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Optimization of high purity germanium (HPGe) crystals growth rate through the simulation and modeling of growth system geometry[1]

JAYESH GOVANI, DONGMING MEI, GUOJIAN WANG, GANG YANG, Physics Department, University of South Dakota, Vermillion, SD 57069 U.S.A — The growth rate and quality of high-purity germanium (HPGe) single crystals depend largely on the control of the thermal field such as the temperature profile and heat transfer. The control parameters of the thermal field can only be regulated externally through the growth system geometry, hydrogen and argon gas pressure, flow rate, pulling rate, and power and frequency of a RF heater. Since quantitative determination of the control parameters is exceptionally challenging and expensive, computer modeling and simulation of C_Z growth processes play an imperative role in the advances of innovative pulling procedures and augmentation of Ge crystal quality. We present a detailed modeling and simulation study of radial and vertical temperature gradient, radial and vertical heat flux, temperature profile, thermo-elastic stresses, and defect density analysis for different crystal positions and diverse growth system geometry. We also virtually studied the consequences of targeted growth rate on temperature gradient and induction heating. A comparative analysis of simulated and available experimental results is also presented. In this effort, we have demonstrated the importance of simulation and modeling as it helps reducing the number of growth experiments significantly for the optimization of crystal quality and targeted growth rate.

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