Influence of Applied Thermal Gradients and a Static Magnetic Field on Bridgman-Grown GeSi Alloys

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The effect of applied axial and radial thermal gradients and an axial static magnetic field on the macrosegregation profiles of Bridgman-grown GeSi alloy crystals has been assessed. The axial thermal gradients were adjusted by changing the control setpoints of a seven-zone vertical Bridgman furnace. The radial thermal gradients were affected by growing samples in ampoules with different thermal conductivities, namely graphite, hot-pressed boron nitride (BN), and pyrolytic boron nitride (PBN). Those samples grown in a graphite ampoule exhibited radial profiles consistent with a highly concave interface and axial profiles indicative of complete mixing in the melt. The samples grown in BN and PBN ampoules had less radial variation. Axial macrosegregation profiles of these samples fell between the predictions for a completely mixed melt and one where solute transport is dominated by diffusion. All of the samples were grown on Ge seeds. This resulted in a period of free growth until the Si concentration in the solid was in equilibrium with the Si concentration in the liquid. The length of crystal grown during this period was inversely proportional to the applied axial thermal gradient. Several samples were grown in an axial 5 Tesla magnetic field. Measured macroscopic segregation profiles on these samples indicate that the magnetic field did not, in general, reduce the melt flow velocities to below the growth velocities.