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Symposium O: Ion Beam Synthesis and Processing of Advanced Materials

FORMATION AND EROSION OF WC UNDER W⁺ IRRADIATION OF GRAPHITE

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The present choice of plasma-side materials in thermonuclear fusion devices includes carbon as a divertor and W as cladding for the first wall. Eroded W atoms will, therefore, be transported onto the divertor plates and modify the carbon surface.

Modifications of carbon by W ion implantation have been investigated by weight change measurements, ion beam analysis, and X-ray photoelectron spectroscopy (XPS) as functions of fluence at 100 keV and 1 MeV. With increasing fluence, the retained W amount increases until the surface concentration gets high enough to reduce W retention by self-sputtering. At room temperature, the retained W reaches a maximum and then decreases, approaching a steady state value after several oscillations. The steady state depth profile has its maximum at the surface and decreases with depth into the bulk. At room temperature XPS reveals the presence of WC inclusions. Initially, the weight of the sample increases as the weight of the implanted W atoms exceeds the weight of the eroded C atoms. As W retention reaches steady state, a continuous weight loss is observed, giving the sputtering yield of C by W ions. Results are compared with predictions of the dynamic Monte-Carlo code TRIDYN. At room temperature, all features of the computer predictions are reproduced quantitatively in the experiments.

At elevated temperatures (400-800C) the implantation profiles change. Even at small fluences the depth profiles peak close to the surface, and all implanted W is in the form of WC. The implanted W distribution broadens with increasing temperature, indicating diffusional effects, and the steady state amount is reached without the oscillatory behavior seen at room temperature. A diffusion coefficient for W in pyrolytic graphite is obtained from the fit of the experimental profiles to TRIDYN calculations.

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