From Multiferroics to Ultra-wide bandgap materials: AFRL’s Big Bet on Oxide Electronics

Abstract: Next-generation warfighter electronics require the development of truly disruptive electronic materials to enable game-changing technologies and maintain battlespace superiority. Recent advancements are bringing capabilities like frequency-agility in RF/microwave electronics, neuromorphic computing for on-board real-time processing, and miniaturization of high power systems closer to realization. Regardless of the challenges, the Secretary of the Air Force is asking us to do things faster, cheaper, smarter, and with higher transition success to real warfighter capabilities. We are at the dawn of a multi-faceted, $30M+ AFRL investment strategy to create a living, breathing, ecosystem in next-generation high throughput electronic materials processing, characterization, and development tools aimed at transition to industry. With oxide electronics at the forefront, it is not surprising we are here at Cornell to learn more.

I will start by discussing our early accomplishments in creating magneto-electro composite sites with energy-efficient voltage-controlled frequency tuning for agile RF/microwave subsystems in a compact, lightweight format. AlNiZnFerriite, an oxide developed in our lab that exhibits a unique combination of high magnetostriction and low RF/microwave losses – a missing link in the RF community - has attracted interest for the development of all-oxide low-loss epitaxial magnetoelectric heterostructures. I will discuss how these and other recent discoveries in the area of oxide electronic materials have spurred broader investments, such as Gallium Oxide, and discuss our perspective on this new and exciting material. Being an ultra-wide bandgap, low symmetry material, developments in oxide synthesis and real-time characterization must be made in order to unlock and explore new process windows and overcome widespread challenges in the greater MBE community. Finally, I will discuss the 10,000 sq. ft. renovation project to create a high throughput electronic materials suite equipped with automated synthesis, characterization, data-basing, processing, and visualization tools to enable young scientists to make discoveries faster, smarter, cheaper, and with an overall higher quality of life. Our investment does not end with the equipment or facilities, Cornell’s recently awarded 5-year Center of Excellence hopes to recruit the best of the best from Cornell to help shape the future of America’s next generation electronics industry.

Biography: Dr. Brandon Howe is a Materials Engineer at Air Force Research Lab’s Materials and Manufacturing Directorate. He was recruited to AFRL under the SMART Scholarship program in 2006. He graduated in 2011 from University of Illinois at Urbana-Champaign, studying under Profs. Ivan Petrov and Joe Greene. Since joining AFRL in 2012, Howe has designed, remodeled, and custom built a unique and versatile epitaxial PVD growth suite. He is an expert in thin film nucleation, growth and microstructural characterization. Known for his work in delivering new materials to the electronics community with enhanced properties, Howe has worked to provide solutions to fellow scientists for Air Force electronic materials-related challenges. He recently received the AFRL Early Career Award, AFOSR Star Team Award, and the AFRL Charles J. Cleary Scientific Achievement Award for leading an epitaxial growth team towards the development of oxide-based warfighter electronics.