Asssignment-6

Heat treatment and Surface hardening – II

1) In the expression $\Delta G^* = f \times \frac{\gamma^3_{\alpha/\beta}}{(\Delta G_v - \Delta G_s)^2}$, the value of f for homogenous (spherical nuclei) and heterogeneous nucleation (lens shaped nuclei) are:

a) $16\pi/3$ and$16\pi/3 \times \frac{(2+cos\theta)(1-cos\theta)^2}{2}$, respectively.

b) $16\pi/3$ and $16\pi/3 \times \frac{(2-cos\theta)(1-cos\theta)^2}{2}$, respectively.

c) $16\pi/3$ and $16\pi/3 \times \frac{(2-cos\theta)^2(1+cos\theta)^2}{2}$, respectively.

d) $16\pi/3$ and $16\pi/3 \times \frac{(2-cos\theta)(1+cos\theta)^2}{2}$, respectively.

2) Following question 1, if contact angle of 10^o is given, the ratio of $\frac{\Delta G^*_{homogenous}}{\Delta G^*_{hetrogenous}}$ lies in the range of

a) 2900-3000.

b) 4000-5000.

c) 7000-8000.

d) 8500- 9000.

3) Which of the following conclusion can be drawn from the solution of question no. 2.

a) The activation energy (barrier for nucleation) for homogeneous nucleation is less compared to heterogeneous nucleation and hence the homogenous nucleation is difficult.

b) The activation energy for heterogeneous nucleation is less compared to homogenous nucleation and hence the homogenous nucleation is difficult.

c) The activation energy for homogeneous nucleation is greater compared to heterogeneous nucleation and hence the heterogeneous nucleation is difficult.

d) None of these

4) The expression of nucleation rate contains two terms i.e. I and II as can be seen in given equation

$I = I_0 \times \underbrace{e^{-\Delta G^*/kT}}_{I} \times \underbrace{e^{-\Delta G_D/kT}}_{II}$ Where ΔG^* *and* ΔG_D(assuming constant) are the activation energies for nucleation and jump, respectively.

The effect of increase in undercooling (ΔT) will be:

a) Increase in term II but decrease in term I.

b) Increase in term I but decrease in term II.

c) Both the terms increases.

d) None of these.

5) The value of θ (degree) in Fig.1 lies in the range of: (given $\gamma_{\alpha/\beta}$ =300 mJ/m^2 and $\gamma_{\alpha\alpha}$ =400 mJ/m^2, where γ represents the surface energy per unit area).

a) 70.0-70.5

b) 59-59.5

c) 48.0-48.5

d) 100-100.5

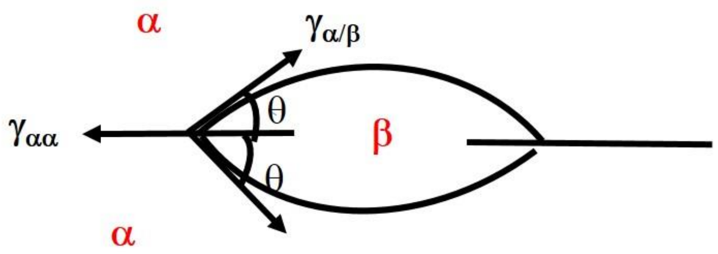


Fig. 1

6) In the diffusion controlled growth rate expression for growth of β phase inside the matrix of α phase, if super saturation increases 5 times compared to its initial value considering D, t and other terms to be constant, then

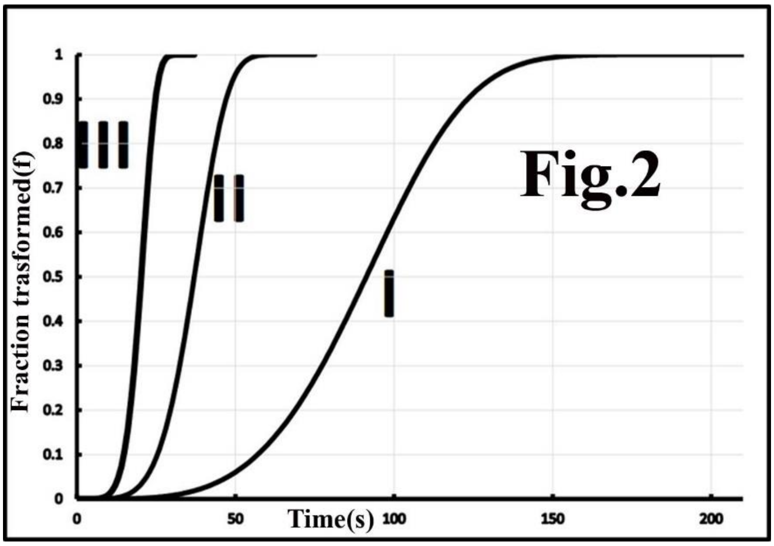
a) Growth velocity (ν) increases 10 times compared to its initial value.

