Actinides and Rare Earths Focus Topic
Room C124 - Session AC+AS+TH-WeM

Nuclear Safeguards, Forensics, Environmental Science, and Stewardship

Moderators: Paul Roussel, AWE, **David Shuh**, Lawrence Berkeley National Laboratory, **Evgeniya Tereshina-Chitrova**, Charles University, Prague, Czech Republic

8:00am **AC+AS+TH-WeM-1 Simulation Tools for Improvement of the Fission Track Analysis Method for Nuclear Forensics*, Itzhak Halevy,*** Nuclear Engineering, Ben Gurion Uni. Be'er Sheva, Israel **INVITED**

To answer nuclear forensics questions, we are developing new innovative techniques and approaches to make this analysis more reliable and accurate. Currently, only trained researchers can analyze microscope images. Since this analysis is dependent on the researcher's own abilities and skills, it is obvious that different researchers will produce results that are slightly distinct. A new worker's certification period is quite long, and it must cover numerous examples from previously measured data as well as some that we can only predict. A good simulation software can aid with training and provide a tool for grading new researchers.[1] The fission tracks were simulated by Monte-Carlo software, GEANT4, which uses all the physics behind the nuclear fission tracks, such as thermal neutrons flux, fission cross-section, radiation time, particle size, enrichment, etc. In this study, our Trainer2.0 software calculates the tracks on our Lexan detector and its projection, according to the physical parameters like neutron flax, size of the particle, the isotope, and radiation time. The result is a "star" centered on the simulated particle. Our full software is written with MatLab code.

We can simulate an extreme condition and learn new aspect in the fission track technique. From the simulation we can learn about the proper amount of material to use as a sample in the FTA technique.

The simulation can predict and compared to the mini-bulk and the micro-bulk analysis.

New idea of using penetrating fluorescent colors give as the ability to scan our detector in 3D instead of 2D. In this case we used the Dapi marker as a first shoot, this marker is well known for biomedical research.

This new idea to investigate the FT Star more than just by his projection.

Identifying the length of the tracks and their distribution allow us to determine the element source isotope be the shape of "fission products distribution" and the density of the impurities in the source.

References

[1] Halevy I., Admon U., Chinea-Cano E., Weiss A.M., Dzigal N., E. Boblil, Dagan M., Orion I. and Radus R. Investigations, Progress in Nuclear Science and Technology, 2018, v. 5; p. 175-178 3.3.

8:40am **AC+AS+TH-WeM-3 Characterizing Actinides in Subsurface Sediments for Contaminant Remediation*, Carolyn Pearce,*** *H. Emerson,* Pacific Northwest National Laboratory*; C. Delegard,* TradeWind Services LLC **INVITED**

The nuclear weapons fuel cycle consists of front-end steps to produce, extract, purify, and engineer plutonium, and back-end steps to safely manage, prepare, and dispose of radioactive wastes. Waste processing has resulted in the release of actinides to the subsurface worldwide, including the release of ~200 kg of plutonium and ~7 Kg of americium from process waste solutions to unconfined soil structures at the Hanford Site in Washington State. The subsurface mobility of actinides is influenced by complex interactions with sediments, groundwater, and any co-contaminants within the waste stream. Developing efficient remediation strategies for released actinides requires a complete understanding of retardation processes and mass flux, including the different mechanisms by which actinides are immobilized in the subsurface, and the effect of localized subsurface conditions. Here, sediments from Hanford waste disposal sites have been selected, based on historical information and sediment composition, for characterization of actinide (plutonium, americium, and uranium) immobilization mechanisms. Results show that the actinides are present in these samples as micron-sized particles, intrinsic and pseudo-colloids, and dissolved species, and that they have been significantly affected by the chemistry of the actinide-bearing waste source term. Spectroscopic characterization of actinides has also proved essential to understand their migration in the deep, unsaturated, vadose zone sediments at the Hanford Site, due to the significant variability in solubility and mobility with speciation and oxidation state.

9:20am **AC+AS+TH-WeM-5 Changes in Oxidation Mechanism with Relative Humidity: Application to Uranium Dioxide Powders*, Scott Donald,*** *L. Davisson,* Lawrence Livermore National Laboratory **INVITED**

It is of interest in nuclear forensic science to understand the relationship between an interdicted sample's history and the resulting chemical and physical characteristics.It may be possible to glean information on the environmental characteristics experienced by uranium dioxide from variations in the chemistry and structure of a powder sample.The reaction between high purity, stoichiometric UO_2 powder over a range of nominal conditions at room temperature was studied using a rage of techniques, including XPS, SEM, and TEM, to interrogate changes to both the surface and bulk properties of the material.Oxidation resulting from the interaction of the surface with the local environment was observed and quantified. A change in the reaction mechanism between low and high relative humidity has been proposed to describe the observed results.

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11:00am **AC+AS+TH-WeM-10 Spatially Resolved Morphological and Chemical Analysis of Nuclear Materials*, Brandon Chung,*** *A. Baker, S. Donald, T. Li, R. Lim, U. Mehta, D. Rosas, S. Sen-Britain, D. Servando-Williams, N. Cicchetti,* Lawrence Livermore National Laboratory*; A. Ditter, D. Shuh,* Lawrence Berkeley National Laboratory (LBNL)

Nuclear forensics requires accurate identification of distinguishing material characteristics of interdicted nuclear materials. Local morphological and chemical variations in nuclear materials are nearly ubiquitous due to the varying provenance, process, and pathways. We will describe our efforts to strengthen operational and scientific methodologies to employ the focused ion beam-scanning electron microscopy (FIB-SEM) on uranium (U) and plutonium (Pu) materials for direct three-dimensional (3D) morphological analysis or to prepare site-specific material features to obtain spatially resolved characterizations using transmission electron microscopy (TEM) and X-ray synchrotron spectromicroscopy. Both U and Pu materials show variations in the internal chemical composition and morphology from their production processes and storage environments. This information is of potential use in discriminating material signatures to identify the origin and history of interdicted nuclear materials

11:20am **AC+AS+TH-WeM-11 Soft and Tender Spectromicroscopy for Nuclear Forensics at the Advanced Light Source*, David Shuh,*** *A. Ditter,* Lawrence Berkeley National Laboratory (LBNL)*; N. Cicchetti,* University of Nevada Las Vegas*; R. Lim, S. Sen-Britain, D. Rosas, D. Servando-Williams, A. Baker, S. Donald, B. Chung,* Lawrence Livermore National Laboratory

The development of new methods and signatures is crucial to ensure that nuclear forensics activities remain effective. Synchrotron radiation analysis offers one way to extend the scope of forensics investigations in elemental, chemical, and structural analysis which all can be done in imaging modes that in some cases, reaches to the nanoscale. X-ray techniques are particularly useful because of their elemental specificity and non-destructive nature. The ability to use tunable, focused beams makes synchrotron radiation sources a potentially key tool for addition into the array of characterization techniques currently employed, particularly when it comes to the investigation of particles or areas of interest in smaller specimens. Recent efforts at the Advanced Light Source conducting tender and soft spectromicroscopy using x-ray fluorescence (XRF; Beamline 10.3.2) and a scanning transmission x-ray microscope (STXM; Beamline 11.0.2). The XRF measurements provide elemental analysis at the micron scale, whereas the STXM can probe chemical speciation with a spatial resolution of better than 25 nm. Several uranium and plutonium specimens have been investigated using these techniques and the potential signatures from this data, as well as its utility, will be demonstrated. The outlook for synchrotron radiation within nuclear forensics including the strengths and drawbacks of these techniques will also be discussed.

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