

Actinide Characterization using Selective Optics and High Resolution X-ray Spectroscopy

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Characterization of actinide-containing materials to identify and quantify the elements and chemical species present is central to materials control and accountability, product specification, and forensics analyses. We will report on two recent efforts to advance characterization capabilities through the development of new instrumentation and approaches in x-ray spectroscopy.

The use of doubly curved crystal optics (DCC) enables selective detection of actinide elements in complex matrices which can prove difficult for conventional x-ray fluorescence and wet chemistry methods alike. Trace levels can be accurately determined without the need for chemical separations and with minimal sample preparation using monochromatic wavelength dispersive x-ray fluorescence. We have evaluated this rapid, sensitive approach for potential applications including determination of plutonium (using La at 14.279 keV) in spent nuclear fuel and neptunium (La at 13.945 keV) in bulk fuel cycle or heat source materials. Advantages include simplicity, reduced waste, and improved safety as compared with existing routine methods. Performance of this instrumentation with respect to selectivity, calibration, limit of detection, and accuracy will be described.

Determining chemical speciation of microscopic samples is important for source attribution and studies of reactivity, solubility, and environmental mobility. High resolution X-ray emission spectroscopy based on transition-edge sensor (TES) microcalorimeter detectors offers the possibility for chemical imaging of particles in a laboratory setting rather than a synchrotron beamline. As part of an effort to develop a practical analytical capability, a new instrument utilizing x-ray excitation (15 and 50 kV, max) and a TES array having <5 eV resolution has been commissioned to study peak shifts and shapes for model actinide matrices. The instrumental setup will be described along with recent results for bulk materials.