RADIATION-DAMAGED TUNGSTEN IN PLASMA FLUX AT ELEVATED TEMPERATURE [[1]](#footnote-1)80

DOI: 10.34854/ICPAF.2022.49.1.024

Khripunov B.I., Koidan V.S., Semenov E.V., Muravyov S.V., Unezhev V.N., Gureev V.M., Tsvetkov A.A.

National Research Center Kurchatov Institute, Moscow, Russia.

Radiation damage of thermonuclear materials and plasma effect on them are simulated experimentally. Tungsten is the main material of the research (Plansee, Austria and POLEMA, RF) as the candidate for usage as the ITER divertor armor.

Neutron effect is simulated on the U-150 cyclotron with heavy ions accelerated to the MeV-range energies, and the damaged samples are produced so far at the high level of radiation damage in the near surface layer corresponding to those expected in thermonuclear reactor (100 displacements per atom, dpa)) in durable operation cycles of the reactor. The exposure of the irradiated samples in deuterium and helium plasmas has been performed on the LENTA facility where the plasma column is generated by an electron beam (beam-plasma discharge) in the magnetic field of 0, 15 T. The plasma performance was as follows: the plasma ion energy 250 eV, sample temperature 1000 ºС, ion current on the surface (30-80) mA cm-2, deuterium ion fluence (1,7 – 4,1)∙1021 Dion/см2. The surface microstructure changes are analyzed (SEM), erosion rate and erosion yield are measured.

The calculations of the radiation damage produced in tungsten by high-energy ions has been performed and the comparative analysis has been made of defect production characteristics for the irradiations with nitrogen and helium ions for the equal ion fluences of 1017 ion/ cm2. It was shown that the average displacement damage level is <D> = 1,5 dpa (Dmax = 10 dpa) for 30 MeV nitrogen and <D> = 0,13 dpa (Dmax = 1 dpa) for the 5 MeV helium irradiations.

Irradiations of tungsten were performed first with nitrogen ions N3+ at 28 MeV to achieve 1017 ion/cm2. The study of the irradiated materials under the plasma has shown that while the fast ion irradiation itself does not lead to the spectacular changes in the surface structure, the exposure of the irradiated material in the deuterium plasma, on the contrary, results in the significant changes of the crystal structure of the material under plasma: etching of the grain boundaries, formation of deep caverns also attached to these boundaries.

The temperature effect has been studied on the tungsten samples after irradiations with 4 MeV helium ions at 2,5∙1016 cm-2 that has been conducted at the samples’ temperature of 600 ºС. The plasma exposure was executed at the material temperature about 1000 ºС. The erosion yield of tungsten in D-plasma was measured as 8,4∙10-3 at/ion (Plansee) and 6,2∙10-3 at/ion (POLEMA). No erosion rate enhancement of the irradiated materials at the elevated temperature has been detected.

References

1. Khripunov B.I.; Koidan V.S.; Semenov E.V., **"Thermonuclear Fusion Reactor Plasma-Facing Materials under Conditions of Ion Irradiation and Plasma Flux", Symmetry, 2021, 13.**
1. 80 [abstracts of this report in Russian](http://www.fpl.gpi.ru/Zvenigorod/XLIX/Mu/ru/CF-Khripunov.docx) [↑](#footnote-ref-1)