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Article

Degradation of fusion reactor plasma-facing materials through surface plasma etching

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Abstract: Plasma-facing materials (PFMs) must be able to withstand conditions that are more extreme than anything naturally met on the face of the earth. Under the high particle and heat fluxes experienced in fusion plasma situations, cracking, surface roughening, blistering, hole formation, and melting have all been observed on tungsten PFMs. Degradation to PFMs in this way can lead to decreased performance in fusion reactors. Continued research and development of materials with properties that improve performance and minimise material degradation of the PFM is critical. This study compares diamond-like carbon (DLC) coatings and tungsten-doped DLC (W-DLC) coatings on pure polycrystalline tungsten substrates that have been exposed to hydrogen plasma. DLC coatings were prepared by plasma-assisted chemical vapour deposition (PECVD) with methane gas as the carbon source, in an RF plasma chamber. W-DLC coatings were prepared layer-by-layer via argon ion sputtering for the deposition of a tungsten layer between DLC layers. We present the results of coating of varying thickness that were prepared by altering the RF power, gas pressure and deposition time. The samples were exposed to a hydrogen plasma for a total of 120 hours. Changes in coating elemental composition and topography after exposure were observed by Auger and scanning electron spectromicroscopies. The thickness of each coating can be optimised to minimise degradation to tungsten PFMs, thereby improving the performance of fusion reactors.

Keywords: Plasma-facing materials; Plasma-etching; diamond-like carbon; scanning Auger; spectromicroscopy; tungsten; DLC; PECVD; plasma

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