Freeze-Casting as a Novel Manufacturing Process for Fast Reactor Fuels

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ABSTRACT

Advanced burner reactors are designed to reduce the amount of long-lived radioactive isotopes that need to be disposed of as waste. The input feedstock for creating advanced fuel forms comes from either recycle of used light water reactor fuel or recycle of fuel from a fast burner reactor. Fuel for burner reactors requires novel fuel types based on new materials and designs that can achieve higher performance requirements (higher burn up, higher power, and greater margins to fuel melting) than yet achieved. One promising strategy to improve fuel performance is the manufacture of metal or ceramic scaffolds that are designed to allow for a well-defined placement of the fuel into the host, and this in a manner that permits greater control than that possible in the production of typical CERMET fuels. The proposed research focuses on the design and manufacture of such novel fuel types. The chosen manufacturing route is *"freeze-casting", a form of directional solidification processing* also known as *"ice-templating,"* which ideally lends itself to the processing of both metals and ceramics and enables us to establish and explore a range of flexible and controllable fuel pellet designs. Two new fuel pellet designs will be examined: (1) metal honeycomb structures as the basis of a CERMET fuel or a purely metallic fuel and (2) ceramic honeycomb structures as the basis of an inert matrix fuel (IMF) form or a form for containing isotopes targeted for geologic disposal.