DREXEL UNIVERSITY
Materials Science and Engineering
College of Engineering

Department of Materials Science and Engineering,

PhD Proposal

January 10th, 2023, 1 pm
Hill Conference Room, Lebow 240

Directing Nucleation and Growth of Lithium Electrodeposits via Patterned Solid Polymer Electrolytes (for High Performance All Solid-State Lithium Batteries)

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Many strategies have been attempted to improve the bulk mechanical properties from that of pure polyethylene oxide (PEO) SPEs in order to effectively suppress dendrite propagation. Some of these include the use of block copolymer electrolytes, addition of inorganic nanoparticles or chemically crosslinking. However, all of these strategies come at the cost of reducing ionic conductivity. Reducing ionic conductivity is not only disadvantageous for achieving room temperature battery operation but can lead to ion depletion in the vicinity of the electrode, which favors tip growth behavior known to accelerated dendrite propagation. In efforts to circumvent this issue, we focus on altering the SPE transport, surface wetting and mechanical properties on micrometer length scales at the interface to guide nucleation and growth and yield stable and uniformly distributed electrodeposits. To achieve this spatial control, we will generate a patterned SPE interface using thiol-ene photopolymerization. This will yield two domains of distinct in composition and/or structure. In the first part of this work, we introduce chemistry of high surface energy and/or diffusivity into one domain to encourage nucleation in that domain over the other. By changing the pattern length scale, we hope to gain spatial control over the nucleation density by altering the overall surface density of potential nucleation sites. In the second part of this work, we focus on post nucleation growth. Here, we use differences in domain modulus and diffusivity to direct and confine growth to domains of specific length scales and see if reducing electrodeposit diameter can increase its stability. To understand the effects of SEI properties on growth, we will monitor the post nucleation growth in systems with distinct SEI properties and chemistry at various nucleation densities. This will clarify the role nucleation density plays on deposit stability by displaying how the SEI properties influence growth behavior.