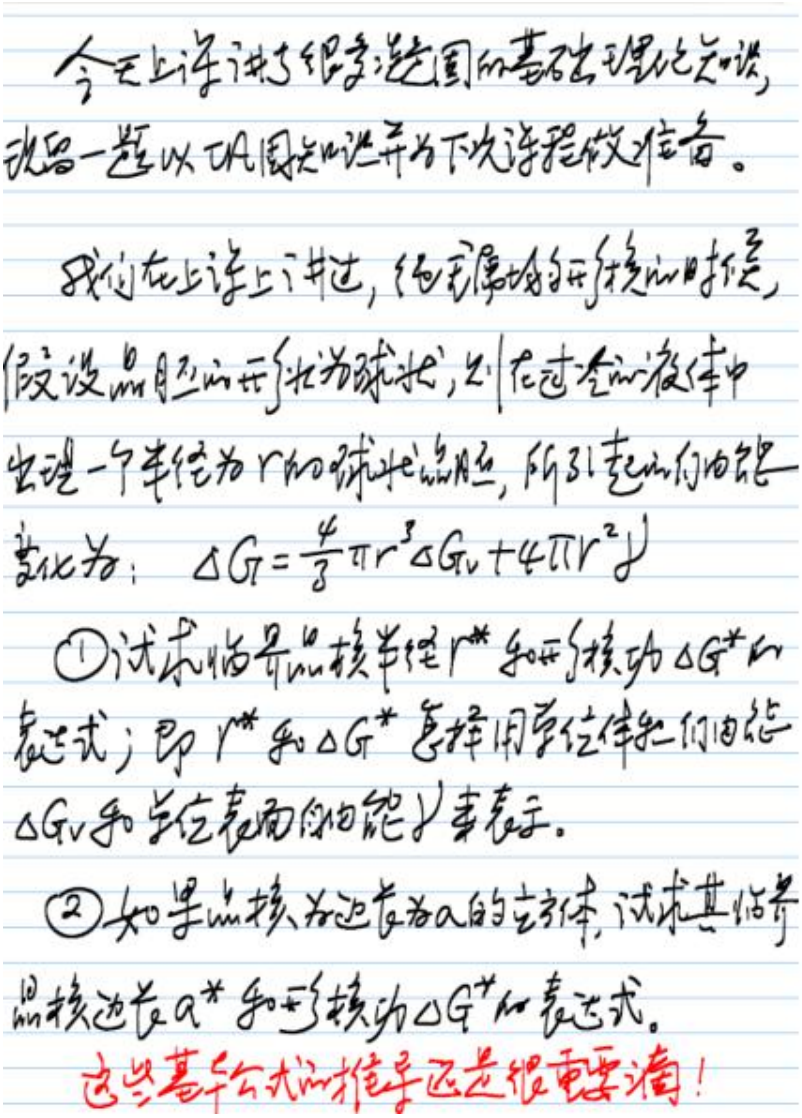
Fundamentals of Materials Science Homework 20

Name: Xiao，Liyang　　Date: 05/10/2017　　Student #: 15090215

Homework Problems:



Solution:

1. $\because \Delta G=\frac{4}{3}\pi r^3\Delta G_v+4\pi r^2\gamma$

$$\therefore \frac{d(\Delta G)}{dr}=\frac{4}{3}\pi\Delta G_v(3r^2)+4\pi\gamma(2r)=0$$

$$\therefore r^*=-\frac{2\gamma}{\Delta G_v}\quad \Delta G^*=\frac{16\pi\gamma^3}{3(\Delta G_v)^2}$$

2. ∵立方体

$$\therefore \Delta G = a^3 \Delta G_v + 6a^2\gamma$$

$$\therefore \frac{d(\Delta G)}{dr} = 3a^2 \Delta G_v + 12a\gamma = 0$$

$$\therefore a^* = -\frac{4\gamma}{\Delta G_v} \quad \Delta G^* = \frac{32\gamma^3}{\Delta G_V{}^2}$$

One More Problem:

Calculation of Critical Radius for the Solidification of Copper

Calculate the size of the critical radius and the number of atoms in the critical nucleus when solid copper forms by homogeneous nucleation. Comment on the size of the nucleus and assumptions we made while deriving the equation for the radius of the nucleus. The elemental data of Cu can be found in your textbook.

Solution:

$$\because T_{m(Cu)} = 1085℃;\ \Delta H_{f(Cu)} = -1628 J/\text{cm}^3; \gamma = 1.77\times10^{-9} J/\text{cm}^2; \Delta T = 236℃$$

$$\therefore r^* = \left(-\frac{2\gamma T_m}{\Delta H_f}\right)\left(\frac{1}{T_m - T}\right)$$

$$= \left[-\frac{2\times177\times10^{-7} J/\text{cm}^2 \times 1358.15K}{-1628 J/\text{cm}^3}\right]\left(\frac{1}{236K}\right)$$

$$=1.25\text{nm}$$

$$\because a_{Cu} = 2\sqrt{2}r_{Cu} = 2\sqrt{2}\times0.128nm = 0.362nm$$

$$\therefore n = \frac{V_1}{V} = \frac{\frac{4}{3}\pi r^{*3}}{a^3} = \frac{\frac{4}{3}\pi\times(1.25nm)^3}{(0.362nm)^3} = 172 \text{ unit cells}$$

$$\therefore N = 4\times n = 4\times172 = 690 \text{ atoms/unit cells}$$