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Effects of Damage Annealing on Thermo-Mechanical Properties of High-Temperature Heavy Ion Irradiated Graphite

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Beam induced hardening and thermal conductivity degradation plays an important role in the failure of targets, beam catchers, beam windows and collimators for the new generation of high power accelerators (Large Hadron Collider, Facility for Antiproton and Ion Research, Facility for Rare Isotope Beam). Operating at high temperatures is expected to anneal significantly the radiation dam-age. The goal of this work is to investigate the effect of damage recovery on thermal diffusivity and hardening behavior of high-temperature ion-irradiated graphite by Raman spectroscopy, photo-thermal radiometry and nanoindentation. Information on ion-induced thermal conductivity degradation of materials is in general extremely scarce. We present the first experimental data on thermal diffusivity of isotropic graphite thin foils irradiated with 8.6 MeV/u 197Au ions, at temperatures up to 1600 ℃, done by innovatively using a photothermal radiometry method for this type of samples. Nanoindentation tests have been performed for following the influence of the irradiation temperature on the hardness and Young modulus of the same ion exposed graphite samples. At high irradiation temperatures, the degradation of thermal diffusivity and the ion induced hardening are less pronounced due to enhanced vacancy mobility. Our results advocate operation temperatures above 1000 ℃ for graphite targets and beam catchers.

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