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## Mechanistic Understanding of Radiolytically Assisted Hydrothermal Corrosion of SiC in LWR Coolant Environments

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**Program:** FC-2.3 Damage and Failure Mechanisms for SiC/SiC Composite Fuel Cladding and Mitigation Technologies

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### ABSTRACT:

SiC is a highly promising material for many applications in nuclear reactor systems. For instance, over the past few decades it has been successfully demonstrated that SiC is a stable and suitable material for tri-structural isotropic fuel and high-temperature gas reactors. In recent years, SiC has also become the focus of extensive research for accident tolerant fuel cladding in light water reactors (LWRs). Development of SiC<sub>f</sub>/SiC composites (or SiC ceramic matrix composite, CMC) to meet all the requirements of reactor environments is challenging, and the main need is the resistance of SiC-based materials to hydrothermal corrosion in LWR coolant environments. While water corrosion of SiC has been studied in other contexts, issues that are unique to the reactor environment are the effects of radiation and of specific water chemistries encountered in LWR environments on hydrothermal corrosion of SiC. These phenomena are still poorly understood.

*The objective of this project is to develop a mechanistic understanding of the hydrothermal corrosion behavior of monolithic SiC and SiC/SiC composites in LWR environment under the influence of water radiolysis products and radiation damage.*

This project will focus on the radiation and radiolysis effects of SiC hydrothermal corrosion on chemical vapor deposited (CVD)  $\alpha$ - and  $\beta$ -SiC variants. Specifically, long-term post-irradiation exposures on neutron and ion irradiated samples will be conducted in the LWR temperature regime to evaluate the effect of damage on corrosion kinetics. The effects of water chemistry and radiolysis products on hydrothermal corrosion will be evaluated via *in-situ* irradiation-corrosion experiments. Extensive post-test characterization will be performed to determine the dissolution rate of the samples, surface morphology, surface chemical composition and depth profile of SiC from the surface, etc. Activation energies will be determined by fitting dissolution rates to simple empirical relations. Complementary atomistic simulations will be carried out to determine the rate controlling mechanisms for dissolution under different water chemistries and in the presence of radiation. Activation energies and kinetic rates will be calculated directly from these simulations and they will be compared to experimentally fitted values. The dissolution rate constants determined and validated in this integrated experimental and modeling approach will allow predictions of long-term corrosion behavior of SiC can be predicted.