Texas Tech University
Department of Chemical Engineering
Seminar Series

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Molecular design of nanostructured electrolytes and polymer interfaces for lithium batteries

Abstract

Advances in the basic science and engineering principles of electrochemical energy storage is imperative for significant progress in portable electronic devices. In this regard, metal batteries based on a reactive metal (like Li, Na) as anode have attracted remarkable attention due to their promise of improving the gravimetric energy density by at least 3-folds, compared to the current Li-ion battery that uses graphitic anode. However, a persistent challenge with metal batteries is their propensity to fail by short-circuiting due to dendrite growth, and by runaway of cell resistance because of internal side reactions. In this talk, I will discuss my research that utilizes multiscale transport modeling and experiments to fundamentally understand and thereby develop rational designs for polymer electrolytes and electrochemical interfaces to overcome these challenges. Specifically, we utilized linear stability analysis of metal electrodeposition and showed that the length-scale on which transport occurs near the electrodes can be as important as electrolyte modulus in stabilizing metal deposition. To evaluate this concept, we designed cross-linked polymer electrolytes with tunable nanostructure and quantified corresponding dendritic growth. Direct visualization of electrodeposition using optical microscopy showed a remarkable agreement with the theoretical predictions. Importantly, these studies showed that while the tendency for dendrite-growth can be reduced, the issue of continuous side-reactions persists. In the second part of my talk, I will show that an ionic polymer interface on the metal anode, provides a fundamental strategy for extending the chemical stability. Complementing these experimental findings, a computational chemistry approach will be utilized to explain the mechanistic processes responsible for the extended performance of a lithium metal battery.

Bio

Snehashis Choudhury completed his B.Tech degree in Chemical Engineering from National Institute of Technology, India and his Ph.D. candidate in Chemical Engineering at Cornell University under the guidance of Professor Lynden Archer. His doctoral research focused on multiscale transport modeling and experiments to fundamentally understand electrochemical instabilities during reactive metal electrodeposition. His thesis, to date, has led to over 30 journal publications and a book in Springer Nature. He was the recipient of the Austin Hooey Graduate Research Excellence Award and Outstanding Teaching Assistant Award at Cornell University. Snehashis is currently a postdoctoral scholar in the Department of Chemical Engineering at Stanford University working with Professor Zhenan Bao. His postdoctoral work focuses on the design and synthesis of novel polymer structures using supramolecular and fluorinated chemistries for energy storage applications. He recently received the DOE-Battery 500 Young Investigator Award.

Monday, Feb 10th
Livermore 101
3:00 pm