Droplet and vapour erosion of tungsten under intensive plasma loads

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During transient events in ITER (ELMs and disruptions) plasma heat loads with duration
t = 1-3 ms are expected to be up to Q = 80 МJ/m2 [1], which is higher than the melting threshold of tungsten and beryllium armor.

Intense heat loads will cause erosion of plasma-facing components, droplet emission and metal vapor formation. Impurity injection leads to energy losses by radiation, in addition, erosion reduces the lifetime of the components and promotes accumulation of metal dust in the vacuum vessel [1]. To validate numerical simulation and theoretical models [2, 3], experimental data about erosion products and materials behavior under intense plasma loads is required. Obtaining such experimental data was the primary goal of the described study.

Experiments were carried out on pulsed plasma facility MK-200UG. Heating powers of incident plasma flow, heat-flux factor (F = Q/t0,5), ions energy, plasma density and pressure provided by MK-200UG are close to those expected in ITER transients conditions [4].

The tungsten target was exposed by hydrogen plasma with a pulse duration of 25 µs, energy density up to 2-2.5 MJ/m2 and ions energy ≈ 1,5 keV. Plasma – target interaction occurred in 1.5 T longitudinal magnetic field.

The data obtained shows that within energy density range from 1 to 2 MJ/m2 and with a pulse duration of 25 µs a luminous layer formation near the target surface takes less than 1.5 µs. The luminous layer can be observed during all hydrogen plasma flux duration. The presence of magnetic field restricts vapor plasma movements across field lines. Isotropic droplet emission from the target surface was detected, droplet velocity assessed as vdr ≈ 5 – 10 m/s.

References

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