

Influence of Magnetic Field on Plasma Energy Transfer to Material Surfaces in ELM Simulation Experiments with QSPA-M

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Features of plasma energy transfer to the material surfaces during the plasma-surface interaction in presence of strong magnetic field are investigated within recently developed quasi-stationary plasma accelerator QSPA-M. This novel PSI test-bed facility is able to reproduce the ELM impacts, both in terms of heat load and particle flux to the surface, and to provide plasma transportation in external magnetic field, which mimics the divertor conditions. Investigations of energy transfer to the material surface have been performed for varied plasma heat load and external magnetic field value. Calorimetry, optical emission spectroscopy and a high speed imaging were applied for PSI characterization.

For perpendicular plasma incidence, it has been shown that the transient plasma layer is formed in front of the surface by stopped head of plasma stream even for rather small plasma heat loads, which not resulted in surface melting. The plasma density in this near- surface layer is much higher than in the impacting stream. It leads to the arisen screening effect for the energy transfer to the surface. For $B=0$, the thickness of screening layer is less than 2 cm, but it increases up to 10 cm when $B= 0.8$ T. Reducing the size of the target leads to growth of the fraction of plasma energy, which is absorbed by the surface.

For plasma exposures of tilted target surfaces, the thickness of transient plasma layer is found to be essentially non-uniform. It is maximal for downstream part of the target while the upstream surface area remains completely unprotected. The impacting plasma shifts significantly the screening layer along the surface and also generates oblique shock wave from the protruding edge. This shock wave together with available shift of plasma layer along the target provides an additional shielding for the downstream part of the exposed surface. The important contribution of external magnetic fields to the plasma energy transfer to the material surfaces is also discussed. It has been found that presence of strong external magnetic field leads to decrease of the energy, which is transferred to the exposed surface, due to the growing plasma density in near- surface layer and its increasing thickness.

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