MSE-S304

Phase Transformation in Metals

Ankur Katiyar
Assistant Professor, MSME Department
UIET, CSJM University

Formation of a Nucleus

Formation of a Nucleus

$\Delta G'$ is initially +ive & inc^s with size of the fluctuation due to dominance of +ive interfacial energy term (σ is always +ive) at small sizes, goes through a maximum & then continuously decreases as volume gibbs energy term becomes more & more dominant.

③ Since σ is always +ive & inc^s gibbs energy of formation of the fluctuation, shape of the most probable fluctuation corresponds to min^m interface energy configuration.

Formation of a Nucleus

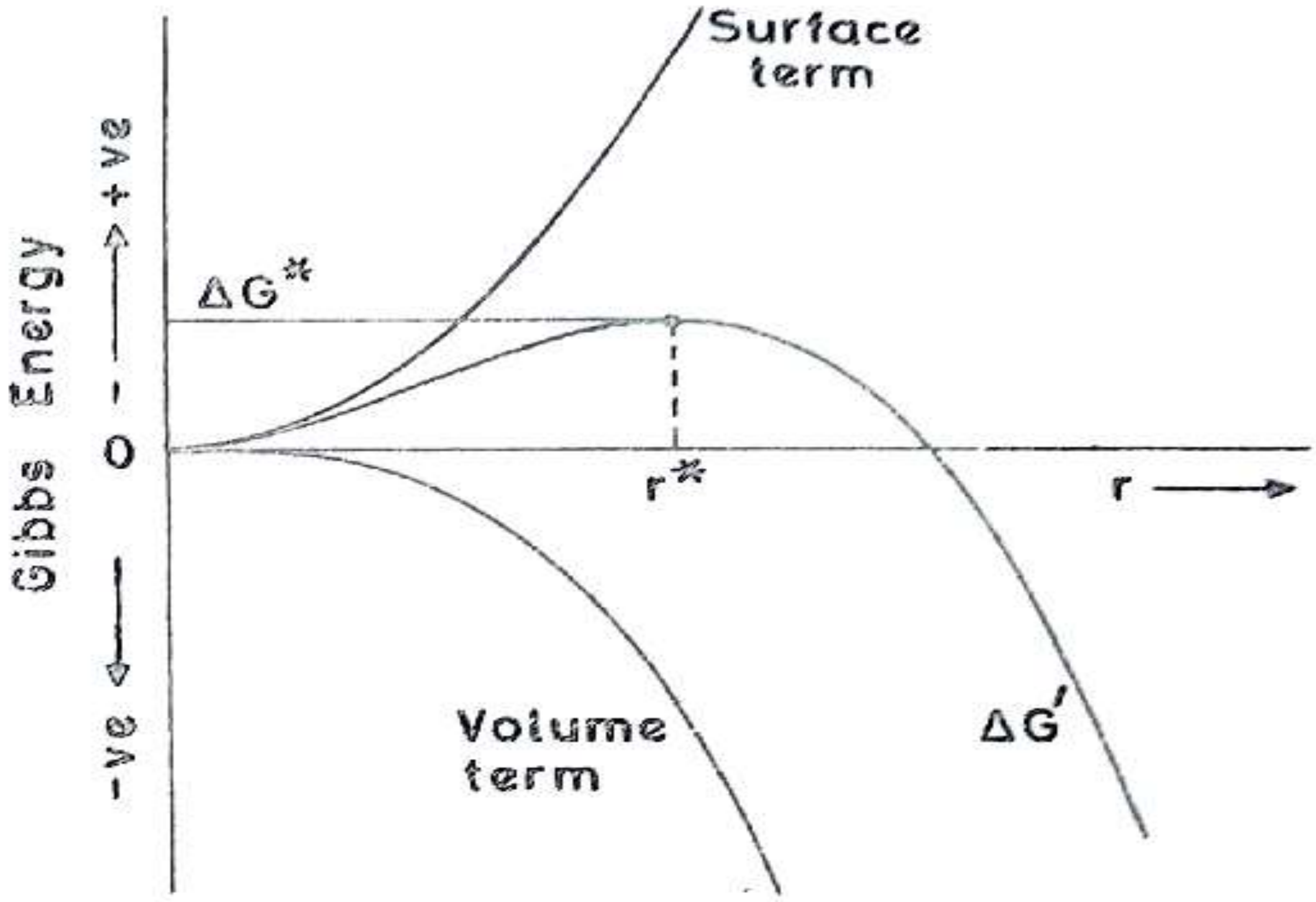
⊙ When interface energy is isotropic, shape of the most probable fluctuations (embryos) would be spherical & ($\Delta G'$) can be rewritten as ($\Delta G'$)

$$\Delta G' = \frac{4}{3}\pi r^3 \Delta G_v + 4\pi r^2 \sigma$$

$r \rightarrow$ radius of spherical embryo.

- $\Delta G'$ initially increases, goes through a maximum at a critical size r^* and then continuously decreases.
- When ΔG_v is positive, $\Delta G'$ would continuously increase.
- Transformation occurs ~~along~~ only when ΔG_v is positive.
- Fluctuations of size greater than r^* can spontaneously grow with continuous decrease in Gibbs energy of the system, i.e. they become stable second phase particles.

Formation of a Nucleus



: Gibbs energy of a spherical embryo as a function of its size.

Formation of a Nucleus

- Concentration of fluctuation (embryos) of given size (r) per unit volume of the parent phase:

$$N_r = N_v \exp\left(-\frac{\Delta G'}{kT}\right)$$

$N_r \rightarrow$ number of embryos of size r.

$N_v \rightarrow$ number of atoms in the parent phase per unit volume of the parent phase.