I-21

Evolution and recovery of the irradiation-induced defect populations and thermal diffusivity in post self-ion irradiated, isochronal annealed tungsten

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Experimental X-ray diffuse scattering (XRDS) measurements and simulations are used to determine the densities of small, transmission electron microscopy "invisible" defects in non-saturated, self-ion irradiated, bulk tungsten (W) at room temperature. Novel defect scattering cross-section calculations are used to analyze laboratory based, "integral" XRDS measurements of irradiated W single crystals and determine separate densities and size distributions for the interstitial and vacancy-type dislocation loop populations. The evolution and recovery of these defect populations as a function of increasing isochronal annealing temperatures post irradiation are measured experimentally and initial comparisons are made to stochastic cluster dynamics simulation predictions of the irradiation-induced defect densities and size distributions upon annealing. The degradation of the thermal diffusivity associated with the measured and modeled defect populations is predicted with both a simple kinetic electron transport model and raytracing Monte Carlo modeling of electron dynamics for W crystals containing defects. These predictions are compared with experimental Transient Grating Spectroscopy (TGS) measurements of the post-irradiation degradation of the thermal diffusivity of the same W single crystals and the subsequent recovery with increasing annealing temperatures.

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