

NUCLEAR FORENSIC RESEARCH ON NUCLEAR FUEL FOR SIGNATURE IDENTIFICATION OF FUEL REPROCESSING

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Florida International University (FIU) has assembled a team with expertise in material characterization, nuclear engineering, and chemical separations for a nuclear forensic research project aiming to identify unique signatures of specific processes in used nuclear fuel (UNF) that may signify it has undergone certain types of reprocessing. This research will begin Sept. 1, 2014 and will initially focus on treatment and non-destructive measurements applied on UO_2 and mixtures of UO_2 with other oxides. FIU has relevant experience with uranium (U) chemistry for research to stabilize U in soils at some sites and to mobilize it into the groundwater at other sites. FIU has also provided surface characterization of U for ORNL. For this research, FIU has secured an agreement with Westinghouse to supply the UO_2 powder and pellets. Oxides of Ce, Th and Zr will be used as surrogates for Pu. Oxides will be characterized by several state-of-the-art instruments in multiple FIU laboratories and collaborations with labs at the DOE complex will be sought out in order to provide more powerful characterization tools, and a better understanding of the system. Oxide samples will then be treated by selected nuclear fuel reprocessing techniques (i.e., variants of the PUREX process) which will convert the oxide to uranyl compounds. These chemical processes will result in the addition of impurities and the creation of different oxidation states and numerous complexes which may be directly or indirectly detected in the UNF formed after certain reprocessing. The plutonium surrogate oxide and uranium species will be treated to reform materials with similar particle size as the original oxides and will be sampled for isotopic composition and particle size. The reformed materials will again be characterized and changes of physical properties will be quantified and explained. The chemistry and thermodynamics of these chemical processes will also be studied, by computational methods. FIU will create theoretical models of the chemistry and thermodynamics and a database of the material characterization knowledge acquired during this investigation. Statistical and trend analyses will be applied to the data. FIU has a broad radiation license from the state of Florida and performs dozens of research projects annually involving radioactivity. Seven laboratories equipped with state-of-the-art material characterization technologies will be used in addition to the Radiological Laboratory (RL). The RL has state-of-the-art equipment and a multi-port glovebox designed and built originally to handle plutonium at Rocky Flats site. The RL is housed in a PermaCon facility with a full air HEPA filtration system and is home to: a new (2014) Liquid Scintillation Analyzer; gamma spectrometers, an ICP-OES used for radioactive samples and a Chemchek Kinetic Phosphorescence Analyzer (KPA) for uranium measurements. FIU staff with Top Secret and Secret Clearances will engage with DOE, NNSA, and DHS to ensure this research proceeds with expert guidance and avoids areas sensitive to the US government. FIU is a Minority Serving Institution (MSI) with 54,000 students (61% Hispanic and 13% African American). FIU is developing a Master's of Radiological Sciences degree

program, expected to launch in 2015 to train nuclear chemists, Health Physicists and Nuclear Forensic Scientists and has secured 3 grants from the US Nuclear Regulatory Commission for student nuclear scholarship and fellowship funding and nuclear curriculum development.