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# Mechanical and Civil Engineering Thesis Defense

## Wednesday, October 21, 2015

**10:00 a.m. in 306 Firestone**

*"Stability of Solid-Electrolyte Interfaces during Discharge in Li-Air Battery"*

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• **Abstract**

In this thesis we study the growth of a solid-electrolyte interface (SEI) in the presence of an elastic prestress. In particular, we focus our interest in Li-air batteries with a solid electrolyte, LIPON, a new type of secondary or rechargeable batteries. Theoretical studies and experimental evidences show that during the process of charging the battery the replated lithium adds unevenly to the electrode surface. This phenomenon eventually leads to dendrite formation, as the battery is charged and discharged numerous times. In order to suppress or alleviate this deleterious effect of dendrite growth, we put forth a study based on a linear stability analysis. Taking into account all the mechanisms of mass transport and interfacial kinetics we model the evolution of the interface. We find that, in the absence of stress, the stability of a planar SEI depends on interfacial diffusion properties and interfacial energy. Specifically, if Herring-Mullins capillarity-driven interfacial diffusion is accounted for, SEIs are unstable against all perturbations of wavenumber larger than a critical value. We find that the effect of an elastic prestress is always to stabilize planar SEI growth by increasing the critical wavenumber for instability. A parametric study results on quantifying the extent of the prestress stabilization in a manner that can potentially be used in the design of Li-air batteries. Moreover, employing the theory of finite differences we numerically solve the equation that describes the evolution of the surface profile and present visualization results on the surface evolution by time. Lastly, numerical simulations performed in a commercial finite element software validate the theoretical formulation of the interfacial elastic energy change with respect to the planar interface.