Interaction of Powerful Plasma Streams with Castellated Structures in ITER Relevant Conditions

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Castellated configuration of the ITER divertor allows mitigation of the currents on the surface and minimization of the stresses that cause cracking of tungsten under the transient high heat loads such as disruptions and ELMs. However, castellated edges of macro-brush armor elements can be a dominating source of the molten/solid dust particles which are injected into the surrounding plasma. Therefore, specific features of the edges erosion for castellated geometry of exposed surfaces need to be comprehensively studied both in corresponding simulation experiments and with predictive numerical simulation.

Experimental simulations of ITER transient events with relevant surface heat load parameters (energy density 0.3-2.4 MJ/m\textsuperscript{2} and the pulse duration of 0.25 ms) as well as particle loads (varied in wide range from $10^{23}$ ion/m\textsuperscript{2} s to $10^{27}$ ion/m\textsuperscript{2} s) were carried out with a quasi-stationary plasma accelerator QSPA Kh-50.

Specific features of the edges erosion for castellated targets are comprehensively studied. The targets that combined in brush-like geometry were irradiated under different inclination angles. In the course of exposures, the mountain of molten material appears on the edge of castellated targets. The onset of particles ejection both in the form of droplets and solid dust from the exposed castellated targets has been determined with high speed imaging. It is shown that particles emission has a threshold character and the cyclical nature, i.e. it begins only after a certain number of irradiating pulses when the mountain of shifted molten material is developed on the edges of castellated structure. Formation of resolidified bridges through the gaps of brush-like targets due to the melt motion is studied in dynamics. With following plasma impacts such bridges became an additional source of W dust.

Roughness of exposed surfaces is developed due to surface modification effects and formation of cracks patterns on the surface. X-ray diffraction (XRD) has been used to study the micro-structural evolution and induced stresses for the exposed targets.