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Morphology, Erosion, and Retention Characteristics of Tungsten Under Simultaneous Helium and Deuterium Bombardment

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The ITER divertor will feature tungsten monoblocks as the plasma-facing component (PFC) and will be subject to extreme temperature and radiation environments. The present research reports the development of surface morphologies on tungsten under helium bombardment at high temperatures, which has important implications for safety, retention, and PFC erosion. Polycrystalline tungsten samples were implanted in the DAISIE dual-beam ion implantation experiment at the University of Wisconsin-Madison with He-only, D-only, and a 0.1He:0.9D mixture at incidence angles of 55°, ion energies of 30 keV, and surface temperatures of approximately 900 °C. Morphologies resulting from angled incidence conditions varied from those produced under normal incidence bombardment at similar energy and temperature conditions in previous work. A variety of morphologies dependent on grain orientation were observed for fluences up to 6×10^{18} He cm^{-2}. Above this fluence, new morphologies emerged that spanned multiple grains and obscured features produced at lower fluence. Mass loss measurements indicated enhanced erosion exceeding that predicted by physical sputtering by a factor of 3. The implantation temperatures were too high to retain D, however, He retention was measured using thermal desorption spectroscopy. The total retention was reduced by a factor of 2 under simultaneous He-D implantation compared to He-only implantation to the same He fluences. Distinct desorption peaks were observed between the He-only and He-D implantations related to the morphologies that developed under D implantation.

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