Effects of High Temperature Neutron Irradiation on the Structure of Graphite

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Graphite has many uses in the nuclear industry, as both a high-temperature structural material and a neutron moderator. The exposure to neutron damage results in changes to the bulk physical properties and the microstructure. In much of the current research, the irradiation temperatures that have been studied are in the temperature range of 300-900°C, but there are systems where the graphite will be exposed to even higher temperatures. One such system is the prismatic gas-cooled reactor, where the fuel will be located within the graphite and the graphite could be exposed to temperatures upwards of 1200°C. As such, it's necessary to investigate what changes will occur in graphite at these conditions. The High Temperature Vessel (HTV) irradiation was performed at Oak Ridge National Laboratory (ORNL) in the High Flux Isotope Reactor (HFIR), which was designed to irradiate graphite specimens at ~900°C, ~1200°C or ~1600°C to a damage level of ~3.3 dpa. Six grades of graphite with a range of filler particle sizes were included in this experiment. The microstructure features of these grades are being investigated to provide an understanding of how irradiation modifies the graphite structure, and how these changes compare to the changes at lower irradiation temperatures. This work will present the results on the effects of irradiation on the graphite crystallinity (measured via X-ray diffraction), and the development and change of pores smaller than 300 nm (via N_2 adsorption), and these results will be compared to results from the same grades, but from lower irradiation temperatures to determine if there are any similarities or differences for changes at these extreme temperatures.

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