



In Situ Microscopy Investigations for Energy Storage and Smart Material Applications

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Time: 2:30 -3:30 p.m

Venue: Room ST602 (4D Theatre), POLYU

Abstract:

Despite strong interest recently into the improvement of energy storage materials and devices, stringent operating conditions and packaging requirements often inhibit physical inspection of their degradation mechanisms and pathways. Therefore, the importance of developing in situ microscopy tools which replicate true operating conditions is essential to improving future devices. With this in mind we have focused on the development of in situ optical and electron microscopy to gain new insights into the fundamental behaviors, mechanisms, and material properties of lithium alloy anodes. In this work, single-crystal silicon nanowires grown using the vapor-liquid-solid technique provide new insights into the electrochemical alloying process which occurs inside lithium-ion batteries. Using our platform, potentiostatic control of lithiation can yield information about the nature of transformation in silicon-based anodes. Furthermore, these same nanowires can be mechanically investigated to determine their basic mechanical properties, such as elastic modulus, fracture strength and creep behavior. Using an optical microscope, thin-film anodes can be cycled reversibly while observing the nucleation and growth of new lithium-rich phases. Findings from these investigations will be discussed. In situ mechanical studies in the electron microscope can also be coupled with real-time electrical measurements. Coupled electro-mechanical testing of vanadium dioxide nanowires confirms the stress-induced phase change in this correlated electron material. The change between the two metal phases of the material is clearly coupled with a change in the material resistivity, which may be of interest for new, smart material applications. Lastly, new investigations and research directions based on the testing platform and methods previously described will be presented.

Biography:

Dr. Boles currently holds the position of Assistant Professor in the Department of Electrical Engineering at the Hong Kong Polytechnic University. He obtained his B.S. in Materials Science and Engineering from Carnegie Mellon University in 2004. From 2002 to 2005, he was a member of the technical staff at Lumileds Lighting in San Jose, CA. He conducted his Ph.D. research at the Massachusetts Institute of Technology in the Department of Materials Science and Engineering. Following his graduation in 2010, he was awarded the Alexander von Humboldt Fellowship to conduct his postdoctoral research at the Institute for Applied Materials at the Karlsruhe Institute of Technology in Karlsruhe, Germany. In 2014 he joined PolyU as part of strategic effort to enhance the field of materials science in the electrical engineering department.

ALL ARE WELCOME!