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Anomalous eutectic formation during solidification of deeply undercooled eutectic alloy melts

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ABSTRACT

Eutectic structures are composed of at least two phases can exhibit a wide variety of morphologies as a function of the alloy feature and processing condition. An issue that has been discussed intensively over the past few decades is the transition from lamellar or fibrous eutectics at low undercooling to anomalous eutectics at large undercooling. Currently, it is widely accepted that anomalous eutectics form due to the remelting of the primary solid during temperature recalescence. As an indicator of the tendency for anomalous eutectic formation, the re-melted fraction of the primary eutectic was analyzed systematically based on the eutectic dendrite growth theory. Its variations with the equilibrium solute distribution coefficients and liquidus slopes of eutectic phases and the position of eutectic point on the eutectic line were clearly uncovered. Three representative binary eutectic alloys – Ag-39.9at.%Cu, Ni-19.6at.%P, and Pd-16.0at.%P – their eutectic products are solid solution-solid solution, solid solution-stoichiometric intermetallic compound, and stoichiometric intermetallic compound-stoichiometric intermetallic compound, respectively, were solidified at large undercooling. The resultant solidification microstructures were in good agreement with the theoretical prediction.

KEYWORDS: eutectic solidification, undercooling, anomalous eutectics, remelting, crystal orientation