Oklo, Inc.
partnered with
Idaho National Laboratory

NE-20-23491, Addressing Gaps in Legacy Data on Fuel Steel Interactions

YEAR AWARDED: 2020

TOTAL PROJECT VALUE: $500k (DOE: $400k, Oklo: $100k)

STATUS: Completed

PRINCIPAL LAB INVESTIGATORS: Dennis Keiser (INL), John Hanson (Oklo)

DESCRIPTION: Oklo Inc. is a privately funded advanced fission technology developer of Aurora, a MW-scale commercial compact fast reactor that will use recycled high-assay, low-enriched uranium (HALEU) fuel originally fabricated for the Experimental Breeder Reactor-II (EBR-II). Fuel-clad chemical interactions (FCCI) between metallic fuel (e.g., U-10Zr) and stainless-steel claddings at relatively high temperatures pose one of the major limits to allowable peak temperatures and burnups in fast reactors using these materials. The work under this GAIN voucher addresses the specific challenge of understanding FCCI that result from the past focus on a particular fuel design. Current state-of-the-art fuel performance modeling cannot fully separate the entangled effects of temperature ranges, burnups, materials, and geometries. To broaden the understanding of FCCI, Oklo partnered with Idaho National Laboratory (INL) to conduct an out-of-pile experimental investigation into FCCI behavior that addresses each of these variables in order to expand the operating envelopes to better align with the Aurora reactor as well as other advanced concepts.

BENEFIT: Currently, the most viable path for licensing a design using this material system is to take significant conservatisms and stay within the operating conditions for which legacy data exists. The current state of the art of fuel performance modeling cannot fully separate the entangled effects of temperature ranges, burnups, materials, and geometries. The proposed solution was to conduct additional experiments and provide targeted data to support the licensing of new reactor designs, which will allow reactor developers to reduce conservatisms they must now take to avoid FCCI.

IMPACT: In the near term, this project will better quantify the operating margins of Oklo's reactor designs in their license reviews. In the longer term, it will allow metallic-fueled fast reactors to operate at higher temperatures and powers, improving the economics and greatly expanding the addressable market.

SIGNIFICANT CONCLUSIONS: The main results of this work show that relatively thin diffusion layers form at the fuel-cladding interface during anneals at 650 and 700°C, when as-cast fuel is mated with Type 316 SS cladding. The presence of a Zr-rich layer in the interdiffusion zones helps impede both overall fuel-cladding interactions and the penetration of Ce and Nd into the cladding.

NEXT STEPS: A complete test matrix and summary of key interest conditions will be developed in conjunction with the metal fuel experts at INL.