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EFFECT OF SPUTTERING ON THE SAMPLES OF ITER-GRADE TUNGSTEN PRELIMINARILLY IRRADIATED BY TUNGSTEN IONS: OPTICAL INVESTIGATIONS

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It is known that tungsten was chosen as the candidate material of the baffle and dome of the divertor of the international thermonuclear experimental reactor (ITER) [1]. These elements will be under the effect of significant fluxes of neutral particles. Therefore, the main requirement to the materials employed is their high stability to radiation damage upon the interaction with neutrons and charge-exchange atoms (CXAs), such as atoms of D and T, with a wide spectrum of energies [2]. The simultaneous action of neutron fluxes and fluxes of CXAs can accelerate the modification of the surface of tungsten as compared to the use of fluxes of only CXAs because of the presence of defects produced by neutrons in the subsurface layer. The clarification of this problem is quite important for the modern concept of the ITER construction. This paper is aimed at studying the effects of conditions that imitate those that exist in the ITER (prolonged sputtering by Ar+ ions after preliminary irradiation by 20 MeV W^{+6} ions) on the optical properties of the ITER-grade tungsten [3]. The simultaneous effect of sputtering and neutron irradiation on the optical properties of tungsten mirrors has been considered, which was simulated by bombardment by 20 MeV W^{+6} ions (dpa-damage). The action of CXAs atoms was imitated using Ar+ ions with energy of 600 eV. The dependence of the structure of the surface and optical properties of tungsten on the fluence of Ar ions has been studied using optical microscopy, interferometry, reflectometry, and ellipsometry. An analysis of experimental data made it possible to suggest a realistic mathematical model of the process of surface modification for samples of ITER- grade tungsten.

The difference between the data obtained by reflectometry and ellipsometry made it possible to relate these changes to the existence of two different scales in the surface roughness: coarse-scaled, which is felt by reflectometry, and fine-scaled, which is registered by ellipsometry. The factor that is responsible for coarse-scaled roughness is sputtering, which is equal for both irradiated and unirradiated sides of the samples. The fine-scaled roughness is due to only the preliminary irradiation by tungsten ions. Thus, the use of neutron irradiation should lead to additional processes on the surface as compared to irradiation by only CXAs atoms.

References

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