ELUCIDATING AND ENHANCING RAMAN SPECTRA FOR URANIUM SPECIATION AND TRACE DETECTION

Grace Lu, University of Iowa, Department of Chemistry

entzu-lu@uiowa.edu

Prof. Tori Z. Forbes and Prof. Amanda J. Haes, University of Iowa, Department of Chemistry

Uranium, a radioactive material with a long half-life time (~10^9 yr) accumulates in the environment in its oxidative form (UO_2^{2+}, uranyl) thereby contaminating soil and water. Uranyl, however, can form complexes with sulfate, phosphate, or carbonate, which complicates detection. Furthermore, uranyl speciation varies with pH. As such, methods that are capable of identifying trace uranyl species in complex samples are needed. Herein, Raman spectroscopy and surface enhanced Raman scattering (SERS) serve as label-free and near real-time methods for identifying uranium species in solution. First, a straight-forward protocol for spectral analysis will be shown using Raman spectroscopy and aqueous uranium samples. Raman excitation wavelength, pH, and coordinating ions are systematically varied. The spectral analysis results are rigorously validated using uranyl speciation models. Next, plasmonic nanomaterials are used to enhance the Raman signals for trace detection of low (and high) abundant species. All in all, the developed protocol provides an accurate and routine analysis of Raman spectra for uranyl species identification and relative abundance elucidation. These advances are expected to provide a straight-forward approach for uranium species identified using Raman spectroscopy and SERS.