Research in the Reifsnyder Hickey Group: Investigating Atomic Structures

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The Reifsnyder Hickey research group investigates the atomic structures of materials using fundamental principles from chemistry and materials science and engineering. Our interest lies in how to understand the origin of atomic features, control them, and correlate them with physical properties at larger length scales. For this, we utilize aberration-corrected scanning and transmission electron microscopy (S/TEM) as an important analytical tool, as well as other structural and chemical probes, simulations, and machine learning. The group aims to push the capability of S/TEM as an analytical tool to study a diverse array of complex systems, including nanomaterials, devices, and biomaterials. Additionally, we synthesize and transform nanocrystalline materials, including using in situ S/TEM techniques such as heating and biasing. For example, we explore temperature effects on structures, such as by heating and cooling to induce structural transformations and phase transitions, and we use cryogenic temperatures to probe hybrid and biological structures that could otherwise be easily damaged by the electron beam. Beyond atomic structures, we also aim to understand the electronic and optoelectronic properties of materials, for example by performing electrical measurements during imaging, as well as spatially mapping changes in materials' plasmonic resonances. We study a variety of materials, including two-dimensional (2D) materials, inorganic nanocrystals, thin films, and engineered biological tissue. In order to achieve atomic-scale insights into structure/property relationships, we use techniques such as the focused ion beam (FIB) to create unique sample configurations. This allows us to access unconventional geometries from which we can extract new atomic-scale insights and correlate them with emerging physical and device properties.