Abstract_

Since several decades crystal growth technology provides an important basis for many industrial branches. Especially, the demand on special oxides, i.e. rare earth scandates (ReScO3, Re = La,Ce, Pr,Nd, Sm,Eu, Gd, Tb,Dy), is very high. Beside the experimental challenges due to high operating temperatures (about 2000°C) and other problems like thermal stresses and chemical purity, the main problem during the Czochralski (Cz) growth of rare earth scandates is the tendency to spiral growth, which decreases the yield. Reasons for the initiation process of the spiral crystal growth has been investigated, while the main hypothesis was that heat and momentum changes in the melt are initiating this unwanted process of spiral growth. High melting point makes experimental approaches non-trivial and therefore, it was mandatory to apply numerical analysis of hydrodynamical instabilities in the melt. The applied code is fully parallelized and could be run on a super computer with a total performance of 10 Tflops. In order to numerically model the realistic crystal growth of rare earth scandates the most important physical properties of the DyScO3 melt (melting point, density, viscosity, surface tension) has been determined experimentally. Direct numerical Simulation (DNS) has been applied, "stability diagrams" have been calculated and oscillatory states analysed. It could be shown that multiple solutions are possible. Therefore, the solution structure has been analysed intensively applying continuation and bifurcation techniques, respectively, which is novice in numerical simulation of the Czochralski crystal growth processes. Also Hopf-bifurcation points as origin of periodic orbits could be detected. The continuation diagrams had shown a multiplicity for realistic crystal rotation rates (10..20 rpm) and this knowledge can be useful for the crystal grower.