Molecular dynamics simulation of high-energy helium interaction with a tungsten surface: first results [[1]](#footnote-1)\*)

DOI: 10.34854/ICPAF.2023.50.2023.1.1.250

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At present, tungsten is considered as one of the main materials for plasma-facing components (PFCs) of future fusion reactors, as ITER. During the operation of the reactor employing the DT-fuel, tungsten will be subjected to high heat loads as well as bombardment of neutrons and plasma ions, including helium. Helium irradiation of tungsten at the first stage initiates formation of helium clusters/bubbles, and then leads to the growth of nanostructured morphology known as fuzz [1].

Development of the fuzz morphology changes the thermophysical properties of the PFC (e.g. thermal conductivity [2]) and rises the probability of unipolar arc ignition [3] and surface
erosion [4]. The latter is extremely undesirable due to the risk of core plasma contamination with heavy impurities. Tungsten fuzz growth at a high potential difference between plasma and a PFC (i.g. a transition growth-sputtering regime) is of particular interest, since in this regime there is a possibility of spontaneous initiation of explosive emission pulses on a nanostructured surface. Up to date, the evolution of tungsten nanofibers has been extensively studied in the case of low-energy helium irradiation (20-100 eV) [5]. Whereas, a detailed description of the fuzz development in the growth-sputtering regime requires additional research on early stages, when clustering of helium occurs, and late phases of the fuzz formation.

The current study presents the first results on the modeling the initial stage of tungsten surface irradiation (fluence $F∼10^{19}-10^{20}$ m-2) by high-energy helium atoms. The tungsten surface with (100) orientation was investigated under typical conditions for the growth-sputtering regime of nanofibers: surface temperature $T=1000$ K, initial energy of incident helium atoms
$E=100-500$ eV. Based on the data acquired, the dynamics of helium implantation, nucleation and growth of helium clusters/bubbles was analysed. As the result, the energy release profiles of implanted atoms, depth and size distributions of helium clusters/bubbles were obtained depending on the fluence and initial energy of incident atoms. The atomistic modeling was carried out using the molecular dynamics package LAMMPS [6].

The work was financially supported by the Russian Science Foundation within the framework of project 22-12-00274. The simulations were performed using the resources of the NRNU MEPhI high-performance computing center.

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1. \*) [abstracts of this report in Russian](http://www.fpl.gpi.ru/Zvenigorod/L/E/ru/JF-Kulagin.docx) [↑](#footnote-ref-1)