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EROSION FEATURES OF TUNGSTEN SURFACES UNDER COMBINED STEADY-STATE AND TRANSIENT PLASMA LOADS

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Fusion devices slowly progress from experimental prototypes like ITER and DEMO toward power plants. Efficiency of fusion reactors is defined by a number of economical factors. One of them is lifetime of plasma-facing components (PFC). Erosion of PFC restricts the operation time of next-step fusion reactors, leads to contamination of the hot plasma by heavy impurities and can produce a substantial amount of the dust. There are few factors, which contribute to the main degradation of PFCs. Among them are: steady-state heat and particles fluxes from plasma, transient events (disruptions, Vertical Displacement Edge (VDE), Edge Localized Mods (ELMs), etc). The experimental studies of erosion plasma facing materials (PFM) in present-day fusion devices are quite problematic. Nevertheless, a number of problems related to fusion reactor PFMs should be solved during a short period of time. First of all, contribution of the steady-state and transient plasma loads to erosion of PFMs should be estimated.

Present work continues the studies of features damage of the tungsten surfaces under combined exposure. Steady-state hydrogen ion fluxes (2×10^{22} $m^{-2}s^{-1}$, $5\text{-}8\times10^{25}$ m^{-2}, average ion energy of 2 keV) were alternated with the pulsed plasma loads which were chosen below the tungsten melting threshold (hydrogen plasma streams with energy density of 0.45 MJm^{-2} and the pulse duration of 0.25 ms). Steady-state bombardment was provided by FALCON ion source, pulsed loads were performed by means of QSPA Kh-50 device. Following the exposures, the sample surfaces have been examined with an optical microscope MMR-4 equipped with a CCD and scanning electron microscopy. X-ray diffraction (XRD) has been used to study structure, sub- structure and stress state of targets. Precise measurements of the surface roughness were also performed.

Studies have revealed that symmetrical thermal residual stresses in exposed surfaces are created mainly due to pulsed irradiations. Steady-state exposure leads to annealing of both linear and complex of point defects. As result of this, residual stresses decrease. Detailed XRD studies have shown that lattice parameter increased negligibly, i.e. impurities have not been introduced into the lattice during the irradiation. The combined plasma loads result in development of tungsten surfaces roughness. Rise of surface roughness is caused by cracks appearing and growth of edges of grains on exposed surfaces.