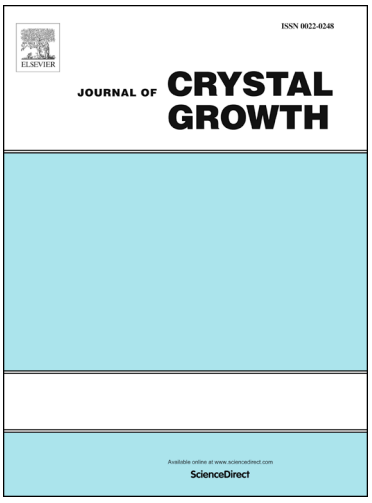

The effects of impurity on the stability of Horizontal Ribbon Growth

Jiaying Ke, Aditya S. Khair, B. Erik Ydstie

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The effects of impurity on the stability of Horizontal Ribbon Growth

Jiaying Ke, Aditya S. Khair, B.Erik Ydstie

Department of Chemical Engineering, Carnegie Mellon University

Pittsburgh, Pennsylvania 15213, USA

Abstract

This paper quantifies the effects of different operating conditions on the stability of the crystallization interface in the horizontal ribbon growth (HRG) process. Specifically, we perform a linear stability analysis of the base state, and we derive the profiles for thermal, solutal and flow fields with regard to small-amplitude normal mode perturbations of the base state. Within the velocity boundary layer induced by the removal of solid ribbon, a linear Couette flow is assumed; at the outer edge of the boundary layer, all perturbations are assumed to dissipate. Critical operating conditions and the unstable modes have been identified. To that end, we demonstrate that fast pulling velocity (greater than 100 mm/min), low wedge factors (the ratio of the length to the thickness of the wafer is less than 500), and insufficient heat removal (temperature gradient G_l is less than 200 K/cm) lead to instabilities. A finite bandwidth of wavenumber for instability occurs for all the unstable modes.

Key words: A1. Computer simulation, A1. Heat transfer, A1. Impurities, A2. Growth from melt, B2. Semiconducting silicon, B3. Solar cells

Highlights

- Linear stability analysis is performed for the Horizontal Ribbon Growth process
- Dispersion relations are derived to demonstrate unstable modes
- The marginal stability curve is computed to guide stable experimental operation