A SHARP-INTERFACE NUMERICAL MODEL FOR DENDRITIC SOLIDIFICATION WITH CONVECTION

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Dendritic solidification of binary alloys in the presence of thermosolutal and shrinkage-induced convection is numerically investigated using a newly developed sharp-interface two-dimensional model. The model based on the Finite Element Method, works directly with physical variables and properties. It solves the coupled energy and solutal concentration equations and the Navier-Stokes equations while tracking the solid-liquid interface explicitly using marker points. The energy equation is solved on a fixed mesh over the whole domain consisting of solid and liquid phases, while the concentration and Navier-Stokes equations are solved on an adaptive mesh covering only the liquid phase. The adaptive mesh conforms to the interface and is regenerated at each time step as the interface evolves. The Navier-Stokes equations are solved using the fractional-step method.

Simulations are conducted to study the individual and combined effects of thermosolutal and shrinkage-induced convection on dendrite growth and solutal microsegragation for both equaxial and directional solidification. Results show a significant effect of convection in the solidification process.

In this presentation, the model structure, its unique features and efficiency are discussed. Results under different solidification conditions are presented.