* Electronic Address: smohagheghi13@ku.edu.tr
† Electronic Address: mserefoglu@ku.edu.tr
[1] Microstructure Evolution Laboratory, Koç University

Dynamics of pattern formation in In-Bi-Sn eutectic system in quasi-2D sample

Samira Mohagheghi[1*], Melis Serefoğlu[1†]

Solidification microstructure is a trace in the solid imprinted by the propagating solid/liquid interface. The formation of solidification patterns is essentially out-of-equilibrium phenomena and the study of this pattern formation has been fostered by nonlinear physics approaches since the 1980s. Recent experimental and numerical works were dedicated to characterize the microstructures of multiphase systems; in particular, alloys with eutectic composition are studied due to their practical importance. In well-controlled experimental conditions, the micro-scale pattern, formed during unidirectional solidification exhibits self-organized array of lamellar or rod structures on a quite large scale. In a 2D three-phased system, one can expect diverse phase configurations; for instance, ABC, ABAC or ABABC repeating units, where A, B, and C are three crystalline phases at equilibrium with the liquid. In this work, we present an in situ experimental study on the microstructure formed during directional solidification of an In-Bi-Sn ternary eutectic alloy. Quasi-2D samples at eutectic composition were directionally solidified using a horizontal Bridgman setup. The dynamics of microstructure formation were examined in real time using a computer controlled high resolution motor and a special optical microscopy system, which enables observation of the solidification front from top and bottom simultaneously. We first map the morphological stability diagram for quasi-2D samples and characterize the instabilities occurring beyond the limits of stability. Second, using recorded image sequences from both sides of the sample, we are able to determine the dynamics of eutectic spacing adjustment mechanisms. We report that beyond the upper limit of the stability, lamellae splitting takes place with phase invasion and exchange, and beyond the lower limit of the stability lamellae termination takes place. Finally we discuss how the system reveals the complex mechanisms to come back to the basic state.