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Application of Enthalpy Model for Floating Zone Silicon Crystal Growth

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Abstract

A 2D simplified crystal growth model based on the enthalpy method and coupled with a low-frequency harmonic electromagnetic model is developed to simulate the silicon crystal growth near the external triple point (ETP) and crystal melting on the open melting front of a polycrystalline feed rod in FZ crystal growth systems. Simulations of the crystal growth near the ETP show significant influence of the inhomogeneities of the EM power distribution on the crystal growth rate for a 4" floating zone (FZ) system. The generated growth rate fluctuations are shown to be larger in the system with higher crystal pull rate. Simulations of crystal melting on the open melting front of the polycrystalline rod show the development of melt-filled grooves at the open melting front surface. The distance between the grooves is shown to grow with the increase of the skin-layer depth in the solid material.

Keywords: A1. Computer simulation, A1. Heat transfer, A2. Floating zone technique, A2. Single crystal growth, B2. Semiconducting silicon

1. Introduction

First 2D axisymmetric global floating zone (FZ) models which considered electromagnetic (EM) field, heat transfer, shapes of the phase boundaries, and transient melt flow appeared in early 1990s [1]. These models could be used to predict such quantities as resistivity and thermal stress distributions in crystal.

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