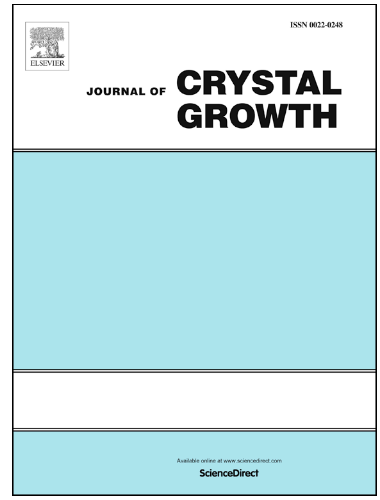
Accepted Manuscript



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PII: S0022-0248(17)30603-6
DOI: https://doi.org/10.1016/j.jcrysgro.2017.10.002
Reference: CRYS 24322

To appear in: *Journal of Crystal Growth*

Received Date: 4 July 2017
Revised Date: 26 September 2017
Accepted Date: 2 October 2017

Please cite this article as: R.P. Mooney, S. McFadden, Theoretical analysis to interpret projected image data from in-situ 3-dimensional equiaxed nucleation and growth, *Journal of Crystal Growth* (2017), doi: https://doi.org/10.1016/j.jcrysgro.2017.10.002

Theoretical analysis to interpret projected image data from in-situ 3-dimensional equiaxed nucleation and growth

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Abstract

In-situ observation of crystal growth in transparent media allows us to observe solidification phase change in real-time. These systems are analogous to opaque systems such as metals. The interpretation of transient 2-dimensional area projections from 3-dimensional phase change phenomena occurring in a bulky sample is problematic due to uncertainty of impingement and hidden nucleation events; in stereology this problem is known as over-projection. This manuscript describes and demonstrates a continuous model for nucleation and growth using the well-established Johnson-Mehl-Avrami-Kolmogorov model, and provides a method to relate 3-dimensional volumetric data (nucleation events, volume fraction) to observed data in a 2-dimensional projection (nucleation count, area fraction). A parametric analysis is performed; the projection phenomenon is shown to be significant in cases where nucleation is occurring continuously with a relatively large variance. In general, area fraction on a projection plane will overestimate the volume fraction within the sample and the nuclei count recorded on the projection plane will underestimate the number of real nucleation events. The statistical framework given in this manuscript provides a methodology to deal with the differences between the observed (projected) data and the real (volumetric) measures.

Keywords:

A1. Nucleation, A1. Optical Microscopy, A1. Solidification, A2. Microgravity conditions, B1. Alloys, A1. Computer Simulation