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Toward High-throughput Surface-sensitive X-ray Scattering Studies of Electrochemical Interfaces

Lithium-ion batteries (LIBs) are recognized as essential parts of portable electronics, electric vehicles, grid storage, and are a fundamental component in sustainable energy systems development [1]. However, several scientific questions still puzzle researchers, including interfaces and interphases [2]. For instance, the structure and speciation of the potential- and surface-dependent electric double layer (EDL) are not fully understood yet. Basic knowledge of multiple properties of the solid electrolyte interphase (SEI), a passivation layer formed on anode surfaces by electrolyte reduction products, needs to be unraveled to predict electrolyte behavior as well as cell kinetics and lifetime [3].
To understand the structural properties of these solid-liquid interfaces and interphases, X-ray reflectivity (XRR) is a powerful method that employs on model electrodes [4,5]. XRR is typically employed for a single electrochemical cell at a given time and an experiment takes several hours up to one day. In this scenario, the experiments are not photon-limited and continuous data collection is not necessary to obtain meaningful results. To overcome this limitation, we designed a high-throughput setup and corresponding experimental workflow, in which up to ten electrochemical cells can be measured via XRR and other surface-sensitive X-ray scattering methods (e.g., GISAXS and GIWAXS) quasi-simultaneously in an interleave fashion. We will present our novel experimental setup and the first results will be discussed.

Literature: [1] Zubi et al., Renew. Sust. Energ. Rev., 89, 292, 2018. [2] Xu, Journal of Power Sources, 559, 232652, 2023. [3] Cao, Steinrück, Encyclopedia of Solid-Liquid Interfaces, 391, Elsevier, 2024. [4] Fister et al. Chem. Mater., 28, 47, 2016. [5] Cao et al., Nano Lett., 16, 7394, 2016.

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Instrumentation and methods

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