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Noah Weber
Cleveland State University

Masoud Ghods

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Spurious grain formation due to convection at cross-section-changes during directional solidification

Washkewicz College of Engineering

Student Researchers: Noah Weber and Claudine Lacdao

Faculty Advisor: Surendra Tewari

Abstract

Turbine blades are a critical component in high powered gas turbine engines. These components are directionally solidified to have a single grain orientation, which allows them to operate under high temperature and stress conditions. Spurious grain formation is a major concern when forming these turbine blades. The purpose of this study was to study the effect convection has on forming these defects within turbine blades. Two alloys, Pb-5.8%Sb (solutally unstable) and Al-19%Cu (solutally stable) were directionally solidified upward in a positive thermal gradient (thermally stable) in a graphite crucible having abrupt cross-sectional area change from 3.2 mm diameter to 9 mm diameter. In the Lead alloy after the cross-section-expansion there is no observable new grain formation. However, in the Aluminum alloy there is extensive new grain formation after the expansion.