Thermal Conductivity Measurement of Irradiated Metallic Fuel Using TREAT

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Program: FC-2.5

ABSTRACT:

With increased interest in metallic fuels from the Advanced Fuels Campaign (AFC) program, and especially the Versatile Test Reactor (VTR) program, it is essential to have thermal conductivity data for irradiated fuels at different burnups to assess fuel performance and safety margins. However, there is a critical knowledge gap in irradiated U-Pu-Zr fuel thermal conductivity. This project intends to (1) provide accurate thermal conductivity and thermal diffusivity data with microstructure characterization of U-Pu-Zr fuels as a function of burnup, and (2) attain fundamental understanding of the thermal conductivity of the irradiated fuel to inform and validate computational models. The specific objective of this project is to measure irradiated U-Pu-Zr fuel thermal conductivity and diffusivity using an innovative thermal wave technique in TREAT, using its power shaping capability and versatile irradiation test vehicle, Minimal Activation Reusable Capsule Holder (MARCH). U-Pu-Zr fuel samples are selected from historical EBR-II experiments covering the full range of burnup levels. The novel, first of its kind measurement technique relies on the phase delay of temperature fluctuation outside fuel cladding to determine fuel thermal conductivity and diffusivity. The research tasks include: (1) sample preparation, (2) pre- and post-transient sample characterization, (3) experiment design and prototype testing, (4) TREAT experiment, and (5) data analysis and model development. The samples, experimental infrastructure, and PIE capability are available at the Idaho National Laboratory. The project team is best positioned to execute the project as the PIs have significant experience in thermal wave techniques and EBR-II fuels, and are leading current TREAT experiments. This proposed project will not only provide thermophysical properties of irradiated U-Pu-Zr fuels, but also create a new approach of using a transient reactor for property measurements of irradiated, intact fuel rodlets.