Engineering Oxide Thin Films at the Atomic Level for New Electronic and Energy Applications

Prof. Ryan Comes

Auburn University, Department of Physics

Complex oxides comprised of multiple positively charged metal cations exhibit a host of intriguing and useful properties for new technologies. Perovskite oxides with the chemical formula ABO_3 and spinel oxides with the formula AB_2O_4 have some of the richest behavior. These materials may be metallic, semiconducting, or insulating, and exhibit ferroelectricity, with a built-in electric polarization, ferromagnetism, or superconductivity. This combination of properties in a single class of materials offers rich opportunities for engineering of unusual combinations of behavior through the design of multi-layer thin film materials. Through the use of molecular beam epitaxy (MBE), we are able to engineer these materials down to the atomic level so that interfaces between two different materials can be controlled to produce desirable properties. In this talk I will present two examples of this type of interfacial engineering, showing how we can design, model, and characterize these properties through a wide variety of techniques. I will first discuss our work on spinel and perovskite oxide nanocomposites that can be used in the oxygen reduction and oxygen evolution reactions. Using a combination of x-ray photoelectron spectroscopy (XPS), x-ray absorption spectroscopy (XAS), scanning transmission electron microscopy (STEM), and spectroscopic ellipsometry we have answered fundamental questions about the properties of $CoMn_2O_4$ and $NiMn_2O_4$. Ongoing work focuses on integrating these materials with perovskites such as $LaNiO_3$ and $LaCoO_3$ to produce bifunctional catalysts. Our second project focuses on the synthesis of defect-free $SrTiO_3$ thin films using hybrid MBE. Using XPS surface studies, we have answered fundamental questions regarding this emerging growth technique. Ongoing work focuses on the use of these materials to produce novel oxide heterostructures for topological phases, high electron mobility 2D electron gases, and spintronic devices.

Biography: Dr. Ryan Comes has been an assistant professor of physics at Auburn University since 2016, with research focusing on the synthesis and characterization of oxide thin films, interfaces, and nanostructures. Prior to joining Auburn, he was the Linus Pauling Postdoctoral fellow at Pacific Northwest National Laboratory in Washington state from 2013 to 2016. He received his B.S. in Physics and Electrical and Computer Engineering from Carnegie Mellon University and the Ph.D. in Engineering Physics from the University of Virginia in 2013, where he was a National Defense Science and Engineering Graduate Fellow and Materials Research Society Graduate Student Silver award winner.