HELIUM IN TUNGSTEN AFTER IRRADIATIONS WITH HIGH-ENERGY IONS AND WITH PLASMA [[1]](#footnote-1)\*)

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The first wall of a fusion reactor will be subjected to high fluxes of the components composing the fusion deuterium-tritium plasma and of the reaction products, namely, fusion neutrons and high-energy helium ions ((reaction D + T → 4He (3,5 MeV) + n (14,1 MeV)). Therefor the reaction itself is feeding two channels for helium generation and accumulation in the wall material. One is helium generation as the result of nuclear reactions (n, α) with the wall material. The second one is the wall bombardment by the helium ions produced in the plasma in the DT reaction. While helium ash builds up in the reactor plasma, the flux of helium ions to the wall will contain those high-energy ions and helium ions relaxed in the plasma down to energies corresponding to the plasma temperature. Tungsten is considered as the candidate plasma-facing material for the divertor coating as for the most high flux component of the fusion reactor first wall.

Experimental results are presented of helium- tungsten interactions in high-energy helium ions irradiations and in helium plasma. The study has been conducted on the experimental devices at Kurchatov Institute U-150 cyclotron and the linear plasma device LENTA.

The damaged layer depth in tungsten was obtained of 5-6 microns for 4Не++ ions at 3,0 – 4,0 MeV by calculations of the defect production and by experimental measurements (ERDA). The damaged layer erosion of irradiated tungsten and helium retention were analyzed in the deuterium plasma exposures.

Changes in the tungsten damaged layer microstructure with the development of blistering, pore production, bubble formation and evidences of the captured helium outcome during surface erosion progress in plasma exposures for the elevated radiation doses (5∙1017- 1019 Не++/см2, 1-80 dpa) have been observed. Helium concentration in tungsten at the depth of ion stopping range was measured to reach 10 %. Also, the formation of nanostructured surface was observed under helium plasma impact on tungsten at the increased temperature (1100 C) (nanofuzz). The observed phenomena evidence the considerable changes in the properties of a fusion reactor plasma-facing material which help lower the material resistance to the plasma flow during its long term operation.

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References

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1. \*) [abstracts of this report in Russian](http://www.fpl.gpi.ru/Zvenigorod/XLVII/Mu/ru/AN-Khripunov.docx) [↑](#footnote-ref-1)