Dendritic growth with the six-fold symmetry: theoretical predictions and experimental verification

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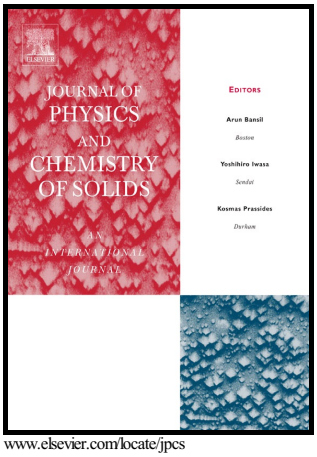

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PII: S0022-3697(16)31368-3
DOI: http://dx.doi.org/10.1016/j.jpcs.2017.04.016
Reference: PCS8043

To appear in: *Journal of Physical and Chemistry of Solids*

Received date: 28 December 2016
Revised date: 22 April 2017
Accepted date: 26 April 2017

Cite this article as: D.V. Alexandrov and P.K. Galenko, Dendritic growth with the six-fold symmetry: theoretical predictions and experimental verification *Journal of Physical and Chemistry of Solids* http://dx.doi.org/10.1016/j.jpcs.2017.04.016

Dendritic growth with the six-fold symmetry: theoretical predictions and experimental verification

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Abstract

A free dendrite growing in a pure substance is considered with the interfacial effect of anisotropy and convective flow. A stable mode of dendritic growth with the six-fold crystal symmetry is studied using the solvability theory. We demonstrate that the obtained selection criterion for a stable mode of dendritic growth is a function of surface energy stiffness, arbitrary values of Péclet numbers and convective flow intensity. To predict the dendrite tip velocity V and its tip radius R a model of dendrite growth with the six-fold symmetry is formulated. We show that the model equations can be reduced to the growth kinetics with the low Péclet numbers, which exhibit the explicit relationships "tip velocity - undercooling". The model predictions are compared with experimental data on ice dendrites grown from pure undercooled water on board of the International Space Station (under microgravitational conditions, μg) and on the Ground (under terrestrial conditions, $1g$).

Keywords: Growth models; Dendrites; Convection; Solvability theory

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