Developing New Electrolytes for Lithium Metal Batteries

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Abstract

Lithium (Li) metal batteries with conventional nickel-rich transition metal oxide cathodes have been regarded as one of the next-generation high-energy-density rechargeable battery systems because the Li metal anode has an ultrahigh theoretical specific capacity (3860 mAh g^{-1}) and a very low standard electrochemical redox potential (-3.040 V). However, two major problems associated with Li metal anode — Li dendrite growth during repeated cycling and low Li Coulombic efficiency (CE) still hinder the application of rechargeable Li metal batteries, although many strategies and great progresses have been made in stabilizing Li metal anode in the past decade, including smoothening Li deposition morphology and increasing Li CE. Among these efforts, the development of novel electrolytes is one of the most important and feasible approaches, which can not only enable Li metal anode to reach high Li CE of 99.5%, but also stabilize high voltage cathodes up to 4.5 V. In this seminar, the development of novel electrolytes to suppress Li dendrites and improve Li CE at PNNL will be introduced. The designing principles of solvating solvents and diluents in a new class of electrolytes called localized high-concentration electrolytes for high-energy Li metal batteries will be reported. The mechanisms for the performance advancements by the new electrolytes will also be discussed, especially through the Li/electrolyte and cathode/electrolyte interphases.

Short Bio

Dr. Wu Xu is currently a Chief Scientist in the Battery Materials and Systems Group under the Energy Processes and Materials Division at PNNL. He obtained his Ph.D. in chemistry from the National University of Singapore in early 2000. He had worked as a Postdoctoral Fellow and Faculty Research Associate in the Department of Chemistry and Biochemistry at Arizona State University, then a Senior Scientist in the Electrolyte Business Group of Ferro Corporation in Cleveland, Ohio, before joining PNNL in April 2008. Dr. Xu's research interests include the development of battery materials (electrolytes and electrodes), the investigation of electrode/electrolyte interphases and the integration of batteries, for various energy storage systems including lithium batteries, organic redox flow batteries and supercapacitors. He has about 200 papers published in peer reviewed journals and has an H-index of 81. He is also a coauthor of 1 book and 7 book chapters, and holds 33 U.S. patents granted with other 11 patents pending. Dr. Xu has received several awards including the 2012 R&D 100 Award, Microscopy Today 2012 Renovation Award, PNNL 2013 Inventor-of-the-Year Award, and 2020 Distinguished Inventor of Battelle Award.