Coupled thermal-solidification process simulation of sapphire growth

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In this work coupled thermal-solidification simulations of sapphire growth in single-boule furnaces with Heat Exchange Method (HEM) are presented. The heat transfer in the furnace is modelled via ANSYS Fluent® by considering: 1) heat conduction and radiation in furnace, 2) heat conduction, laminar convection and radiation in sapphire melt, and 3) heat conduction and internal radiation in sapphire crystal. The crystal growth is modelled by the enthalpy-porosity approach. The physical models used in the sapphire growth simulations are validated by using a temporal series of measurements in the real furnace geometry, which capture the crystal-melt interface position during the technological growth process. For the studies of the effect of different side and top heater powers on the movement of the crystal-melt interface during the growth process, a simplified furnace geometry is considered. A main focus is put on the possibilities for upscaling the sapphire crucible dimensions (height and width) to make the process more efficient and to be able to produce larger wafers.