Electrochemical Corrosion Studies for Modeling Metallic Waste Form Release Rates

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ABSTRACT

A metallic host phase for many nuclear fuel components after reprocessing activities is desired by the Department of Energy (DOE). An engineered metallic host phase for some components is preferred because the efficient immobilization and disposal of fuel cladding, or other metals, remaining after electrorefining operations can easily be incorporated into a metal ingot. Undissolved solids (UDS), such as the epsilon phase and cladding shards can remain as the metal after fuel dissolution; these and other candidates for incorporation into a suitable metallic phase also include Tc. Due to the volatilization of Tc(VII) species, disproportionation of Tc(IV) during glass formation, low weight loading of Tc in borosilicate glass-types, and high leach rate of pertechnetate ($TcO4^-$) from these glass formers, a metallic phase to incorporate this pseudo-noble metal is also desirable. Essentially, noble metals, and to some degree other transition metals or alloys that are present in glass refiners, have a low weight loading in borosilicate glass and are not efficiently incorporated into this type of waste form. A metal waste form can effectively overcome these barriers for Tc and the other mentioned components. Despite the need to produce a metallic phase to incorporate these materials, while protecting Tc from the environment, efforts to model the behavior of Tc in these material-types is limited. This project will examine electrochemical methods which will elucidate the metallic corrosion mechanisms for a metal waste package with focus on microstructure changes, speciation of corrosion products, and reported corrosion rates as components from the waste package degrades in an aqueous environment. This work will improve the fundamental understanding of the degradation process for metal alloys housing fission products through systematic experiments under controlled conditions which will provided data regarding material properties while elucidating to the long-term behavior of these, or similar, materials over geological time-scales.

A series of stainless steel alloys containing varying amounts of Tc and other noble metals will be produced and a corrosion model will be generated from electrochemical data. Electrochemical data will be evaluated by the Tafel method whereupon interpretation of cathodic and anodic exchange rates (βc and βa) will be reported. This will be performed in three tasks: Task 1: Preparation and characterization of Tc containing alloys (Months 0-21), Task 2: Corrosion studies (Months 6-36), and Task 3: Computational studies (Months 3-36).