

# Physical Chemistry Seminar

Tuesday,  
September 16, 2014

11:00 am

Room 1315  
Chemistry Building

## ***Transport Phenomena and Electrodeposition in Lithium Metal Batteries***



Professor Lynden Archer  
*School of Chemical & Biomolecular Engineering  
Cornell University*

Host: Professor Mahesh Mahanthappa

Electrodeposition is used in various manufacturing processes for creating metal, colloid, and polymer coatings on conductive electrode substrates. The process also plays an important role in electrochemical storage technologies based on batteries, where it must be carefully managed to facilitate stable and safe operations at low operating temperatures, high rates and over many cycles of charge and discharge. A successful electrodeposition processes requires fast transport of charged species (e.g. ions, particles, polymers) in an electrolyte and stable redox reactions and transport at the electrolyte/electrode interface at which the deposition occurs. This talk considers the stability of electrodeposition of metals on planar electrodes with an emphasis on its role in enabling secondary batteries based on lithium metal anodes. Development of a practical rechargeable lithium metal battery (LMB) remains a challenge due to uneven lithium electrodeposition and formation of ramified dendritic electrodeposits during repeated cycles of charge and discharge. Known consequences of unstable electrodeposition in LMBs include accumulation of electrically disconnected regions of the anode or “dead lithium”, thermal runaway of the cell, and internal short circuits, which limit cell lifetime and may pose serious hazards if a flammable, liquid electrolyte is used in a LMB. Lithium-ion batteries (LIBs) are designed to eliminate the most serious of these problems by hosting the lithium in a graphitic carbon substrate, but this configuration is not entirely immune from uneven lithium plating and dendrite formation. Specifically, the small potential difference separating lithium intercalation into versus lithium plating onto graphite, means that a too quickly charged or overcharged LIB may fail by similar mechanisms as a LMB. Using a continuum transport model for electrodeposition in a structured electrolyte in which a fraction of the anions are fixed in space, the talk will show that electrodeposition at the lithium anode can be stabilized through rational design of the electrolyte and salt. Building upon these ideas, the talk will explore structure and transport in novel nanoporous hybrid electrolyte configurations designed to stabilize the lithium metal anode against dendritic electrodeposition and premature failure. Finally, the talk will explore an application of these electrolyte/separators designs to full-cell LMBs to evaluate the stability conditions deduced from theory.

Refreshments will be available prior to the seminar at 10:45 a.m. outside room 1315

Graduate Students may meet with the speaker at 1:00 p.m. in Room 8305F