FORMATION AND GROWTH OF MULTICOMPONENT BUBBLES AND DROPLETS

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There are two general approaches to theory of first-order phase transitions in a closed system with a limited availability of the nucleating species: the approach with the mean-field supersaturation and the approach with the excluded volume. The first approach implies that nucleation and growth of supercritical new-phase particles is governed by stationary diffusion of molecules and accompanied by a synchronous and uniform decrease in the mean supersaturation.[1,2] The excluded volume approach is based on a self-similar solution for non-stationary diffusion onto the growing supercritical particles and takes into account that the nucleation of new particles is strongly suppressed around growing particles.[3-6]

In this communication, we report new theoretical results for the nucleation stage of gas bubble formation in liquid solutions and droplet nucleation in supersaturated vapors with arbitrary number of components and any supersaturation values. The nucleation stage is an important stage of degassing in decompressed liquid-gas solutions and condensation in supersaturated vapors, on which a certain size distribution of gas bubbles or liquid droplets is formed, being the starting point for further growth. It has been recently shown[7] that the initial composition and size dependence of the surface tension of a small supercritical bubble does not affect the peculiarities of the development of the nucleation stage, but affects the rate of nucleation at the initial total supersaturation. Analysis of the effects of non-stationary diffusion confirmed that they can be very significant in the growth of multicomponent bubbles and, in particular, are responsible for large swelling and foaming the decompressed liquid solution. An extended mean-field approach that allows one to find all vapor supersaturations and the distribution of supercritical droplets in sizes as functions of time on the nucleation stage, has been proposed[8] for a real multicomponent solution in the droplets.

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