הטכניון - מכון טכנולוגי לישראל

TECHNION - ISRAEL INSTITUTE OF TECHNOLOGY

הפקולטה להנדסה כימית
ע״ש וולפסון
The Wolfson Department of Chemical Engineering

Wolfson Department of Chemical Engineering Seminar
Lecture Hall 6, Wolfson Department of Chemical Engineering,
Wednesday December 6th at 1:30pm

William E. Mustain

Professor, Department of Chemical Engineering
University of South Carolina

Understanding and Advancing Metal Oxide Anode Materials for Li-Ion Batteries

Since its discovery as a reversible intercalation material over 30 years ago, graphite has remained the anode of choice for commercial lithium-ion batteries well into the 21st century. However, as consumer demand continues to rise for enhanced capabilities of portable electronics such as laptops, tablets and smartphones, the need for higher capacity and higher energy density materials has emerged. The transition to lithium-ion batteries in fully-electric and hybrid-electric vehicles has also contributed to this accelerating demand, and it is clear that future generations of lithium-ion batteries will need to be dramatically improved in order to satisfy weight and power requirements.

One of the most promising classes of anode materials are conversion transition metal oxides (MOs). These MOs rely on chemical transformations with more than one electron transfer step to store and deliver energy, which results in theoretical capacities 2-3 times higher than graphite. In addition, they have a safer lithiation potential that eliminates the possibility for problematic lithium plating during charging. Lastly, MOs are naturally abundant and typically environmentally friendly. However, the use of metal oxides in their raw state has been limited by their low electronic conductivity – which promotes phase separation and large domain sizes from the metal and Li2O phases that form during charging. It is this nanoscale phenomena that limits MO cycle life to graphite compared to graphite. To circumvent these challenges, our group has focused on methods that increase the intra-particle and inter-particle electronic conductivity of MO anode electrodes. In this talk, the efficacy of several approaches to improve conductivity are discussed, as well as their effect on structural and chemical reversibility (capacity retention), and rate capability. Success stories from multiple chemical platforms, NiO, SnO2, Co3O4 and MnO, will be shared, which includes supporting the MOs onto advanced carbons, creating metal-metal oxide composites, transition metal doping, and ionic impregnation. There will be a specific focus on material families that have been engineered, through fundamental scientific discoveries, to achieve stable anode electrodes over several hundred cycles. We will also discuss opportunities and challenges when pairing these MO anode materials with traditional cathodes in Li-ion battery full cells.

Refreshments will be served at 1:15pm