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ITR/P1-26: Analysis of Tungsten Dust Generation under Powerful Plasma Impacts Simulating ITER ELMs and Disruprions

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In this paper, experimental simulations of ITER transient events with relevant surface heat load parameters (energy density 0.45-1.1 MJ/m2 and the pulse duration of 0.25 ms) as well as particle loads (varied in wide range of 1023-1027 ion/m2 s) were carried out with a quasi-stationary plasma accelerator QSPA Kh-50. Particular attention is paid to the material erosion due to particles ejection from the tungsten surfaces both in the form of droplets and solid dust. The erosion products flying from the tungsten target have been registered using high-speed 10 bit CMOS digital camera. Traces of particles ejected from the tungsten surface allow calculation of the particles velocity and the time moment when it started from the target surface. Additionally the mass loss of the target was measured after several shots. Erosion products ejected in the form of droplets and solid dust were also collected and examined with microscopy. Several mechanisms of dust generation under the transient energy loads to the tungsten surfaces have been identified. Dust particles with sizes up to tens microns are ejected from the surface due to the cracking development and major cracks bifurcation. Fatigue cracks after a large number of transient impacts to the preheated W surface became a source of smaller dust. Surface modification of tungsten material after the repetitive plasma pulses with development of ordered submicron cellular structures contributes significantly to the nm-dust generation. It is shown that majority of generated dust nano-particles, generated due to cells evolutions, are deposited back to the surface by a plasma pressure, in contrast to micrometer-size dust. For plasma exposures with energy loads above the melting threshold both droplets splashing and solid dust ejection is observed. Analytical estimations of dust production rate have been performed, and the results are verified with experiments in plasma guns having typical for ITER ELMs.

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