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“Electrochemically-Modulated Separations for Safeguards Analyses”

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Abstract: The safe and secure use of nuclear power requires an advanced and robust analytical infrastructure supporting nuclear material safeguards. The International Atomic Energy Agency maintains an on-site material safeguard lab at the Rokkasho Nuclear Fuel Reprocessing Facility in Japan as well as the general Safeguards Analytical Laboratory in Siebersdorf, Austria. An international Network of Analytical Laboratories (NWAL), including the US DOE NWAL provides support for environmental analysis of nuclear materials under the direction of the 1993 Additional Protocols.

From the analyst's perspective, both high-level actinide analysis in spent fuel solutions and low-level actinide analysis in environmental samples present significant challenges. Against the metrics of quality, timeliness, and low cost, the challenge is greater still. Electrochemical separations have been investigated as an approach for rapid sample preparation in-line with multi-collector inductively coupled plasma mass spectrometry for trace isotopic analysis and “at-line” with gamma spectroscopy for spent fuel analysis. Termed Electrochemically-Modulated Separations (EMS), the method is analogous to electrochemical stripping analysis and provides selectivity through target electrode design, solvent conditions, and the ability to accumulate and release elements sequentially with rapid and efficient redox selectivity. The benefits of coupling EMS with mass spectrometry for low-level isotopic detection will be described. Challenges arising from solvent radiolysis and in scaling the EMS surface area for gamma spectroscopy of spent fuels will also be discussed.

Bio: Dr. Douglas Duckworth is a scientist specializing in nuclear materials analysis. He joined PNNL in 2006 and holds a Ph.D. in Analytical Chemistry from Clemson University. He began his career at Oak Ridge National Laboratory developing, executing, and managing research programs in isotopic and elemental analysis. Doug's primary expertise is in mass spectrometry and its application to the analysis of nuclear materials. His background includes investigations of fundamental gas-phase ion chemistry, plasma-based mass spectrometry, instrument development, and research advancing electrochemistry as a hyphenated separations approach prior to mass or spectroscopic analysis. His experience also includes the development of light stable and radiogenic isotope signatures related to national security. Doug's research has been supported the DOE's Office of Basic Energy Sciences, Department of Homeland Security (DHS), and the National Nuclear Security Administration (NNSA). He has co-edited one book, *Inorganic Mass Spectrometry: Fundamentals and Applications*, contributed four book chapters, and published forty-six articles in peer-reviewed journals. He currently serves as Chair of the Division of Analytical Chemistry of the American Chemical Society.

**Coordinated by Dr. David Roelant, Program Director,
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