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PII: S0022-0248(15)00036-6
DOI: http://dx.doi.org/10.1016/j.jcrysgro.2015.01.015
Reference: CRYS22621

To appear in: *Journal of Crystal Growth*

Received date: 18 September 2014
Revised date: 14 December 2014
Accepted date: 13 January 2015

Cite this article as: Mohamad Reza Nasresfahani, Behzad Niroumand, Ahmad Kermanpur, Design, fabrication and testing of an apparatus for in-situ investigation of free dendritic growth under an applied electric field, *Journal of Crystal Growth,* http://dx.doi.org/10.1016/j.jcrysgro.2015.01.015

Design, fabrication and testing of an apparatus for in-situ investigation of free dendritic growth under an applied electric field

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Abstract

Modification of dendritic growth of primary phase during solidification has been a continuous quest for materials researchers during last decades. Use of electric current during solidification has been recently proposed as a suitable tool for refinement and modification of dendritic microstructures. Mechanisms by which an electric field could affect a dendritic morphology are not entirely clear as it is difficult to study the solidification phenomena during cooling. This paper reports the design, fabrication and testing of an instrument for in-situ study of the dendritic growth of transparent model materials in the presence of an applied electric field. The system consists of an isothermal bath, a growth chamber and an optical and imaging system. The structure of the growth chamber is designed to allow the growth of only a single dendrite under the applied electric field. In contrast to some previously made instruments which use two orthogonally placed cameras to take care of dendrite tilting or rotation errors, in this research a mathematical approach for calculating the actual dimensions and growth velocity of the dendrite using only one camera was suggested. This greatly simplifies the structure of the instrument. Solidification of a transparent model material, i.e. a succinonitrile alloy, was investigated as a case study under different applied electric fields using the instrument. The results of the study showed a reduction in the dendrite tip velocity in the presence of the electric field.

Keywords: Solidification; Free dendritic growth; Modification; Electric Current; Succinonitrile

1. Introduction

Dendritic growth is a common mode of crystal growth observed in most materials. Study of the evolution of dendrites and control of their growth pattern are important as they determine the final solidified