NUMERICAL modeling of melt METAL LAYER motion UNDER impact OF AN INTENSE PLASMA STREAMs [[1]](#footnote-1)\*)

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Armour materials of ITER divertor and the first wall will be subjected to intense plasma-thermal impacts during the reactor operation. It is expected that extreme loads on the plasma-facing materials will occur during transient processes – plasma disruptions and Edge Localized Modes (ELMs). Heat flux factor was estimated within range 15–300 MJ/m2s0.5 during ELMs and 90–2000 MJ/m2s0.5 for disruptions. Meanwhile, melting thresholds for tungsten divertor and beryllium first wall corresponds to 50 MJ/m2s0.5 and 28 MJ/m2s0.5 accordingly [1]. Erosion processes will affect lifetime of the reactor significantly and therefore require investigation. Previous QSPA-T experiments demonstrated that the erosion of armour occurs mostly due to movement of melt layer along their surfaces [2]. So far there is no full understanding of underlying physical processes due to complexity of this phenomenon. Therefore, development of numerical models and comparison of calculation results with experiment are required.

This paper concerns developing computational model, which describes the behavior of a metal under the action of an intense plasma stream. The model is based on a system of strongly coupled heat transfer and hydrodynamics equations. To inhibit the movement of material in solid part of the domain the combination of equivalent viscosity and damping force methods is applied. Material properties are temperature dependent. The equivalent enthalpy approach is used to describe the heat capacity during phase transitions. The model takes into account the evaporation of the material. Two external factors originated from plasma influence on the material are pressure gradient and friction force. Movement of the melted metal is calculated in the presence of an external magnetic field.

Velocity and displacement of melted layer are obtained at a range of plasma heat loads. Final surface profile is considered as a result of plasma steam action at various power density and pressure distribution. It is shown that the movement of the melted metal cannot be explained only by plasma pressure gradient over the target surface confirming the conclusions in the article [2]. Metal motion simulation in the presence of an external magnetic field has been carried out. It is shown that the additional plasma friction force makes it possible to achieve better agreement with the experimental results. A circular waves structure on the surface which was found experimentally earlier [2] demonstrated by the numerical simulation. It is shown that this structure can be associated with the periodic flow of the melted metal onto the already cooled surface area.

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References

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1. \*) [abstracts of this report in Russian](http://www.fpl.gpi.ru/Zvenigorod/L/E/ru/IW-Alyab'ev.docx) [↑](#footnote-ref-1)