Abstract for an Invited Paper
for the MAR11 Meeting of
The American Physical Society

Imaging Interfacial Structure and Reactivity with X-ray Reflectivity and Microscopy

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A fundamental understanding of interfacial reactions is best achieved with ability to observe the systems of interest directly, ideally with molecular-scale resolution and/or sensitivities. X-ray-based approaches offer broad opportunities for probing complex interfaces in environments (e.g., liquids) that are normally inaccessible. I will describe two complimentary approaches for imaging interfaces. The first, X-ray reflection interface microscopy (XRIM), uses the weak interface-reflected X-ray beam to image laterally heterogeneous interfacial structures and processes using a full-field imaging approach. This approach incorporates all of the sensitivities of X-ray reflectivity (XR, including sensitivity to interfacial topography, structure and composition) as potential contrast mechanisms. Recent applications of XRIM will be described, including the abilities to observe: elementary surface topography (i.e., 6.5 Å-high steps) with ~100 nm spatial resolution; interfacial reactivity; and liquid-solid interfaces, in-situ. A second, complementary, approach images the vertical distributions of element-specific sub-structures at an interface through the use of resonant dispersion at X-ray energies close to element’s absorption edge (resonant anomalous X-ray reflectivity, RAXR). Recent applications of RAXR will be described including the ability to image element-specific distributions (i.e., ions near a charged liquid-solid interface) and its sensitivity for probing oxidation state specific structures at interfaces. The use of these techniques to observe charge transport at interfaces with respect to energy-related processes will be discussed.

1This work supported by the Geoscience Research Program of the US Department of Energy, Office of Basic Energy Sciences. This work is done in collaboration with M. J. Bedzyk, J. Catalano, S. S. Lee, C. Park, N. C. Sturchio, Z. Zhang, and P. Zschack.