Prospects for actinide STXM

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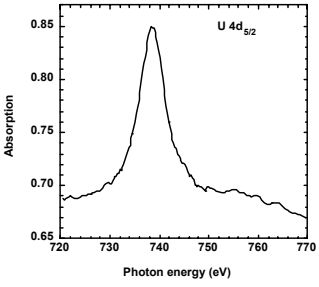
In assessing the migration behavior of actinides and other radionuclides in the environment it is of great importance to have detailed knowledge of the chemical interactions between the migrating actinide species with surrounding minerals, as well as with particulates present in transporting groundwater. There are several methods used to experimentally gain such information such as laboratory sorption experiments and hard x-ray x-ray absorptioin fine structure (XAFS). Recently, scanning transmission x-ray microscopy (STXM) has been utilized with actinides and shows the ability to give spatially-resolved chemical information from high-resolution near-edge XAFS (NEXAFS) on the 25 nm length scale.

The results from the initial studies of the common uranium, neptunium, and plutonium oxides will be presented, demonstrating the capabilities and limitations of soft x-ray STXM spectromicroscopy for the investigations of actinide systems. The actinide 4d edges are employed for both imaging and for oxidation state determination. Additional information can be obtained from light element edges, such as the oxygen K-edge. The results from the initial investigation of actinide colloids and actinide sorption on mineral particles will be shown. Actinide sample preparation methods, as well as sample radiation damage considerations, will be described and discussed. The prospects for future actinide investgations by STXM will be critically evaluated.



NEXAFS spectrum collected at the U $4d_{5/2}$ edge from a 35 nm edge region of a UO_2 particle.

Soft X-ray absorption and emission spectroscopies as probes of metal dopants and clusters

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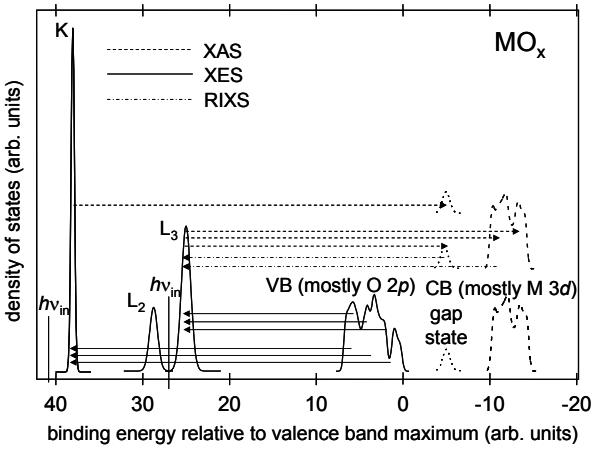
Characterization of isolated transition metal (TM) dopants and TM clusters in both organic and inorganic media is a formidable challenge with significant implications for the chemical, electronic, magnetic and optical properties of the material as a whole. In this talk, I discuss the physical underpinnings of x-ray absorption and emission spectroscopies with spatial resolution, and illustrate what can be learned using a variety of material systems of interest to solid-state physicists, mineralogists, environmental scientists and physicians. Specific examples include ferromagnetically doped TM oxides in which the dopant is dispersed or clustered, elemental speciation in minerals such as ilmenite and zircon, Fe speciation in Fe-oxidizing bacteria, and Gd neutron capture therapy for treatment of brain tumors.



Schematic representation of x-ray absorption (XAS) and emission (XES) processes in a metal oxide. In XAS, electrons are excited from core states to low-lying unoccupied states. XES results from the decay of electrons in occupied states to the core holes created in XAS. XES can be obscured by the direct decay channel accompanying XAS, and the resonant inelastic x-ray scattering (RIXS) of these x-rays. RIXS can be distinguished from XES by varying the incident x-ray energy ($h\nu_{in}$); RIXS disperses with $h\nu_{in}$ whereas XES does not.

Acknowledgement

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