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Nano-Indentation study of radiation damage induced by swift heavy ions in HOPG and polycrystalline graphite

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Operation under intense radiation damage conditions and thermo-mechanical loads is common for both targets and beam protection components for high power particle accelerators like FAIR (Facility for Antiproton and Ion Research) which is currently under construction in Darmstadt, Germany. To ensure safe operation and less frequent maintenance shut-down's related to beam catchers and targets, optimized material and design solutions are needed. Due to its low atomic number combined with very good and stable thermo-physical properties and with its high radiation hardness, graphite and other carbon based materials are possible candidates for beam dumps and targets. We used nano-indentation to characterize the radiation induced embrittlement in carbon based materials. HOPG (highly oriented pyrolytic graphite) and high density isotropic graphite samples have been exposed to 3,6 MeV/u 197Au25+ and 4,8 MeV/u 238U29+ ion beams at the M-branch facility using fluxes of 5e8 ions/cm²s up to 2e10 ions/cm²s, at the UNILAC accelerator at GSI. Typical pulse lengths for 197Au25+ were 5ms @ 30Hz - 50Hz and 500µs @ 0,1JHz - 2Hz for 238U29+. Fluences between 1e11 ions/cm² and 5e13 ions/cm² were achieved. A general increase of young modulus and surface hardness with increasing ion-fluence can be observed for both HOPG and isotropic polycrystalline graphite samples.

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