MSE-S304

Phase Transformation in Metals

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Rate of Homogeneous Nucleation

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- A critical embryo becomes stable nucleus of the second phase, when one more atom is added to it.
- Addition of an atom to critical embryo occurs by "thermal activation".
- Number of attempts per second an atom at the interface in parent phase makes to cross the interface is equal to vibrational frequency of atoms normal to the interface.
- Probability of an attempt being successful is $\exp\left(-\frac{\Delta G_D}{kT}\right)$

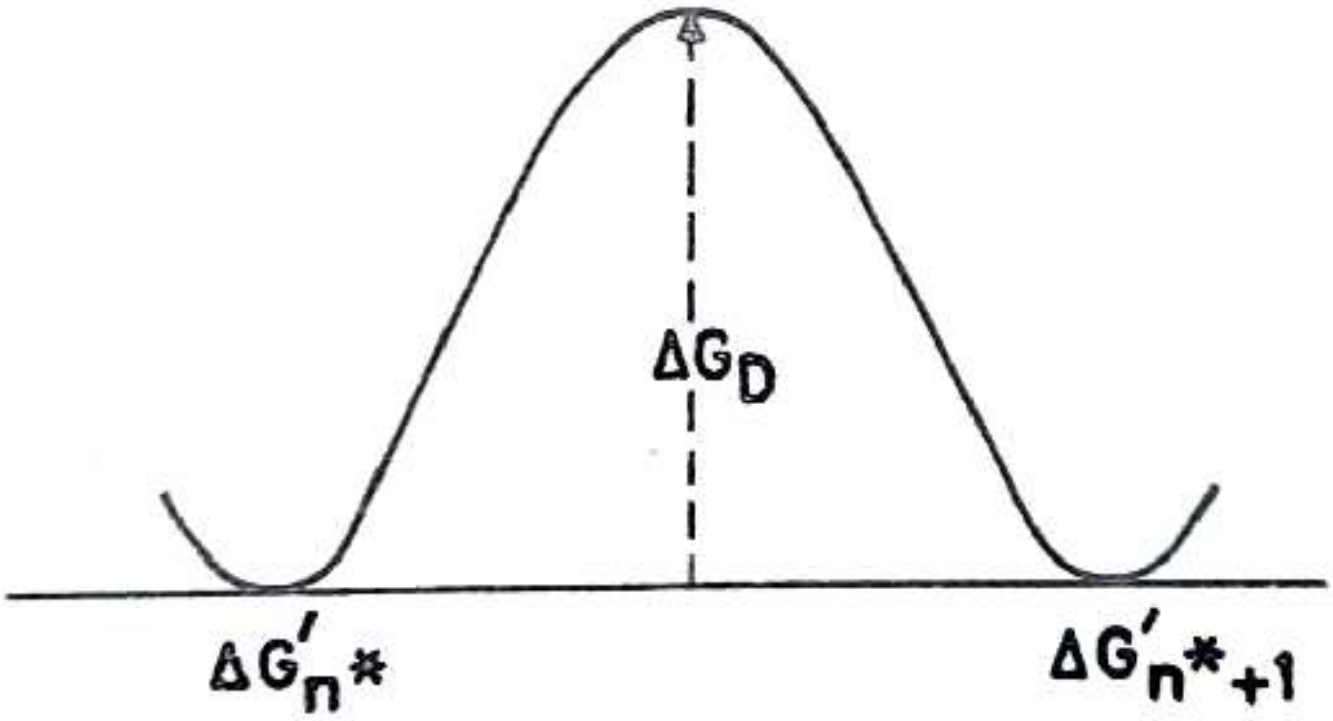
  $\Delta G_D \rightarrow$ Activation energy for atomic movement across the interface.
- Vibrational frequency of atoms is (kT/h)

  $k \rightarrow$ Boltzmann's constant.

  $T \rightarrow$ Temperature in degrees K.

  $h \rightarrow$ Planck's constant.

Rate of Homogeneous Nucleation



3: Activation barrier for growth of a critical embryo.

Rate of Homogeneous Nucleation

⊙ Rate of Homogeneous Nucleation (I_h):

$$I_h = N_r^* N_S^* \left(\frac{kT}{h}\right) \exp\left(-\frac{\Delta h_D}{kT}\right) = \left(\frac{kT}{h}\right) N_S^* N_V \exp\left(-\frac{\Delta G^* + \Delta G_D}{kT}\right)$$

$$\left[\text{because, } N_r^* = N_V \exp\left(-\frac{\Delta G^*}{kT}\right)\right]$$

N_S^* → Number of atoms at the interface of a critical embryo.

I_h → Number of nuclei formed per unit volume per unit time.