Mechanical & Materials Engineering

Pierson Graduate Seminar

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Materials Structural Characterization Using Synchrotron X-ray and Electron Microscopy Techniques

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As a key component in modern materials science, structural characterization plays a central role in bridging all other aspects of materials research. In light of the ever-increasing demand for controlling materials at the atomic level and probing their response to external conditions in ultrafast timescales, today's structural characterization techniques are required to possess extremely high resolutions in spatial and/or temporal domains. Among all, x-ray imaging/scattering and electron microscopy are the most versatile and extensively used techniques. In general, synchrotron x-ray techniques do better in studying real materials under real conditions, as high-energy x-ray photons penetrate much deeper into samples than electrons; while electron microscopy provides unprecedented spatial resolution. Here, by presenting a few projects I have been doing, I intend to elucidate the key elements involved in developing and applying structural characterization techniques.

First, I will address the unique roles of grazing-incidence small-angle x-ray scattering and scanning x-ray nanodiffraction techniques in understanding the mechanisms and behaviors of ceramic oxides. Second, I will introduce two novel approaches based on coherent scattering. One is x-ray coherent surface scattering imaging, developed for visualizing surface/interface structures, and the other one is electron correlograph analysis for probing the medium-range orders in amorphous materials. Third, I will discuss the strength and limitations of multiple x-ray imaging techniques that are currently available in synchrotron facilities.

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