11th International Conference on Advanced Materials
ICAM2009
Rio de Janeiro Brazil
September 20 - 25

NUMERICAL MODELLING OF THE INTERACTION OF SPHERICAL PARTICLES WITH AN ADVANCING CONVEX SOLIDIFYING FRONT

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Abstract – In some systems a foreign particle interacts with an advancing solidifying front producing the phenomenon called pushing. In the present report results of a numerical finite element model for a system producing a convex interface is presented an compare with the case of a planar interface.

A moving solidifing front interacts with a steady solid particle in the melt producing what is normally called as pushing. When the particle has a different thermal conductivity than the solid and melt the interface could adopt a convex or concave shape if the particle has a smaller or larger conductivity, respectively.

In the present report the case of particles generating a convex interface is considered. The two main forces acting during pushing are the drag and the pushing forces. The calculations are made in a decoupled way determining first the shape of the interface then the drag force and also the pushing force. The thermal and fluid flow fields were calculated using the finite element methods assuming the system is axi-symmetric. Both, the drag and pushing forces are integrated at each step and compared until both are equal and the steady state of pushing is reached. The pushing force is integrated using the Casimir-Lifshitz-van der Waals interaction.

The steady state of pushing is characterized by a separation distance between particle and interface which decreases with the solidifying velocity. The results are compared with those obtained for the case of planar interfaces which is obtained for systems with the same thermal conductivity. As a result it is shown the reduction of equilibrium separation distance for a convex interface with respect to a planar interface which results in a larger solidification velocity for trapping.