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# Dynamic instability of the steady state of a planar front during non-equilibrium solidification of binary alloys

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**Abstract**

The dynamic stability of the steady state arising during rapid solidification of a binary alloy with a planar front is examined. Earlier work (Galenko and Danilov, 2000) that was derived under the assumption of dilute solutions and linearized phase diagrams is extended and generalized to the case of non-linear phase diagrams and concentrated alloys. The present treatment confirms the validity of the earlier derived criteria for the stability of a steady state of a planar front independently of any thermodynamic model describing non-equilibrium solidification of binary alloys.

It is found that in temperature and concentration ranges where the solidus concentration increases with increasing solidification velocity, the steady state of the planar front is dynamically unstable. It is discussed how such a dynamic instability of the steady state of a solidifying planar front has an effect on its morphological stability. This is a possible explanation for the discrepancy between morphological stability theory and published experimental data (Hoglund et al. 1998) obtained from rapidly solified Si-Sn melts.

*Keywords:* A1. rapid solidification, A1. morphological stability, B1. alloys

## 1. Introduction

It is general knowledge that solidification processes with interface velocities in the order of magnitude of the diffusion velocity cannot be described by equilibrium thermodynamics. Instead, non-equilibrium effects lead to the establishment of velocity dependent solidus and liquidus lines or (hyper)surfaces that are termed kinetic phase diagrams [1, 2].

Several thermodynamic models that describe non-equilibrium effects and predict kinetic phase diagrams are documented in the literature. One of the most prominent models is the "continuous growth model" (CGM), first formulated by Cahn [3] and refined by Aziz and Kaplan [4]. This model, however, predicts

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