Microstructure Experiments-Enabled MARMOT Simulations of SiC/SiC-based Accident Tolerant Nuclear Fuel System

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ABSTRACT:

In the recent years, replacing the current Zr alloy-based cladding with silicon carbide composites has gained traction in the DOE as well as in the industry. A small thermal neutron cross-section, a remarkably low chemical reactivity and hydrogen gas generation under accident conditions, and an excellent irradiation response indicate a promising path forward for SiC/SiC composites-based accident tolerant fuel (ATF) in current light water reactors. This promise is attested by a host of research and development activities through DOE-backed programs at the national laboratories and universities, and in the industry.

The key focus of this project is to characterize steam attack, hydrothermal corrosion and radiation swelling of SiC/SiC composites-based accident tolerant fuel using a combination of experiments, microstructure evaluation and phase-field simulations using MARMOT. Central to the project is the mapping of the microstructure after steam/hydrothermal/irradiation tests through a unique non-destructive x-ray microscopy technique. This mapping allows experimentally realistic phases and microstructure to be ported to the phase-field simulations. MARMOT will track the evolution of microstructure and chemical transport under normal/accident conditions followed by validation against experimental results.