a platform for studying dynamic and structural process with a high local resolution making neutron imaging to a rising investigation tool in energy research. An overview of latest neutron battery and fuel cell research will be presented, providing a deep insight in dynamic, multi-dimensional, complementary neutron imaging and structural analysis with focus on direct probing in 3D and 4D with the fourth dimension being time or energy. The main challenges for neutron imaging of electrochemical devices will be outlined and an outlook on development methods in the field and their potential and significance for future research on electrochemical devices will be discussed.

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