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Convective Instabilities in Czochralski Model

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Instabilities are the main reason of the striation defects in crystals grown by Czochralski method (pulling crystal growth from the melt), which is widespread in crystal growth technology. The paper contains direct numerical simulation of the axisymmetric, 3D flows and linear stability analysis of the 3D instabilities in hydrodynamic (or so-called idealized) Czochralski model for buoyancy-driven and thermocapillary convection on the basis of Navier–Stokes equations (Boussinesq approach). Comparison of the nature of the buoyancy-driven and Marangoni instabilities for high and low Prandtl numbers, impact of the thermal boundary conditions on the melt surface and overview of the critical Mn and Gr numbers for the parameters of the benchmark configuration are done. Possibilities for control of the temperature oscillations in the melt are discussed. This work was supported partly by the Ministry of Science and Technology of the Russia and by grant RAS Parallel computing using multi processor computational systems and the work of NVN – by RFBR grant 02-01- 00492.

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