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DEUTERIUM RETENTION IN DENSE AND DISORDERED NANOSTRUCTURED TUNGSTEN COATINGS

Three types of nano-structured tungsten (W) coatings were investigated in respect to deuterium (D) retention after the low-energy D plasma exposure. The D depth profile was measured up to 6 μm by nuclear reaction analysis (NRA) and the total deuterium retention was measured by thermal desorption spectroscopy (TDS). In the present work, we investigated (i) a dependence of the D retention in a W coating on substrate, (ii) a dependence of the D retention in a W coating on the nano-crystalline structure, namely, columnar-like or amorphous-like, and (iii) the D retention at an interface between layers. It was shown that most of deuterium is trapped in the interlayer between W coating and substrate. Consequently, the D retention in the interlayer between different materials can be a concern. It was found that all types of coatings show higher D accumulation compared to bulk polycrystalline W. The disodered W coating produced by Pulsed Laser Deposition (PLD) has highest deuterium (D) concentration compared to dense W coating produced by Combined Magnetron Sputtering and Ion Implantation (CMSII) technology and W coating produced by standard vacuum magnetron-sputtering (SMS) method. The lowest D concentration was found in SMS-W coating. No significant influence of the substrate on the D retention in coatings was found. The D retention correlates with microstructure of multilayer W coating: the D retention drastically increases with decreasing the grain size. Consequently, from point of view of the hydrogen isotope retention, coarse-grained crystals are recommended for application of W-based materials in fusion devices. At the same time, coarse-grained crystals are undesirable from point of view of blister formation under the plasma exposure. Nano-crystalline structure of W coatings suppresses the blister formation. A compromise in the development of new promising nanostructured tungsten films is necessary to keep the hydrogen concentration at an acceptable level and reducing/preventing high density of defects at the interface between nanostructured coating and substrate.