

MSE 310

Kinetics and Microstructural Evolution

2015-2016 Spring

Self Study Questions - 1

1- Compare the energies (chemical and strain) and mobilities of high angle, low angle and twin boundaries.

2- By considering a water droplet on a wooden table,

i- show wetting and non-wetting conditions by showing dihedral angle and surface tensions on your drawings

ii- How wetting behavior of water changes when the table become polished?

iii- Compare the wetting behaviors of water and oil dropped on the polished table.

(Try to explain by considering cohesive and adhesive forces if exists in any case)

3- Consider a liquid phase on a triple junction of three solid beta grains. Sketch the shape of the liquid phase when

i- $\gamma_{l\alpha} = \gamma_{\alpha\alpha}$

ii- $\gamma_{l\alpha} \gg \gamma_{\alpha\alpha}$

iii- $\gamma_{l\alpha} \ll \gamma_{\alpha\alpha}$

4- Show that a quadripole junction of high angle grain boundaries is not stable.

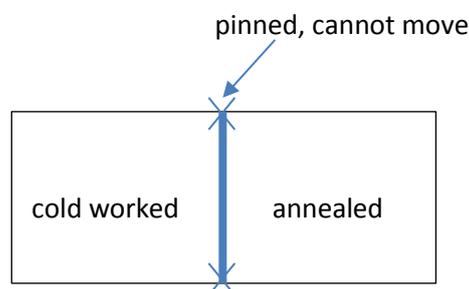
5- In an alloy with coherent precipitates, if the precipitate-matrix interface energy is isotropic (non-directional)

i- Sketch the shape of the precipitates (assuming that the strain fields are negligible)

ii- Repeat part-i for the case of incoherent precipitates, showing the difference clearly.

6- Consider a two dimensional rectangular crystal with side lengths L_1 and L_2 , and with corresponding surface energies γ_1 and γ_2 . The size of the crystal remains constant ($L_1 * L_2 = \text{const.}$). What would be the equilibrium dimensions of this crystal in terms of surface tensions, assuming that the shape remains to be rectangular. $L_1/L_2 = f(\gamma_1, \gamma_2) = ?$

7- Consider a bicrystal consisting of a cold worked (high dislocation density) and annealed (low dislocation density) parts as shown below. If the boundary between these two parts is locked (pinned) at the surface of the bicrystal, what would be the equilibrium shape of this boundary? Clearly explain your reasoning.



8-Grains with smaller than 6-sides shrink when heated, while grains having more than 6-sides become coarser or grow. Explain the reason.

9-Explain how grain boundary segregation affect the grain growth.

10-Draw grains with convex and concave grain boundaries and show relative directions of atoms and boundaries in each case. Also explain the reason.

11-What are the similarities and differences between surface tension and surface energy?

12-Energies of twin boundaries are sensitive to misorientation angle such that small changes in misorientation angle produces a considerable change in boundary energy, while energies of high angle grain boundaries are insensitive to misorientation. Explain why this so?

13-Calculate the surface tensions of [110] directions in simple cubic and BCC structures.

14-What would be the shape of a solid crystal when surface tension is

- i- independent of direction
- ii- dependent on direction

15-Cite the variables that affect the velocity of grain boundary.

16-Given the following grain growth data obtained at constant temperature, calculate the expected grain size after 2 hrs of annealing at the same temperature. Also calculate the change in the energy of this metal upon 2 hrs of annealing.

HAGB energy: $5 \times 10^{-5} \text{ J/cm}^2$.

t(sec)	0	1	2	4	10	20	50
D(μm)	5	31.5	37.65	46.3	62.4	76	100