The chemistry of spent nuclear fuel from x-ray absorption spectroscopy

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Abstract

Present and future nuclear fuel cycles will require an understanding of the complex chemistry of trace fission products and transuranium actinides in spent nuclear fuel (SNF). Because of the unique analytical challenges presented by SNF to the materials scientist, many of its fundamental physical and chemical properties remain poorly understood, especially on the microscopic scale. Such an understanding of the chemical states of radionuclides in SNF would benefit development of technologies for fuel monitoring, fuel performance improvement and modeling, fuel reprocessing, and spent fuel storage and disposal. We have recently demonstrated the use of synchrotron x-ray absorption spectroscopy (XAS) to examine crystal chemical properties of actinides and fission products in extracted specimens of SNF. Information obtained includes oxidation state, chemical bond coordination, and quantitative elemental concentration and distribution. We have also used XAS in a scanning mode to obtain x-ray spectral micrographs with resolution approaching 1 micron. A brief overview of the technique will be presented, along with findings on uranium, plutonium, neptunium, technetium, and molybdenum in commercial PWR SNF specimens.

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