Physical Interpretation of the Phase Stability Test of a Macroscopic Phase: Homogeneous Nucleation

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The thermodynamic state of the so-called critical nucleus in the nucleation process of a dispersed phase inside a metastable phase is analyzed from the point of view of the thermodynamic stability of such a metastable phase. It is demonstrated that the basic assumption of constant intensive properties of the metastable phase in nucleation theories represent, in fact, an extreme condition for a homogeneous macroscopic phase to be thermodynamically stable. In addition, it is shown that most results of classical nucleation theories can be obtained from the tangent plane distance analysis used for determining the thermodynamic stability of a homogeneous phase. Finally, these results allowed the calculation of the intensive properties of the critical nucleus by the use of standard approaches in the determination of the equilibrium coexistence between evolved macroscopic phases. With this, the thermodynamic stability analysis, used to solve the traditional phase equilibrium problem, is extended to establish the condition at which a new phase appears and grows.