Reduction of thermocapillary convection in a silicon liquid bridge by a non-contaminating method

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Abstract

The floating zone technique is a promising containerless method for the growth of high-quality silicon crystal under microgravity. In the absence of buoyancy driven flow, thermocapillary (Marangoni) convection induced by surface tension gradient becomes highlight and plays an important role. Some attractive methods to reduce thermocapillary convection, such as liquid encapsulatant float zone method, were suggested.

In the present work, the reduction of the thermocapillary convection in a silicon liquid bridge by a non-contaminating method is numerically investigated. The non-contaminating method is characterized by the introduction of a gas jet, which was blown tangentially over the free surface, producing a viscous shear drag opposing the Marangoni shear at the surface. Microgravity conditions are imposed to dominate the buoyancy convection. For simplicity, the free surface is assumed non-deformable. Several physical models with different temperature difference between the two solid disks and different liquid bridge length with a fixed diameter of 2 cm are taken into account. The results show that the Marangoni convection in the melt can be significantly suppressed by the gas shear drag. The degree of the flow reduction depends on the entrance gas velocity and the arrangement of the channel. It is possible to obtain an average velocity suppression of 99% by optimal choice of the gas velocity and the channel configuration.

Numerical simulation of themocapillary convection in the silicon liquid bridge with a deformable free surface is in progress.

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