**Department of Electrical and Computer Engineering**
**Materials Engineering Program**
**Center for Integrated Bio and Nano Systems**
**10:00 a.m., Feb. 5, 2021**

**Join Zoom Meeting**
**https://zoom.us/j/845619943?pwd=QlZvYUV6M2dxNDkvNWxBd3F2YzdJZz09**

**Meeting ID: 845 619 943**
**Password: 016104**

# Interfacial Engineering of Solid-State Batteries


## Neil P. Dasgupta

Department of Mechanical Engineering,
University of Michigan



**Abstract**: Solid-state batteries have seen a dramatic increase in research in recent years because of their ability to address safety challenges associated with flammable liquid electrolytes, and the potential to enable Li metal anodes. However, all solid-state interfaces present unique challenges, including high interfacial impedances, accommodation of mechanical stresses due to solid-solid interfacial contact, and (electro)chemical instabilities that can evolve during dynamic cycling conditions.

To address these challenges, our group focuses on gaining new fundamental insights into the coupled phenomena occurring at interfaces, and applied this knowledge to rationally design interfacial composition and structure to address the root cause of performance limitations. In this talk, I will first present a multi-modal in situ/operando characterization approach to study Li metal-solid electrolyte interfaces during cycling. As model systems, I will discuss examples of Li metal cycling against the garnet oxide electrolyte Li7La3Zr2O12 (LLZO) and sulfide electrolyte Li10GeP2S12 (LGPS). Mechanistic insight will be provided into solid-electrolyte interphase (SEI) evolution, as well as nucleation and growth dynamics of the Li metal anode during cycling.

In addition to these coupled morphological/chemical/electrochemical phenomena, the unique mechanical properties of Li metal will be discussed in the context of solid-state battery interfaces. Using a unique glovebox-integrated mechanical testing system, we demonstrate that the mechanical deformation of Li metal is dominated by creep over a wide range of battery conditions. Furthermore, the wettability of molten Li metal to solid electrolyte surfaces will be quantitatively described using glovebox-integrated sessile drop tests to demonstrate the coupled relationships between interfacial chemistry and impedance.

Equipped with this fundamental knowledge, I will describe the rational design of interlayers at the Li metal-SE interface using Atomic Layer Deposition (ALD). Examples will be presented in both bulk solid-state battery interfaces, and thin film electrolytes deposited by ALD. By studying interfacial chemistry across length scales ranging from atoms to millimeters, we have been able to systematically identify the mechanisms of interfacial degradation, and answer the question of why a particular interface exhibits the observed electrochemical behavior. Through this interdisciplinary approach of fundamental materials chemistry and applied engineering, strategies to address future interfacial challenges will be addressed, pointing towards rational design and manufacturing of optimized interfaces.

**Short Bio**:
Neil Dasgupta is an Associate Professor in the Departments of Mechanical Engineering and Materials Science & Engineering at the University of Michigan. He earned his Ph.D. from Stanford University in 2011. Prior to joining University of Michigan in 2014, he was a postdoctoral fellow at the University of California, Berkeley. He is a recipient of the NSF CAREER award, DARPA Young Faculty Award (YFA), AFOSR Young Investigator Award (YIP), 3M Non-Tenured Faculty Award, and the ECS Toyota Young Investigator Fellowship. His research focuses on the intersection of materials chemistry, energy conversion, and manufacturing.

Please contact Dr. Yan Yao <yyao4@Central.UH.EDU> or Jiming Bao (jbao@uh.edu) if you want to meet with the speaker.