Characterization of Plasma-sprayed Ceramic Coating Layers for Melting Crucible of Metal Fuels

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Metal fuels, such as a U-Zr alloy system for a sodium-cooled fast reactor (SFR), have been melted in graphite crucibles slurry-coated with a ceramic to prevent liquid melt/crucible material interactions. Slurry-coating applications in a hot cell are labor-intensive and operator-dependent, and can introduce additional waste streams. Porous slurry-coating can also be a source of melt contamination and fuel losses. Thermal plasma-sprayed coatings of refractory materials can be applied to develop a re-usable crucible for metal fuel. A plasma-sprayed coating can provide a crucible with a denser coating layer, compared with a more friable coating layer formed by a slurry-coating. The melt penetration of a U-Zr alloy system through a protective layer is more difficult in a dense coating than in a porous coating.

In this study, candidate ceramic coating materials on the melting crucible have been selected through a literature search as promising candidate coating materials to prevent chemical reactions and the formation of reaction phases. The characteristics of plasma-sprayed ceramic coating layers such as the microstructure and contact state have been investigated for a melting crucible of metal fuels. Thermal cycling tests have been conducted to investigate the reusability of a plasma-sprayed coating crucible.

Keywords: Plasma-sprayed coating, Ceramic coating layer, Melting crucible, Metal fuel