In Situ X-ray Studies of Functional Oxides for Energy Systems

Functional oxides and their interfaces offer new opportunities to overcome the current limits of energy storage and conversion systems, e.g., water dissociation and formation. However, the understanding of complex oxide interfaces and their electrochemical properties is far from complete, particularly with regard to electronic and ionic dynamics occurring in aqueous solutions or ionic liquids under applied electric fields. To elucidate the physical and electrocatalytic properties of oxide surfaces and interfaces, it is necessary to build a model system and to employ in situ experimental tools to detect and analyze the complex time-dependent phenomena.

In this talk, I will introduce recent in situ synchrotron studies [1,2] conducted at Argonne National Laboratory that combine structural, spectroscopic, and electrochemical characterization on model systems, e.g., epitaxial perovskite or layered oxide thin films. With this methodology, we can determine both the reactivity and stability of active sites on complex oxide surfaces during water dissociation and formation. This approach offers much needed insight into the electrocatalytic properties of oxide interfaces and provides new strategies for the creation of new stable and active energy materials designed at the atomic level.