Structural and phase state of cacrbidized layer tungsten obtained in a beam-plasma discharge

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The use of tungsten (W) for areas with high ion and heat fluxes does not adequately resolve the problems accompanying interaction between plasma and divertor surface. These circumstances determine the concern in continuing to use graphite and carbon-graphite materials as plasma-faced ones. However, erosion and transport of sputtered graphite and carbon-graphite materials (C) will lead to simultaneous irradiation of W with hydrogen isotopes, C atoms, and hydrocarbon molecules, which will lead to the formation of a mixed W–C surface layer.

This paper provides research results of the structural and phase state of near-surface tungsten layers after irradiation with a methane ion beam. Based on interaction with an electron beam, gaseous methane decomposes into fragments such as H^+, H^{2+}, C^+, CH^+, CH^{2+}, CH^{3+} and CH^{4+}, which enables simulating the conditions of local transfer of C atoms along surfaces wetted by plasma by means of hydrocarbons.

The structural and phase state of the near-surface tungsten layers was researched using SEM, TEM, and XRD methods. The temperature dependence of microstructural evolution and phase transformations has been determined. Carbide phase generation was recorded after irradiation at 1000°C. Three phases of tungsten carbide (WC, W_2C and WC_{1-x}) were observed, mainly as mixtures of two phases (WC, W_2C). According to the results of microstructural analysis, it was found that presence of a carbon coating as a continuous film is observed on the sample surface during the interaction between tungsten and methane. Thermally unstable carbon film is destroyed under high temperatures and carbon is already chemically bounded forming tungsten carbide phases, as XRD results evidence.

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