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Stacey, Christopher and Ghods, Masood, "Effect of Solidification through Cross-Section Change on Dendritic Array in Single Crystal Castings" (2015). *Undergraduate Research Posters 2015*. 51.
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Effect of Solidification through Cross-Section Change on Dendritic Array in Single Crystal Castings

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Abstract

Dendritic single crystal turbine blades are the most critical component in a gas turbine engine. These are made by directional solidification in ceramic molds having many cross-section changes. Abrupt cross-section changes during casting are the source of casting defects, such as, freckles and spurious grains. Purpose of this study was to examine the role of convection associated with cross-section changes in producing microstructural defects. Al-7%Si alloy was directionally solidified at 11, 29 and 73 μm s^{-1} in graphite crucibles having abrupt cross-section decrease and cross-section increase to simulate solidification of turbine blades. It is observed that, (i) shrinkage flow leads to composition inhomogeneity in the vicinity of section decrease and (ii) spurious grains form after section increase. It is therefore, important to minimize convection in the melt by selecting alloy compositions which minimize the change in melt density due to composition changes occurring during solidification.