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Quantification of reactions on absolute scales via operando neutron and X-ray methods to understand energy storage systems

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Quantitative insight into reactions as well as into structural (physical and electronic) and morphological properties on an absolute scale and under reactions conditions is imperative towards understanding atomic- to meso-scale mechanisms and processes in energy storage systems. Interpreted in the context of device performance, this knowledge can be used for rational design of and new concepts for improved materials and processes.

In the first part of contribution, the particular usefulness of operando neutron and X-ray methods for the quantification of reactions on absolute scales will be discussed conceptually. It will be rationalized how the respective information can be utilized to understand energy-relevant systems, using the examples of electrochemical energy storage, electrochemical desalination, and thermocatalysis. In the second part, specific science examples will be discussed in which a variety of different X-ray and neutron methods were employed. These include the surface electrochemistry of model electrodes, the degradation mechanism during extreme fast charging of Li-ion batteries, and the dynamics and transport in electrolytes.

The final part of the talk will be devoted to future opportunities to utilize neutrons (in combination with and inspired by X-rays) to study dynamic processes in energy storage systems.

Primary author: STEINRÜCK, Hans-Georg (FZ Jülich, Institute for a Sustainable Hydrogen Economy (INW) / RWTH Aachen)

Presenter: STEINRÜCK, Hans-Georg (FZ Jülich, Institute for a Sustainable Hydrogen Economy (INW) / RWTH Aachen)