Pattern Selection of a Solidification Microstructure

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This presentation is devoted to an examination of possible answers to the following two questions. How is it that a crystal structure is being selected under certain conditions as a single dendrite, but with a shift of a governing parameter it turns into a chaotic collection of multiple crystals? How and under the influence of which mechanisms is the pattern selection imposed on a solidifying system? The empirical observations which motivate the questions are drawn from a binary Al + Si alloy system exposed to solidification after the micro layer of molten metal has formed an equilibrium membrane under the influence of surface tension.

A governing parameter responsible for the alterations of the microstructure pattern is assumed to be the undercooling present prior to an onset of a sluggish quench in pure nitrogen at the atmospheric pressure, and under normal gravity conditions.

The computation modeling, based on the same conditions corroborates the findings and fully confirms the pattern selection. That is, the results of the modeling of the system evolution clearly indicate a transition from a single crystal to an ensemble; hence the pattern selection is the same as has been established empirically.

Discussion is focused on the following additional question. Where in the morphological spectrum should the considered system reside under conditions controlled by undercooling as a governing parameter vs. the solidification velocity? The issues addressed include the morphological spectrum of structures observed in a binary alloy which feature in a solid solution (i.e., the α - phase in an Al + Si system). Numerical simulations have supported the existence of such a spectrum. Temperature and concentration conditions during the pattern formation will be discussed as well.

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