Department of Materials Science and Engineering
Pohang University of Science and Technology

AMSE502 Phase Transformations

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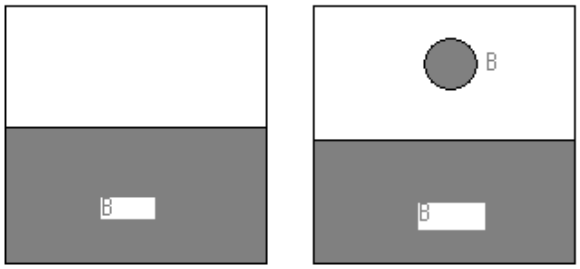
Problem Set #3

Prof. Byeong-Joo Lee
calphad@postech.ac.kr
Room 1- 311

1. Consider the total Gibbs energy difference between the following two cases. The second case involves a spherical precipitate, with radius r and interfacial energy with the matrix γ.



The energy difference between the two cases can be calculated by the following two ways.

a. interfacial area × interfacial energy : $4\pi\ r^2 \cdot \gamma$

b. energy increase due to capillary effect per volume × volume: $\frac{2\gamma}{r} \cdot \frac{4}{3}\pi\ r^3 = \frac{2}{3} \cdot 4\pi\ r^2 \cdot \gamma$

Why different results are obtained? How one had to calculate the quantity?

2. What do you expect from two exponential terms concerning the temperature dependence of nucleation rate?

$$I = \frac{kT}{h} \exp(-\Delta G_a/kT) \quad \exp(-\Delta G_c/kT)\ N_v$$

3. Explain why superheating is not necessary for melting while supercooling is necessary for solidification.

for Cu: $\gamma_{SV} = 1780\ \mathrm{mJm^{-2}}$, $\gamma_{gb} = 625\ \mathrm{mJm^{-2}}$ (925°C)

$\gamma_{SL} = 177\ \mathrm{mJm^{-2}}$, $\gamma_{LV} = 1300\ \mathrm{mJm^{-2}}$ (1083°C)