In Situ Nanoprobe Beamline for APS MBA Lattice

White Paper

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Abstract

The In Situ Nanoprobe (ISN) will utilize the massive increase in coherent flux in the hard x-ray range enabled by the APS MBA Upgrade to provide transformative imaging and spectroscopy capabilities for *in-situ* studies of complex hierarchical systems in varying environments, at very high spatial resolution, and with close to atomic sensitivity. This will enable entirely new microscopic studies of materials as diverse as batteries, catalysts, photovoltaic systems, nanoelectronics, earth and environmental systems, under a broad range of conditions, such as during synthesis and during operation. These systems have in common, heterogeneity at length scales from nanometers to macroscopic scales, complex compositional, chemical and structural features and functional units and sites, and high sensitivity to often multiple external environments such as temperature, gaseous environment, acidity and fields. The ISN will focus the coherent flux provided by the MBA lattice into a focal spot of 20 nm, enabling rapid, multidimensional imaging across many length scales, and combining x-ray fluorescence imaging and spectroscopy with coherent methods to achieve sub-10 nm spatial resolution and close to atomic sensitivity. The combination of brilliance increase and instrument design enables an increase in focused flux by 3 to more than 5 orders of magnitude compared to current nanofocusing capabilities, enabling very fast data acquisition across many length scales, and fast imaging of responses to changes in environmental parameters. Coupled with broad *in-situ* capabilities, this enables qualitatively new understanding of functional materials and systems, and contributes to inspiring and conceiving new materials, materials systems and approaches required to address some of the current and future challenges in energy and sustainability.