Advanced Light Source MES Beamline

Advanced Light Source – Molecular Environmental Sciences (MES) Beamline 11.0.2 Facility

Program Summary

The Advanced Light Source-Molecular Environmental Sciences (MES) Beamline 11.0.2 Facility at Lawrence Berkeley National Laboratory (LBNL) is a national user facility for soft X-ray synchrotron radiation which was established in late 2002. The beamline conforms to the U.S. Department of Energy (DOE) Office of Basic Energy Sciences (BES) general user facility model. The MES Beamline is managed and supported by the Chemical Sciences Division (CSD) of LBNL in partnership with the ALS. The MES Beamline serves two branchlines (spectroscopy 11.0.2.1 and microscopy 11.0.2.2) and two facility endstations that share beamtime from a 5-cm-period elliptical polarization undulator (EPU) providing soft X-ray photons from ~75 eV to 2000 eV. The primary endstation on the spectroscopy branchline is the ambient pressure photoelectron spectrometer (APPES) system used for surface science investigations at pressures up to 10 Torr. In addition, a second endstation (APPES-II) is used as a platform for several different experimental chambers, among them a droplet train instrument for the investigation of liquid/vapor interfaces and a microscopy chamber for the development of 100 nm resolution, zone plate-based ambient pressure photoemission microscopy (APSPEM). The scanning transmission X-ray microscope (STXM) endstation on the microscopy branchline has spectromicroscopy capabilities of 9 nm spatial resolution (at present the best resolution of all X-ray microscopes) and spectral E/E of greater than 8500. All MES endstations are currently world-leading, best-in-class instruments.

The scientific themes at the MES Beamline center around spatially-resolved and spectroscopic investigations of materials using soft X-ray techniques under realistic controlled environments of pressure and temperature. They include ambient pressure surface studies of solid/vapor and liquid/vapor interfaces using in situ techniques. Scientific areas of investigation are: heterogeneous chemical reactions at solid and liquid interfaces; nanoscience (including nano-biogeochemistry); energy science (fuel cells, solar cell materials); aerosol and atmospheric science; heterogeneous catalysis; magnetization dynamics; actinide science; environmental science; atomic molecular and optical science.

A,B Small- and large-scale STM images of FeO$_2$/Pt(111) films after 20 Torr CO at 520 K. C APPES measurements of a FeO$_2$/Pt(111) film during exposure to 1 Torr CO at room temperature (lower spectra) and 510 K (upper spectra). The inset depicts the proposed Fe$_3$O$_2$ structure with Pt atoms in the hollow sites. (Pt: gray, Fe: pink, O: red).