NUCLEAR ENERGY UNIVERSITY PROGRAMS

Quantification of UV-Visible and Laser Spectroscopic Techniques for Materials Accountability and Process Control

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Abstract

Ultraviolet–visible spectroscopy (UV–Visible) and time-resolved laser fluorescence spectroscopy (TRLFS) optical techniques can permit on-line analysis of actinide elements in a solvent extraction process in real time. These techniques have been used for measuring actinide speciation and concentration under laboratory conditions and are easily adaptable to multiple sampling geometries, such as dip probes, fiber-optic sample cells, and flow-through cell geometries. To fully exploit these techniques, researchers must determine the fundamental speciation of target actinides and the resulting influence on spectroscopic properties. Detection limits, process conditions, and speciation of key actinide components can be established and utilized in a range of areas, particularly those related to materials accountability and process control.

Through this project, researchers will develop tools and spectroscopic techniques to evaluate solution extraction conditions and concentrations of U, Pu, and Cm in extraction processes, addressing areas of process control and materials accountability. The team will evaluate UV–Visible and TRLFS for use in solvent extraction-based separations. Ongoing research is examining efficacy of UV-Visible spectroscopy to evaluate uranium and plutonium speciation under conditions found in the UREX process and using TRLFS to evaluate Cm speciation and concentration in the TALSPEAK process. A uranyl and plutonium nitrate UV–Visible spectroscopy study met with success, which supports the utility and continued exploration of spectroscopic methods for evaluation of actinide concentrations and solution conditions for other aspects of the UREX+ solvent extraction scheme. This project will ex examine U and Pu absorbance in TRUEX and TALSPEAK, perform detailed examination of Cm in TRUEX and TALSPEAK, study U laser fluorescence, and apply project data to contactors. The team will also determine peak ratios as a function of solution concentrations for the UV-Visible spectroscopy studies. The use of TRLFS to examine Cm and U will provide data to evaluate lifetime, peak location, and peak ratios (mainly for U). The bases for the spectroscopic techniques have been investigated, providing fundamental evidence for the application's utility.