Using gas adsorption for probing defective surface structures in neutron irradiated nuclear graphite

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Nuclear graphite is a major component of high temperature reactors, serving as moderator, reflector, and structural element. In the aggressive environment of the reactor core, graphite undergoes structural changes which a reflected on its dimensional stability, thermal and mechanical properties, porosity and creep behavior. These changes must be known, and their effect must be evaluated for each new grade of nuclear graphite. Gas adsorption is useful not only for quantifying pore development (< 300 nm), but also for understanding structural modifications which may result in crystallite fracturing, splitting, and deformation. High resolution gas adsorption isotherms were measured for several grades of un-irradiated and neutron-irradiated graphites at fluences before and after the volume turn-around. Their comparison reveals gradual shrinking of uniform, atomically smooth (basal planes) surfaces and simultaneous defect multiplication on the increase of irradiation dose. These results will help better understand the effect of neutron irradiation on graphite's surface atomic disorder and its consequences for chemical reactivity. Project funded by the U.S. Department of Energy, Office of Nuclear Energy.