Effect of unsteady melt flow features on the melt/crystal interface shape and thermal stresses in Cz Ga_2O_3 crystal growth

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Gallium oxide is a wide-bandgap material with unique properties, which has a potential to reduce the manufacturing cost of high-power electronics. In order to achieve higher performance and lower cost of devices based on gallium oxide, it is critical to increase the diameter and to reduce defect density in Ga_2O_3 substrates. Increase of crystal diameter in Cz process is accompanied by the increase of melt volume and intensification of the melt flow, which may have a significant effect on the melt/crystal interface shape, and thermal stresses. The thermal stresses, in turn, are the driving force for generation of defects and dislocations in Ga_2O_3 crystals. Therefore, optimization of melt/crystal interface shape and control of thermal stresses is an important challenge in crystal growth process optimization.

In present work 3D unsteady computation of the melt flow using LES approach and anisotropic sub-grid scale turbulence model has been used for calculation of unsteady melt flow and for analysis of the effect of unsteady melt flow features on the melt/crystal interface shape. Calculated interface shapes have been used for computation of thermal stresses taking into account anisotropic elastic properties of the crystal, and effect of the unsteady melt flow features on thermal stresses is discussed.