Goldschmidt 2024 Abstract
https://doi.org/10.46247/gold2024.24588

Corrosion of 316 SS in Contact with Zircaloy-4 in a Deep Geological Repository

STEVEN NGUYEN[1], DIDAC G CASTELLVI[1], ARTAS A. MIGDISOV[2] AND SARAH C FINKELDEI[1]

[1]University of California, Irvine

[2]Los Alamos National Laboratory

Presenting Author: stevenn8@uci.edu

The risk assessment for the safe disposal of spent nuclear fuel (SNF) in a deep geological repository (DGR) remains a challenge due to the knowledge gaps regarding redox chemistry that will occur in the case of technical barrier failure. For failed engineered barrier systems, scenarios where groundwater is interacting with the waste canister material, cladding material and eventually, the SNF are studied. This current study aims to elucidate the mechanisms and controls governing the dominating redox pairs that may be observed during containment failure in a DGR through a bottom-up approach, starting with waste canister material, austenitic 316 stainless steel (316 SS), and Zircaloy-4 cladding material to first provide baseline data for understanding the redox interactions between these two containment materials before introducing UO_2 into the system. Hydrothermal corrosion experiments with sandwiched Zircaloy-4 and 316 SS coupons are performed as a function of varying temperatures, 150 °C and 250 °C, water chemistry, synthetic groundwater and MilliQ water, as well as for different corrosion times of 1-6 weeks. Secondary phase analysis was performed on both metal-to-metal and metal-to-water interfaces of the corroded coupons using SEM-EDS, XRD, and Raman spectroscopy. ICP-MS was additionally performed to determine the ion concentrations of the aqueous solutions after termination of the corrosion experiments. Ongoing analyses indicate iron oxides to be the most dominant secondary phase formed, with hematite being the most common iron oxide. Thin, hexagonal-shaped brucite is additionally observed in experiments performed in synthetic groundwater. ICP-MS results reveal relatively high concentrations of iron in solution compared to zirconium, suggesting that the majority of the corrosion occurring in the system originates on the 316 SS waste canister. In-depth analysis of the redox conditions leading to the observed secondary phases is underway utilizing the Hch thermodynamic modeling program.