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Mathematical modelling of the feed rod shape in floating zone silicon crystal growth

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Abstract

A three-dimensional (3D) transient multi-physical model of the feed rod melting in the floating zone (FZ) silicon single-crystal growth process is presented. Coupled temperature, electromagnetic (EM), and melt film simulations are performed for a 4" FZ system, and the time evolution of the open melting front is studied. The 3D model uses phase boundaries and parameters from a converged solution of a quasi-stationary axisymmetric (2D) model of the FZ system as initial conditions for the time dependent simulations. A parameter study with different feed rod rotation, crystal pull rates and widths of the inductor main slit is carried out to analyse their influence on the evolution of the asymmetric feed rod shape. The feed rod rotation is shown to have a smoothing effect on the shape of the open melting front.

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

1. Introduction

The floating zone crystal growth method is used for the production of very high purity silicon (Si) wafers for high power electronic devices. A modern FZ system consists of a growth chamber with inert atmosphere where a crack-free polycrystalline feed rod is melted by a high-frequency (HF) single-turn needle-eye induction coil, see Fig. 1. The open melting front is a surface at the bottom

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