Structurally ordered oxides exhibit a broad range of structural, compositional, and functional properties, which can be further tuned by means of judicious elemental doping, strain and defect engineering. As such, they have found widespread application in energy storage and conversion devices, particularly for use as electrocatalysts, cathodes, and solid state ionics. However, as-designed materials can undergo dramatic changes due to ion diffusion, which, in many cases, leads to performance degradation and device failure.

This talk will highlight our most recent effort aiming to modify complex oxides through heteroepitaxy to achieve tunable functional properties. Combining in situ and environmental transmission electron microscopy (TEM), $^{18}$O$_2$ labeled time-of-flight secondary ion mass spectrometry (ToF-SIMS), and ab initio simulations, we elucidate the structural and chemical evolution pathways in selected materials systems and reveal how such changes impact their functional properties. The first part of my talk focuses on Brownmillerite (BM)-structured SrFeO$_{2.5}$ (BM-SFO), and rhombohedral-structured SrCrO$_{2.8}$ (R-SCrO), which are perovskite (ABO$_3$)-associated structures that contain ordered oxygen vacancy channels. We show that at relatively low temperatures, a topotactic phase transition between BM-SFO (R-SCrO) and perovskite SrFeO$_3$ (SrCrO$_3$) can be promoted, delayed, or prohibited based on the interfacial strain conditions, highlighting the importance of interface engineering in designing robust and efficient ion conducting materials. In another example, I will present the epitaxial growth and in situ TEM studies of LiCoO$_2$ with or without overlayers to understand the Li transport processes and device failure mechanisms. In both cases, the high spatial and temporal resolution offered by advanced electron microscopy allow us to visualize the reaction onset, kinetics, intermediates, and final products, which are critical for the rational design of functional materials.

**Date:** September 18th, 2019  
**Time:** 11:00 a.m.  
**Place:** SN1001B Fountain Room  

*All are welcome*