Contribution ID: **25387** Type: **Poster**

Evaluation of microstructural evolution of glassy carbon induced by helium implantation and annealing

Tuesday, 4 November 2025 13:44 (1 minute)

The effects of helium ion (He+2) implantation into glassy carbon (GC) were systematically investigated. He+2 ions with an energy range of 17 keV were implanted into GC to fluences of 10^{16}, 10^{17}, and 10^{18} cm-² at room temperature (RT). The as-implanted GC samples were subsequently vacuum annealed at 300 °c, 500 °c, and 800 °c for 1 hour. The structural evolution of GC was characterized using Raman spectroscopy and transmission electron microscopy (TEM). A fluence-dependent trend in displacement per atom (dpa) and He concentration was observed. Raman spectroscopy revealed progressive structural disorder and amorphization at fluences of 10^{17} and 10^{18} cm-², marked by merging and redshifts of the D and G peaks, indicating tensile strain in the carbon matrix. Partial recovery of D/G peak separation and crystalline order was observed, especially at 800 °c for the 10^{16} cm-² fluence. TEM micrographs showed a confined damaged region of about 130 nm, with distinct defect aggregation towards the bulk for fluences of 10^{16} and 10^{17} cm-², whereas the defect aggregation appeared in two channels for the fluence of 10^{18} cm-². At a fluence of 10^{17} cm-², nonlinear dispersion and saturation effects were observed. Overall, annealing facilitated partial microstructural recovery, particularly for samples with fluences of 10^{16} and 10^{17} cm-² at 800 °c.

Technical Track

Fuel Cycle and Waste Management

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Session Classification: Poster