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Effect of cross-section-change induced advective flow on the primary dendrite array morphology of hypoeutectic Pb-Sb alloys during directional solidification

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ABSTRACT

The morphology and distribution of primary dendrites have been examined in Pb-2.2, 5.8 and 10.8 wt. pct. Sb alloy samples directionally solidified (DSed) in ampoules shaped like an hour-glass to examine the influence of cross-section change induced advective flow on the cellular/dendritic interface. This sample design increases the advective flow of the melt towards the array tips, as the liquid-solid interface enters the neck of the ampoule, and then decreases it as the interface exits the neck. The warm solute-rich melt flowing towards the growth front suppresses the extent of side-branching, decreases the primary dendrite spacing, and increases the primary dendrite trunk diameter as observed in the Pb-5.8 and 10.8 Sb alloys. The flow appears to suppress the formation of cells. A cellular interface growing in the Pb-2.2Sb alloy became planar as the solidification front entered the neck, becoming cellular again as it exited the neck.

Keywords:
A1. Convection
A1. Cross-section change
A1. Directional solidification
A1. Dendrites
B1. Pb-Sb alloys

1. Introduction

Ideally the primary dendrite arms in superalloy single crystal castings are uniformly distributed and all are in a <100> orientation parallel to the blade axis, without sub-grains. The molds for these castings contain ceramic cores. Solidification thus progresses through several cross-sectional changes. In addition, the helical grain selector at the bottom and the platforms at the root and the tip of the blade introduce other major section changes. Castings with grain misalignment, low angle grain boundaries, spurious grains, "slivers" and "freckles" are rejected; all these defects are believed to be related to the convection at the cross-sectional changes. Effect of convection due to cross-sectional changes during directional

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