CONVECTION MODELING IN DENDRITIC SOLIDIFICATION

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Modeling of solidification processes has been a very active field of research over the past ten years, and is likely to remain so in view of the fact that producers of cast metals still struggle with all kinds of macrosegregation defects. Many of these defects can be linked directly to convection in the castings during the solidification process, which makes the accurate simulation of the viscous incompressible flow taking place in the casting an essential part of the modeling effort.

Two different types of models can be found in the literature depending on the length scales associated with the type of segregation to be modeled and the castings of interest. The first are generally known as Mushy Zone models and are used to simulate segregation in castings with dimensions on the order of centimeters to meters, where it is not possible to resolve the growth of the individual dendrites, and the scale of the segregation defects is on the order of millimeters or larger. In this models, the major issues involving incompressible flow are the accurate modeling of the flow induced by the step change in density during phase change and the efficiency, or lack thereof, of current computational algorithms. The second type of models, attempt to describe the microscopic features in the process and simulate the growth of individual dendrites together with the associated microsegregation. Convection at this scale is also known to have a strong effect in the final material properties, and although models that include convection at this level have been developed in the past years, these models are rather limited and much remains to be understood about how convection interacts with dendritic growth.

In this presentation, an overview of the two types of models is given. The advantages and drawbacks of the currently available models are discussed, and an outlook into future advances in the field is offered.