THEORETICAL MODELING OF WALL PLASMA IN PULSED SIMULATION OF THERMAL LOADS OF ITER TUNGSTEN BY AN ELECTRON BEAM BETA [[1]](#footnote-1)\*)

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It is impossible to reproduce all the factors of the influence of plasma, radiation and neutron fluxes on existing facilities. Pulsed thermal loads are one of the main wall-destroying factors in future thermonuclear reactors according to modern concepts, therefore, the BETA facility was developed at the BINP to reproduce heat flows to the wall. It is possible to pulse heat the sample using an electron beam or laser radiation, conducting in-situ diagnostics of the destruction of the sample. It was found that when heated to high temperatures, rotation of the melt was observed, which could not be explained easily. In particular, the beam current in the leading magnetic field created a Lorentz force that could not accelerate the melt to the observed velocities.

Earlier[1] it was shown that on BETA it is possible to achieve a cooling by evaporation mode, when, despite the continued heating, the surface temperature no longer increases, since the heat removal from the surface by evaporating becomes commensurate with the incoming energy flow. It has been shown that in this mode, the evaporation rate stops growing, so the development time of vapor shielding increased.

In the presented paper, we analyze what can happen in the model of the evaporation cooling mode with near wall evaporated gas. It is shown that even without taking into account the additional heating and ionization of the gas by the electron beam, saturated vapor is plasma. It is shown that plasma in the evaporation cooling mode at the BETA facility can be considered collisional, not magnetized, not degenerate, weakly non-ideal. It is shown that conditions are created for the formation of closed currents flows around the inhomogeneity of heating through near wall plasma and dense tungsten. The total current obtained by integrating the inhomogeneous current density in the model turns out to be much larger than the beam current that created the heating inhomogeneity. Refinement of the model may lead to the explanation of the observed rotation by a closed current on the inhomogeneity of heating to high temperatures by a power flow penetrating through the vapor layer.

The effect under study does not imply the peculiarities of heating by an electron beam and can be reproduced by laser radiation or a flow of high-energy particles with sufficient penetrating depth. For the presented results, a calculation with a heating power density of 10 GW/m2 was used, which corresponds to the load in ELMs, and for the development of cooling by evaporation in present conditions, it was necessary to evaporate about 10 g/m2. According to modern concepts[2], in the thermal quenching of plasma, thermal radiation flows from the plasma to the surface are expected to be sufficient to lead to melting and heating to the discussed mode.

References

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2. M. Moscheni, et. al., Nucl. Mater. Energy 25, 100824 (2020), doi:10.1016/j.nme.2020.100824

1. \*) [abstracts of this report in Russian](http://www.fpl.gpi.ru/Zvenigorod/L/Lt/ru/EY-Popov.docx) [↑](#footnote-ref-1)