

Investigation of Plutonium Metal for Materials Compatibility Testing

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Ensuring material compatibility with plutonium is essential to minimize chemical and mechanical instability, as these interactions can affect system performance, plutonium purity, and safety across a range of processing environments. The authors present an investigation into material compatibility testing of molten plutonium metal at elevated temperatures (500°C). Molten plutonium compatibility with other materials, such as Inconel 718, graphite, tantalum, and tantalum carbide, was investigated with exposure tests and characterization to evaluate any metallurgical interactions. Other metals that have similar metallurgical properties to molten plutonium, such as cerium and gallium, are also tested on the same materials using the same procedure. These additional results are presented and discussed to enable more accessible and comprehensive scientific research where plutonium experiments cannot be performed. The samples are characterized with SEM/EDS to examine the plutonium and sample interface. These results are used to characterize the corrosion and materials compatibility. These plutonium exposure results are compared to molten cerium and gallium exposure results to evaluate if they are suitable surrogates for molten plutonium.

To address the failure of the Inconel 718 when exposed to molten plutonium metal a tantalum coating was applied onto the Inconel 718 and reevaluated with molten plutonium. This follow up was used to identify if tantalum deployed via molten salt electrodeposition would protect the Inconel from the Pu. Molten salt electrodeposition is a premier coating technique that can apply tantalum metal onto a substrate. A molten fluoride salt system with K_2TaF_7 as the precursor was oriented as an electrochemical cell at 700-900°C to apply the tantalum coating. The exposed samples are characterized with SEM/EDS to examine the survivability of the tantalum coating when exposed to molten plutonium metal. These results are compared with the exposure tests of molten plutonium on pure tantalum.

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