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New materials for electrochemical storage - from post Li ion to post Li systems

The paper deals with current strategic approaches to develop battery technology further in direction of cost effective, powerful, safe, and sustainable systems. Recent work is presented from our group on post Li ion and post Li systems for electrochemical storage. In the field of Li-S batteries, it was possible to re-direct the reaction pathway of the sulfur reduction by melt infiltration of the sulfur in ultramicroporous carbon with pore diameters at around 0.5 nm. Thus, the reaction space is restricted and the spacious S8 ring cannot enter the pores. In effect, smaller allotropes of the sulfur are infiltrated that are in equilibrium with the S8 until the sulfur has almost completely filled the pores. Moreover, the electrolyte cannot enter the small pores and the Li is stripped at the surface of the carbon, migrates and makes a quasi-solid-state reaction. In effect, no higher order polysulfides are formed and observed in the electrolyte over hundreds of cycles and only one voltage plateau is generated during cycling. Higher sulfur loaded (> 3 mg S/cm^2) electrodes can be made using this approach and less electrolyte may be used due to the lack of reacting polysulfides in the liquid. A logical step towards Li-free systems is the development of the Mg-S battery. This would be particularly attractive as Mg doesn't form dendrites upon plating and can be used in metallic form without compromising the safety. Moreover, Mg is comparably cheap and abundant and the theoretical energy density of an Mg-S cell is higher than that of the Li-S couple. In this respect, a new non-nucleophilic electrolyte was developed that is compatible to sulfur and is easy to prepare from two ingredients while a variety of solvents can be used. Its electrochemical stability window is 4.3 V and first 20 Ah Mg-S cells were built and cycled for dozens of times. Still, the system suffers from degradation upon cycling, which is again due to the generation of polysulfides, electrode bleeding, and passivation of the Mg surface.

Biography

Maximilian Fichtner is a full professor (W3) for Solid State Chemistry at the Ulm University and head of Materials-I at the Helmholtz-Institute Ulm for Electrochemical Storage (HIU), a German Center of Excellence in Battery Research, with approx. 120 employees. Since 2015 he is also Executive Director of the institute. His current research interest is on novel principles for electrochemical energy storage and the related materials in insertion and conversion-type battery systems. Recent work has focused on the new class of Li rich materials with rocksalt structure, anionic shuttles, magnesium batteries, and organic electrode materials. He has published more than 250 research and conference papers and is (co-)author of 20 patent applications. His h index is 40.

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