

UC SAN DIEGO NANOENGINEERING SEMINAR

Wednesday, November 14th, 2018

Seminar Presentation: 11:00am - 12:00pm

SME 248

“Interfaces in Lithium-Sulfur Electrochemical Systems”

Dr. Juchen Guo

Associate Professor

*Department of Chemical and Environmental Engineering
University of California, Riverside*

Abstract: Electrochemical reactions between lithium and sulfur constitute the fundamental building blocks for enabling rechargeable Li-S batteries. However, the exact chemical fate and transport processed at the complex Li-S interphase is not clearly understood to date. In this presentation, we will first discuss the interphase properties at the sulfur cathode under lean electrolyte condition. Our *operando* impedance measurement demonstrates significant and rapid increase of the charge transfer resistance induced by the lithiation of sulfur. The high charge transfer resistance, originating from the high local concentration of lithium polysulfides at the interphase, is believed to be the main reason for the inferior performance of Li-S batteries under lean electrolyte condition. As a potential strategy to address this challenge, we seek to shift the Li-S electrochemical reactions to a new system without involving polysulfide species. Our results indicate distinct change of Li-S electrochemical behaviors when sulfur is in sub-nanometer confinement in microporous carbon. Based on thorough analysis and characterizations of the sub-nano-confined sulfur system, we propose a new solid-state Li-S electrochemical reaction mechanism enabled by Li-ion desolvation. The effects of the Li-ion solvation binding energy and structure on the proposed solid-state Li-S electrochemical reaction are investigated. In addition to the microporous carbon as the sulfur sub-nano confinement, narrow-diameter (< 1.0 nm) single-walled carbon nanotubes (SWNTs) are also investigated as sulfur confinement. The S@SWNTs show some unprecedented electrochemical properties, which can be attributed to the synergistic effect of sub-nano confinement and interactions between the wall of SWNTs and the confined sulfur chain.

Biosketch: Juchen Guo earned his Bachelor degree from Zhejiang University in 1999 and his Ph.D. from University of Maryland in 2007, both in Chemical Engineering. From 2007 to 2012, he worked as postdoctoral researcher at University of Maryland (2007 to 2011) and Cornell University (2011 to 2012). He joined the Department of Chemical and Environmental Engineering at University of California, Riverside in summer 2012. His research interests are interfacial phenomena and material properties in electrochemical systems including Li-ion, Li-S, and multivalent ion batteries. He is the recipient of 2014 Hellman Fellowship and 2018 NSF CAREER award.