

# Purdue University

## School of Materials Engineering 690 Seminar Series

**Date: Friday,  
Nov. 15, 2013**

**Time: 3:30 Refreshments  
3:45 Seminar**

**Place: ARMS 1010**



**Infinite  
Possibilities**

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### ABSTRACT

#### **Electrochemical Shock: Mechanical Degradation of Ion-Intercalation Materials**

“Electrochemical shock”—the electrochemical cycling-induced fracture of materials—contributes to impedance growth and performance degradation in ion-intercalation batteries, such as lithium-ion. Using a combination of micromechanical models and acoustic emission experiments, the mechanisms of electrochemical shock are identified, classified, and modeled in targeted model systems with different composition and microstructure. Three distinct mechanisms of electrochemical shock are identified, and a fracture mechanics failure criterion is derived for each mechanism. In a given material system, crystal symmetry and phase-behavior determine the active mechanisms. A surprising result is that electrochemical shock in commercial lithium-storage materials occurs by mechanisms that are insensitive to the electrochemical cycling rate. This fundamental understanding of electrochemical shock leads naturally to practical design criteria for battery materials and microstructures that improve performance and energy storage efficiency. While lithium-storage materials are used as model systems for experimental study, the physical phenomena are common to other ion-intercalation systems, including sodium- and magnesium-storage compounds.

### SHORT BIO

Billy Woodford received his B.S. in Materials Science and Engineering from Penn State in 2008 and did undergraduate thesis research with Prof. Clive Randall. He received his Ph.D. in Materials Science and Engineering from MIT in 2013, supervised by Profs. Yet-Ming Chiang and Craig Carter. He is currently a Postdoctoral Associate in Materials Science and Engineering at MIT.