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Multiphase Waste Form Performance Evaluation: Laboratory Testing Techniques for a Wide Range of Materials

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Multiphase waste forms have become a key element in waste cleanup missions worldwide. As part of the performance evaluation of a candidate waste form, selecting appropriate characterization and durability test methods is critical to generate the empirical data for use as inputs into the development of a long-term corrosion model. This presentation will discuss the evaluation of a suite of corrosion tests common to glass and multiphase waste forms (ceramics, glass-ceramics, cermet, cementitious waste forms) and the test method evolutions brought to each technique to accommodate the heterogeneous nature of the materials and understand corrosion mechanisms at play within these waste forms.

In particular, the Stirred Reactor – Coupon Analysis (SRCA) method will be presented and discussed. SRCA is a PNNL-developed method to evaluate the corrosion behavior of material in far-from-equilibrium conditions to derive forward dissolution rate parameters. To develop a consensus standard, this test method completed an international round-robin evaluation so as to provide a precision and bias statement in 2022 and is now an ASTM International standard (ASTM C1926). The method consists of immersing monoliths of the material(s) to test in a solution at constant pH and temperature in very dilute conditions (surface area of material to solution volume ratio of 1 m^{-1} or less) for a controlled time. The material's dissolution rate is derived by measuring the surface recess between a masked area unexposed to solution and the surface of the solid exposed to solution. This surface recess measurement is performed using surface and solid characterization techniques (e.g., optical profilometry, electron microscopy).

The applicability of other testing techniques and ASTM International methods (e.g. static glass corrosion testing with powder and/or monoliths) to multiphase waste forms will also be discussed in regard to the ability to use them to quantify the release of pertinent contaminants of concern, investigate the mechanisms involved in corrosion (e.g., dissolution or diffusion controlled release from specific phases), and derive parameters to be used to inform modeling efforts for the development of a long-term corrosion model for multiphase waste forms.