Phase III Beamline: Concept Design and Construction for Soft X-ray Absorption Spectroscopy

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Abstract

Soft X-ray absorption spectroscopy (sXAS) performed by the intense and tunable X-ray beams from synchrotron light source is known as a powerful tool to determine the electronic structures, such as valence, spin-state and site-symmetry of the absorbing atom by exciting the electrons in the relatively shallow core level into unoccupied energy levels or unbound continuum states as photoelectrons. Generally, covalency determines magnetic interactions and electron delocalization and hence the physical properties particularly for many 3d transition-metal (TM) oxides with unoccupied 3d orbitals, which cover a wide range of practical applications such as superconductivity, pyro electricity, giant magnetoresistance, metal-insulator phase transition, magneto-optical, semi-metal, electro- or photo-catalysis, ion conductor and energy-related materials. sXAS technique operating in the photon energy range of 100 - 2500 eV is able to probe the X-ray absorption of $L_{2,3}$ edge of TM and K edge of ligand element, such as carbon, nitrogen, oxygen, fluorine, phosphor, sulphur etc., and is a very sensitive technique to investigate the covalency of a metal-ligand bond of materials revealed by measuring sXAS spectra of both TM and ligand. Combination of the high-flux X-ray source with quick photon-energy scan and the introduction of liquid (or gas) cell system for high vacuum or ultra-high vacuum environments, liquid (or gas) samples become feasible to perform sXAS spectrum so that the dynamic electronic structures of liquid (or gas)-solid interfaces in energy-generation, energy-conversion, and energy-storage materials can also be investigated.