Fabrication of UN-Mo CERMET Nuclear Fuel using Advanced Manufacturing Techniques

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Ceramic-metallic (CERMET) nuclear fuel consist of ceramic fuel particles embedded in a metal matrix. The interest in CERMET fuel originates in the search for a fuel suitable for use in high temperature reactors, like those proposed for deep space exploration. The required fuel properties therefore include a high thermal conductivity, chemical stability at high temperatures, and compatibility with hydrogen coolant. Efforts to conventionally fabricate CERMET fuels were extensive under a number of programs started to enable nuclear thermal propulsion (NTP). Recently established advanced manufacturing techniques now create a unique opportunity in CERMET fuel design, including the ability to push beyond previous geometrical limitations. This work demonstrates the use of Binder Jet 3D printing and Spark Plasma Sintering (SPS) to fabricate a composite UN-Mo fuel pellet with uranium nitride microspheres geometrically placed and completely encased in the molybdenum. These results demonstrate the ability to spatially place fuel within a metal matrix, providing a new blueprint for fuel design which will have lasting impact on the future of nuclear fuel development.