

Non-Destructive Rapid Turnaround Characterization to Support Plutonium Experimentation

Adrien Terricabras^{1*}, Olivia Dale¹, David Arellano¹, Douglas Smith¹, Najeb Abdul-Jabbar¹, Timothy Coons¹, Jarom Chamberlain¹

¹Los Alamos National Laboratory, Los Alamos, United States of America; *adrien@lanl.gov

Plutonium-based experiments are necessary for advancing our understanding of this exotic element. Characterization of related experimental products, materials, and processes, often can introduce additional challenges especially when plutonium and other radioactive contaminants are present. Therefore, introducing non-destructive and rapid turnaround characterization techniques and methods, such as X-Ray Computed tomography (XCT), to plutonium-based experiments will increase safety and ensure deadlines and deliverables are met. One area that is currently benefiting from this characterization technique is the application of protective coatings for plutonium environments. These protective coatings are prepared with a molten salt electrodeposition method. Advancing molten-salt electrodeposition as an efficient fabrication methodology requires comprehensive multi-scale characterization to assess coating uniformity, defect evolution, and long-term performance. In this work, coatings produced in a controlled inert-atmosphere molten-salt environment were characterized using a suite of electrochemical, microscopy, and tomography techniques. These characterization methods are presented and evaluated against each other to examine the molten salt electrodeposition method as well as the plutonium and other metal exposure assessments.

Surface morphology and microstructure were evaluated using digital microscopy, profilometry, and scanning electron microscopy (SEM), while chemical uniformity was examined with energy-dispersive X-ray spectroscopy (EDS). Subsurface structure was resolved using XCT, which enabled non-destructive three-dimensional quantification of coating thickness, uniformity, and overall defect characterization. Presented results will include details on protective refractory metal coatings on nickel alloy substrate as well as molten plutonium exposure assessments on the protective coatings. These characterization methods were used to evaluate the hermeticity and materials compatibility of the coatings for application in plutonium environments, where chemical stability, defect tolerance, and barrier integrity are critical. The presented work and related dataset presents a framework and comparison when evaluating experimental procedures involving plutonium.