Correlative Characterization of Li-S Batteries with *In situ* TXM and XRD

J. Nelson[1], S. Misra[1], Y. Yang[2], A. Jackson[2], Y. Cui[2], J. C. Andrews[1], M. F. Toney[1]

[1] Stanford Synchrotron Radiation Lightsource, SLAC National Accelerator Laboratory, Menlo Park, CA 94025, USA
[2] Materials Science and Engineering, Stanford University, Stanford, CA 94305, USA

Sulfur is an attractive Li-ion battery cathode material because of its high specific energy (2600 Wh/kg); however, it is well known that Li-S batteries suffer from capacity loss or fading. It is generally accepted that this is due to the loss of active material and the formation of nonconducting Li_2S as a thin film coating the electrode. Both phenomena stem from the dissolution of active sulfur particles in the non-aqueous electrolyte as soluble long chain polysulfides form during the early stages of cell discharge.

Using *in situ*, high resolution transmission X-ray microscopy (TXM) at SSRL beam line 6-2 and *in situ* X-ray diffraction (XRD) at SSRL beam line 11-3, we have explored the early discharge region in real time during discharge. By combining these complementary methods, we can characterize both the cathode morphological changes as well as the changes in cathode crystallinity and crystal structure. We can then correlate these changes and the electrochemistry to better understand the reduction of elemental sulfur and various adaptations employed to retain battery capacity over many cycles.