DEFINITION OF METASTABLE REGIONS BELOW THE LIQUIDUS TEMPERATURE T_L AND SOLIDUS TEMPERATURE T_S ON A EUTECTIC PHASE DIAGRAM

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Metastable phase equilibrium obeys the same thermodynamic rules that apply in the case of stable equilibrium. In particular, the temperatures and chemical potentials of all phases of the system at equilibrium must be equal. Metastable phase diagrams do not contain any unusual features, except for regions near the boundaries of metastability where the nucleation barrier ceases to exist. The displacement of the liquidus and solidus lines can be influenced by the cooling rate of the melt, its thermal history, the curvature of the phase interface, pressure, and so on.

At the same time, the definitions of "non-equilibrium" crystallization and "metastable diagram" do not mention the presence of pre-crystallization undercoolings in alloys (similar to those in pure substances) relative to the liquidus and solidus temperatures, which cause spontaneous, self-initiated crystallization.

By definition, equilibrium crystallization begins at the liquidus temperature T_L and ends at the solidus temperature T_S. Spontaneous crystallization, however, does not begin at the liquidus T_L or solidus T_S temperatures. It begins at temperatures T_{min} significantly below T_L and T_S. That is, for this type of crystallization, undercoolings $\Delta T_L^- = T_L - T_{min}$ and $\Delta T_S^- = T_S - T_{min}$ are necessary.

Plotting the T_{min} points on the diagram for all alloys allows for the construction of a non-equilibrium phase diagram with metastability boundaries across the entire concentration range.

Thus, for alloys, a wide variety of crystallization types are observed with undercoolings ΔT_L^- and ΔT_S^-, both relative to the liquidus line and relative to the solidus line, respectively.