b) Growth velocity (ν) decrease 10 times compared to its initial value.

c) Growth velocity (ν) increases 5 times compared to its initial value.

d) Growth velocity (ν) decrease 5 times compared to its initial value.

7) In fig. 2 fraction transformed of a phase has been plotted against time (s) using Avrami's kinetics $f = 1 - e^{-kt^n}$ for different values of n, keeping k as constant. By examining the plot, identify the correct order of n for three curves i.e. I, II and III.



a) $n_I < n_{II} < n_{III}$

b) $n_{II} < n_I < n_{III}$

c) $n_I < n_{III} < n_{II}$

d) $n_{III} < n_{II} < n_I$

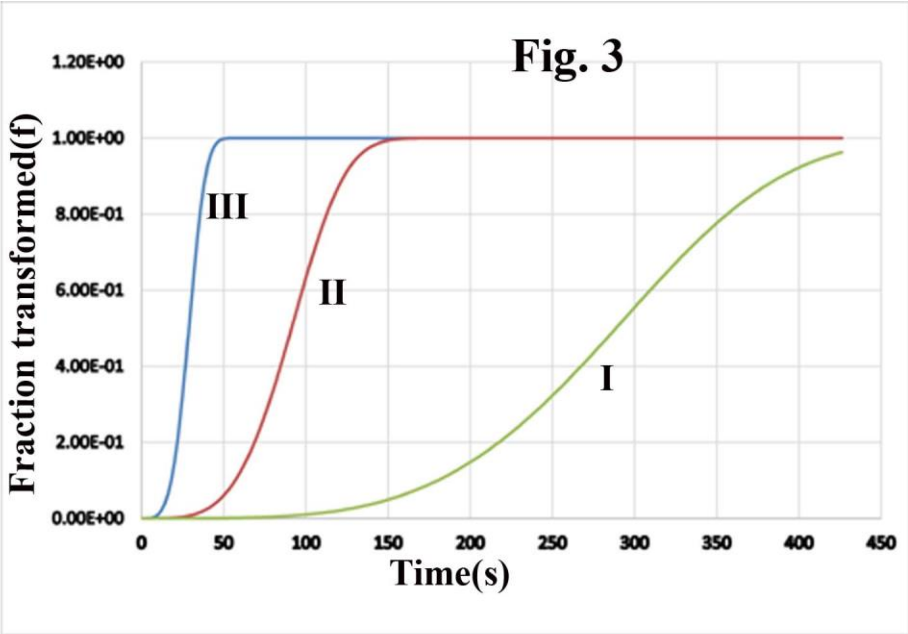
8) In fig. 3 fraction transformed of a phase has been plotted against time (s) using Avrami's kinetics $f = 1 - e^{-kt^n}$ for different values of k, keeping n as constant. By examining the plots, identify the correct order of k for three curves i.e. I, II and III.

a) $k_{II} < k_I < k_{III}$

b) $k_I < k_{II} < k_{III}$

c) $k_I < k_{III} < k_{II}$

d) $k_{III} < k_{II} < k_I$



9) For some transformation having kinetics that obey the Avrami's equation [f= 1-exp (-kt^n)], the parameter *n* is known to have a value of 1.5. If, after 125 s, the reaction is 25% complete, total time for the transformation to get 90% completed will be:

a) 500

b) 400

c) 300

d) 200

10) The fraction recrystallized–time data for the recrystallization of a deformed copper are as follows

Fraction Recrystallized	**Time (min)**
0.30	95.2
0.80	126.6

Assuming that the kinetics of this process obeys the Avrami relationship, the fraction recrystallized after a total time of 116.8 min will lie in the range of

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a) 0.78-0.80
b) 0.64-0.66
c) 0.85-0.87
d) 0.90-0.95