Exceptional Radiation Stability of Advanced SiC/SiC Composites

Silicon carbide fiber-reinforced silicon carbide matrix (SiC/SiC) composites are a relatively new class of structural materials that are attractive for fusion energy blanket components due to their outstanding thermo-mechanical / thermo-chemical performance and the inherent low activation/low decay heat properties. However, tolerance of these materials to the harsh nuclear environment had only been demonstrated for relatively low neutron damage levels. In a recent study performed at ORNL, advanced SiC/SiC composite specimens were irradiated in High Flux Isotope Reactor to neutron fluence in excess of 40 displacement-per-atom (dpa), a fluence level approaching that which these materials will see in the blanket region of fusion power reactors. The post-irradiation evaluation of these materials revealed no degradation in mechanical properties, indicating lack of apparent irradiation effects on strength of the matrix, fiber reinforcement, and the fiber-matrix interface. Moreover, it was found that other known irradiation effect phenomena for SiC, including swelling, thermal conductivity, Young's modulus, do not undergo progressive evolutions beyond the marginal change that occurs by a few dpa. This study thus demonstrated the general lack of irradiation effects after fission neutron exposure to at least 40 dpa at 800°C on mechanical properties and swelling of an advanced SiC/SiC composite, proving it an exceptionally radiation-stable structural material.