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Undercooling and solidification of liquid metals under different conditions of convection

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Abstract

The dynamics of dendrite growth and its influence on microstructures evolution in metallic alloys is essentially influenced by changes in heat and mass transport due to fluid flow during solidification. We investigate the kinetics of crystal growth by measurements of the dendrite growth velocity as a function of undercooling during non-equilibrium solidification. Measurements are conducted under different conditions of convection. The liquid samples are levitated and undercooled containerlessly in strong alternating electromagnetic fields. In such experiments the electromagnetic fields cause strong forced convection. The electromagnetic stirring of the melt is avoided if the samples are processed in a liquid or glassy slag. In this case heat and mass transport is only affected by natural convection. Also, experiments of containerlessly processed samples in reduced gravity are planned, in which natural convection is reduced. Results of all sets of investigations are compared with each other in order to infer the influence of convection on the growth dynamics of dendrites in undercooled melts. The experimental data are analysed within current models of dendrite growth. We choose the congruently melting compound Ni_2B as a proper sample material for our investigations, because it forms an intermetallic phase with a superlattice structure with a growth dynamics controlled by atomic diffusion. This is a rather sluggish growth mechanism, which may be influenced by convection in a more significant way than rapid dendrite growth in melts of pure metals and solid solutions.

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