

MSE-S304

Phase Transformation in Metals

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Theory of Nucleation

Introduction to Theory of Nucleation

- ⊙ First order phase transformation consist Meta stable phase transformation to a stable phase by the process of **Nucleation & Growth**.
- Nucleation → Metaphase thermal fluctuations in meta-stable parent phase.
- Growth → During the process of growth, the product phases continuously & irreversibly grow at the expense of parent phase.

Introduction to Theory of Nucleation

• Hetero-phase Fluctuations → Fluctuations that corresponds to distinctly different possible phases.

- example:
- ① For liquid phase → Large fluctuation in density in a small region of a vapor phase.
 - ② For solid phase → Structural fluctuation in liquid phase region.
 - ③ For another solid phase → Fluctuation in structure and/or composition in a solid phase.

Introduction to Theory of Nucleation

- ⊙ Gibbs energy change ($\Delta G'$) → Gibbs energy change ($\Delta G'$) accompanying a hetero-phase fluctuation corresponding to a second phase can be written as:

$$\boxed{\Delta G' = V \Delta G_v + A \sigma}$$

V → Volume of the fluctuation.

A → Interfacial area between fluctuation and the parent phase.

ΔG_v → Gibbs energy of formation of the second phase from the parent phase per unit volume of the second phase.

σ → Interfacial energy per unit area of the interface formed between fluctuation and the parent phase.

Introduction to Theory of Nucleation

⊙ Probability of occurrence of the fluctuation → when $\Delta G'$ is positive (+ive),

probability of occurrence (P_r) of the fluctuation by thermal activation is given by: $P_r \sim \exp\left(-\frac{\Delta G'}{KT}\right)$

K and T are Boltzmann's const. & temperature in degrees K.