The Dynamics of Surface Target Layers Irradiated by Intense Charged Particle Beams

N.B. Volkov[1], A.Ya. Leyvi[1,2], K.A. Talala[2], A.P. Yalovets[1,2]

[1]Institute of Electrophysics, Russian Academy of Sciences, Ural Branch, Ekaterinburg, 620016, Russia
[2]South-Ural State University, Chelyabinsk, 454080, Russia

The intense charged particle irradiation of systems like support-films is used for material adhesion improvement as a result of layer mixing. The main mixing mechanisms are Richtmyer-Meshkov instability on the interface and thermocapillary convection. Richtmyer-Meshkov instability on the interface can cause surface mixing only in case of surface perturbations corresponding to the wave number range which is defined by irradiation regime. To research roles of the mechanisms in mass transfer mathematical model describing medium flow as a result of irradiation taking into account thermoactivated diffusion and thermocapillary convection has been developed.

In the suggested model division of hydrodynamic velocity on the potential (laminar) velocity, $\mathbf{v}^p$, and the vortex velocity, $\mathbf{v}^w$,: $\mathbf{v} = \mathbf{v}^p + \mathbf{v}^w$ $(\nabla \times \mathbf{v}^p = 0, \nabla \times \mathbf{v}^w = 0)$ is used. Continuum mechanics equations system is solved in coordinates moving with potential velocity. Thus the grid keeps its regularity in calculations with free surface and vortex flows. The authoring 2-D program was tested on known examples of thermogravitational and thermocapillary convection.

Carried out numerical researches reveal that thermocapillary convection is the main surface mixing mechanism of the irradiated target. Pulse duration should be less than characteristic heat conduction time, which is necessary for execution of convective mixing. It is shown, that the mixing zone for thermocapillary convection is 1 – 20 μm depending on the irradiation regime.

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