Synchrotron Studies of Battery Materials

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Lithium-ion batteries have reached a high state-of-development, are nearly ubiquitous in consumer devices, and are now being utilized in electric vehicles such as the Nissan Leaf. “Beyond Lithium-ion batteries,” such as configurations using lithium metal anodes with solid electrolytes, or sodium-ion systems, are not yet commercialized, but are still subjects of intense research interest. Understanding the functioning of materials in these batteries is critical to improving energy density, maximizing cycle life, and ensuring safe operation, no matter what the configuration or state-of-development. To this end, synchrotron techniques can be extremely useful for characterization of both bulk and surface properties of candidate materials as a function of state-of-charge and cycle number. In this talk, the author will give specific examples of her research efforts on sodium-ion batteries, NMC cathodes for Li-ion batteries, and $Li_7La_3Zr_2O_{12}$ (LLZO) solid electrolytes. Techniques used include *in* and *ex situ* synchrotron x-ray diffraction (XRD) and hard x-ray absorption spectroscopy (XAS) to determine bulk structural and electronic changes as a function of state-of-charge in electrode materials, soft XAS and XPS for surface characterization of electrodes and solid electrolytes before and after cycling in electrochemical cells, and transmission x-ray microscopy (TXM) to determine the spatial distribution of elements in complex metal oxides.