Materials Panel Abstract & Speaker Biography

A Materials-Based Redesign of the Lithium-Sulfur Battery

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Creating a cost effective, high energy density, long cycle life transportation battery based on the lithium – sulfur electrochemical couple requires overcoming a series of scientific and technical challenges. These challenges include reducing the electrolyte volume fraction within the cell, increasing the sulfur loading in the cathode, reducing the sulfur loss from the cathode and the subsequent redox shuttle of lithium polysulfides, and reducing excess lithium in the anode, all while maintaining the necessary kinetics to support facile charge transport.

The Joint Center for Energy Storage Research (JCESR) is redesigning the lithium-sulfur battery using a combination of novel materials concepts to address these challenges. Electrolytes that are sparingly solvating of the polysulfide reaction intermediates are used to constrain sulfur at the cathode, reducing the quantity of electrolyte necessary within the cell. These electrolytes are designed to tailor the reduction reaction pathway to enhance accessible sulfur capacity. Redesign of the binder as an extension of the electrolyte is implemented to ensure that polysulfide/sulfide remains in proximity to the electrode interface, increasing capacity utilization with cycling. The functionality of the binder/electrolyte system is increased with the inclusion of a redox mediator to facilitate the sulfur redox chemistry. Cathode architecture and structure are tailored to create a mechanically compliant host to accommodate volume change with the sulfur conversion reaction and ensure ion transport. Protective membranes are employed at the Li anode surface to limit consumption of the electrolyte and reduce irreversible loss of lithium. The integration of these material concepts and their impact on cell performance will be discussed.

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Speaker Biography:

Kevin R. Zavadil is a Distinguished Member of Technical Staff in the Material Sciences and Engineering Center at Sandia National Laboratories (USA). He received a PhD in Chemistry from the University of Arizona in 1989 and has spent the last 29 years conducting research on energy related materials at Sandia. Kevin manages the Transportation Storage portfolio for the Joint Center for Energy Storage Research (JCESR), a DOE Energy Innovation Hub.

His current research is focused on developing rechargeable high energy density lithium and magnesium metal batteries based on conversion cathodes like sulfur, oxygen, and metal halides that undergo chemical transformation reactions.