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Numerical investigation of factors affecting the shape of the crystal-melt interface in edge-defined film-fed growth of sapphire crystals

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Abstract

Numerical modeling is used to investigate the shape of the crystal-melt interface in edge-defined film-fed growth (EFG) of large size sapphire rods and sheets. The present analysis shows that the temperature distribution in the meniscus is significantly affected by the internal radiative exchanges in the sapphire crystal. 2D axisymmetric computations performed in the case of sapphire rods, show a concave shape of the interface for opaque crystals, and a convex shaped interface for semi-transparent crystals. The temperature gradient across the meniscus increases significantly in the case which accounts for the internal radiative effect in the crystal. Large temperature differences along the free surface of the meniscus generate intense Marangoni flow, which can influence the shape of the growth interface. In this case, the meniscus height increases, producing instabilities in the growth process. The effect of die geometry on the interface shape is analyzed by increasing the angle between the working edges of the die. Computations shows that the interface curvature decreases as this angle increases, but the solidification isotherm moves up, leading to an increased meniscus