Trapping and anti-trapping of solutal atoms by diffuse interface in rapid solidification of alloys

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Solute trapping by moving diffuse interfaces in a rapidly solidifying system takes place if solutal atoms have not enough time to escape the advancing interface and are accumulated in the growing phase. This effect becomes important at interface velocities V higher than a characteristic value W of the order of W=D/d (with D being characteristic diffusion coefficient of a solute and d the interface thickness). Therefore in solidifying systems solute trapping is more pronounced if the interface thickness is large. In the present report we analyze the influence of the diffuse interface thickness on solute trapping in rapid solidification. It is shown that with the increase of the interface thickness the trapping of solutal atoms increases abnormally. To resolve this problem in a phase-field model with artificially large interface thickness a new type of anti-trapping is developed which allows the control of partitioning as a function of velocity independent of interfacial thickness. The range of applicability of this approach is demonstrated in numerical simulations.