Mechanism Panel Abstract & Speaker Biography

Spatially Resolved Operando X-Ray Absorption Spectroscopy and Fluorescence Mapping: Interconnection of Electrolyte Species and Electrodes in Lithium-Sulfur Batteries

Anna T.S. Freiberg,[a] Anne Berger,[a] Rowena Thomas,[a] Yelena Gorlin,[a] Moniek Tromp,[b] Hubert A. Gasteiger[a]*

[a] Chair of Technical Electrochemistry, Department of Chemistry and Catalysis Research Center, Technische Universität München, Garching, Germany
[b] Van't Hoff Institute for Molecular Sciences, University of Amsterdam, Amsterdam, Netherlands

In order to comply today's energy demand using green energy, efficient energy storages need to be developed. Due to its abundance and outstanding theoretical capacity, sulfur is seen to be a promising candidate as active material in next generation Lithium-Ion batteries. Though in recent years a lot of effort has been made in improving Lithium-Sulfur batteries, the low first cycle capacity, tremendous capacity fading, and self-discharge result in Lithium-Sulfur batteries being outgunned by state of the art Lithium-Ion batteries.(1) Furthermore, the combination of chemical and electrochemical reactions in the cathode, the electrolyte, and on the anode complicate the understanding of the overall processes happening in the cell. While most Lithium-Ion batteries can be looked at from a simple „active material vs electrolyte“ or „solid vs liquid“ point of view, the complexity within the Lithium-Sulfur battery does not allow a strict differentiation between the electrolyte and the active material and therefore makes in-situ studies especially valuable and likely indispensable.(2)

X-ray absorption near edge spectroscopy (XANES) is a powerful tool to differentiate between different kinds of sulfur-species. With our spectro-electrochemical cell we are able to simultaneously monitor the processes happening in the electrode and in the electrolyte with high spatial resolution.(3) Combining XANES spectra with fluorescence mapping, we can monitor not only the formation and depletion of intermediate polysulfides in different electrolytes, but also their distribution within the electrolyte, which allows a deeper understanding of the electrode/electrolyte interconnection. In this study we reveal the true interaction of polysulfides with the cathode and anode electrodes by adding a Lithium-Ion conducting but polysulfide repelling membrane into the cell and thus, gaining control over the unwanted diffusion and subsequent chemical side reactions of the polysulfides. With the new mechanistic understanding of the cell chemistry, the Lithium-Sulfur battery can be optimized in terms of solvent influence, additive choice, and possible replacement of the lithium metal anode.

References:

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Speaker Biography:

Anna T.S. Freiberg holds a B.S. degree in Chemical Engineering from Technical University of Munich. Since then she is working as a research assistant in the group of Technical Electrochemistry under guidance of Prof. Dr. Hubert A. Gasteiger focusing on Li-Ion Batteries, synchronized to her Master's studies. Her research interests include high power battery systems, electrolyte optimization and operando spectroscopy.