

8th International Conference on Physical and Numerical Simulation of Materials Processing (ICPNS)

14–17 October 2016

Seattle, Washington | Hosted by Purdue University

SESSION 2: SOLIDIFICATION AND CASTING, SALON B

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SATURDAY, OCTOBER 15, 2016

The permeability and flow field in the mushy zone during solidification under ultrasonic treatment

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ABSTRACT

The dendrite model, which was derived based on phase field simulation result, was chosen to obtain a series of images of the dendrite's cross-section along the height direction. The images were then black–white–binary processed and reconstructed to reveal the 3D morphology of the dendrite. The relationship of permeability with height, temperature, and solid fraction was calculated based on Blake–Kozeny model, which is helpful for the comparison of classical theories and experiment results later. The mushy zone which contains the dendrite and liquid was chosen to research, the meshes for calculation were generated based on the 3D morphology of the dendrite. The flow field as well as the solute distribution in the mushy zone under ultrasonic treatment was calculated using ANSYS Fluent, it is found that the tortuosity of the streamlines in liquid is apparently larger than that in the dendrite, the promotion of solute diffusion caused by ultrasonic treatment in liquid is much more effective than that in the dendrite. The fluid flow could significantly boost the solute diffusion to the melt, fluid flow is a key factor which determines the solute distribution in the mushy zone during solidification.

KEYWORDS: dendrite morphology, permeability, flow field, ultrasonic treatment