

Spectroscopy on catalyst surfaces in high pressure gas or liquid environment

Daniel Friebe
SLAC

We present our recent efforts and future directions for hard x-ray techniques to take the investigation of technologically important heterogeneous catalysis systems, i.e. solid/high pressure gas and solid/liquid interfaces, to a level of cleanliness and chemical accuracy that will be comparable with that of traditional ultrahigh vacuum surface spectroscopy. To achieve this goal, we need to improve three key parameters of our spectroscopic experiment: spatial resolution, energy resolution, and time resolution. High spatial resolution, especially along the interface normal, is essential to achieve sufficient surface sensitivity. Here, we need to overcome the discrepancy between bulk penetration, necessary to access the interface in a high pressure or liquid environment, and undesired bulk excitation, since we want to selectively probe interface atoms. Hard x-ray absorption spectra with enhanced energy resolution, currently on the order of $\sim 1-2$ eV have already allowed us to obtain more accurate but still limited information on the chemical state of surface Pt atoms in a fuel cell model catalyst. Finally, we will discuss examples of catalysis experiments ranging from operando spectroscopy to pump-probe experiments and, correspondingly, a wide range of magnitudes of desirable time resolution.