Size distribution and growth rate of crystal nuclei near critical supercooling in small volumes

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Physical properties and structure of the newly forming material are often predetermined by the formation of nuclei from the supercooled (or supersaturated) parent phase. The phase transition is detected using optical measurements or thermal analysis methods when critical supercooling is determined. Analysis of the critical supercooling in various volumes enables to determine the stationary nucleation rate from so-called survivorship function [1]. However, it is not clear how many particles of various sizes is formed near the critical supercooling ΔT_C. The classical nucleation theory, which is applied for the determination of the stationary nucleation rate, underestimates the number of nuclei formed in Ni droplet. The size dependence of the interfacial energy of clusters has been taken into account to overcome this discrepancy [2].

Kinetic equations are numerically solved to determine the size distribution of crystal nuclei, *F,* formed in Ni droplets near ΔT_C supercooling. The maximum size of nuclei r_{max} was determined from F as a function of time and the growth rate of the largest particles $v = dr_{max}/dt$. In the sufficiently large volumes of the parent phase, the growth rate of particles v reaches some minimum value (at certain time when the critical clusters are formed) and then increases with time to the growth rate of the flat interface limit. In smaller volumes, only a certain maximum size of nuclei r_{max} is reached, which quickly increases with supercooling. In consequence of depletion of the parent phase, the growth of the largest particles is stopped in small volumes. The growth of nuclei occurs only when the number of critical nuclei is sufficiently high.

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