Operando SAXS/WAXS studies for structure determination of energy storage materials using a unique electrochemical-scattering cell

H. Santner[1], C. Prehal[2], A. Keilbach[1], G. Urstöger[1], A. O. F. Jones[1]

[1]Anton Paar GmbH, Graz, Austria
[2]ETH Zürich, Zürich, Switzerland

heiner.santner@anton-paar.com

The performance, properties and function of electrochemical energy storage materials is not only rooted in their chemistry but also in their structure and transport behaviour at the atomic and nanometer scale. Investigative techniques for elucidating the structural evolution of these materials are scarce, which makes it hard to obtain a deeper mechanistic knowledge.

Operando small- and wide-angle X-ray scattering (*in situ* SAXS/WAXS) can in general provide such structural and dynamic information of electrochemical reaction products, solvation processes in complex electrode materials, etc. In this contribution we present a unique electrochemical cell which can be used for performing combined electrochemical scattering studies on a laboratory SAXS/WAXS system. It allows analysing a variety of electrochemical and electrochemical storage materials such as metal-ion/metal-air batteries, nanoparticle intercalation-type materials as well as supercapacitors. The optimized cell design ensures short diffusion pathways and fast electrochemical processes along with excellent scattering data quality.

Different application examples are discussed, including the nanoscale phase evolution in lithium-air batteries and structural studies of nanoporous carbons which are applied in batteries and hybrid supercapacitors.

[1] Prehal C. et al., Nat Commun, 11, 4838 (2020)

[2] Prehal C., Freunberger S. et al., PNAS April 6, 2021 118 (14)

Keywords: SAXS; WAXS; *in situ* studies; operando studies; electrochemistry; energy storage