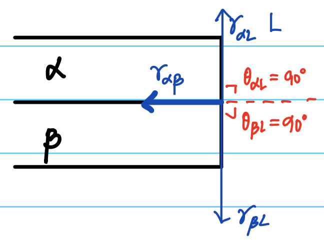
Homework #6 신소재공학과 20222389 김창훈

1. (a) growing tip 이 없다고 가정해보자.



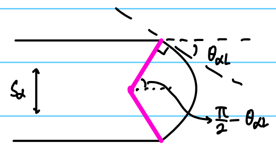
$$\rightarrow \gamma_{\alpha\beta} = \gamma_{\alpha L} \cos \underbrace{\theta_{\alpha L}}_{90°} + \gamma_{\beta L} \cos \underbrace{\theta_{\beta L}}_{90°}$$

$$\rightarrow \gamma_{\alpha\beta} = \gamma_{\alpha L} \cdot 0 + \gamma_{\beta L} \cdot 0 = 0$$

$\gamma_{\alpha\beta}$ 가 0 이라는 것은 모순이다.

따라서, Curvature 가 존재한다.

(b)



$$S_\alpha = 2\gamma_\alpha \cos\theta_{\alpha L} \quad , \quad S_\beta = 2\gamma_\beta \cos\theta_{\beta L}$$

$$S_\alpha = S_\beta \ , \ S_\alpha^2 = S_\beta^2$$

cos식 이용하기 위해 변형

$$\rightarrow r_{\alpha L}^2 \cdot \sin^2\theta_{\alpha L} = \gamma_{\beta L}^2 \cdot \sin^2\theta_{\beta L} \rightarrow \gamma_{\alpha L}^2 \cdot (1-\cos^2\theta_{\alpha L}) = \gamma_{\beta L}^2 \cdot (1-\cos^2\theta_{\beta L})$$

$$\rightarrow \cos\theta_{\beta L} = \sqrt{\frac{\gamma_{\beta L}^2 - \gamma_{\alpha L}^2 + \gamma_{\alpha L}^2 \cdot \cos^2\theta_{\alpha L}}{\gamma_{\beta L}^2}} \qquad \left(\frac{r_\alpha \cos\theta_{\alpha L}}{r_\beta} = \cos\theta_{\beta L} \right)$$

$$\rightarrow \gamma_{\alpha\beta} = \gamma_{\alpha L} \cdot \cos\theta_{\alpha L} + \gamma_{\beta L} \cdot \cos\theta_{\beta L}$$

$$\rightarrow \gamma_{\alpha\beta} = \gamma_{\alpha L} \cdot \frac{S_\alpha}{2 r_\alpha} + \sqrt{\gamma_{\beta L}^2 - \gamma_{\alpha L}^2 + \gamma_{\alpha L}^2 \cdot \frac{S_\alpha^2}{4 r_\alpha^2}}$$

대입, eq. 풀면

$$\Rightarrow r_\alpha = \frac{S_\alpha \cdot \gamma_{\alpha\beta} \cdot \gamma_{\alpha L}}{\gamma_{\alpha\beta}^2 - \gamma_{\beta L}^2 + \gamma_{\alpha L}^2} \ , \ r_\beta = \frac{S_\beta \cdot \gamma_{\alpha\beta} \cdot \gamma_{\beta L}}{\gamma_{\alpha\beta}^2 - \gamma_{\alpha L}^2 + \gamma_{\beta L}^2}$$

(c)

$$\Delta G_{capillary} = \frac{\gamma_{\alpha L}}{r_\alpha} \cdot V_m^\alpha + \frac{\gamma_{\beta L}}{r_\beta} \cdot V_m^\beta$$

(b 번 문제에서 나온 관계식 대입)

$$= \frac{V_m^\alpha}{S_\alpha} \cdot \left(\frac{\gamma_{\alpha\beta}^2 + \gamma_{\alpha L}^2 - r_{\beta L}^2}{\gamma_{\alpha\beta}} \right) + \frac{V_m^\beta}{S_\beta} \cdot \left(\frac{\gamma_{\alpha\beta}^2 + \gamma_{\beta L}^2 - \gamma_{\alpha L}^2}{\gamma_{\alpha\beta}} \right)$$

$$\left(\frac{V_m^\alpha}{S_\alpha} = \frac{V_m^\beta}{S_\beta} = \frac{V_m}{S} \right)$$

$$= \frac{V_m}{S} \cdot \frac{2 \cdot \gamma_{\alpha\beta}^2}{\gamma_{\alpha\beta}} = 2 \cdot \frac{V_m \cdot \gamma_{\alpha\beta}}{S} = \Delta G_{\text{平}}(S)$$

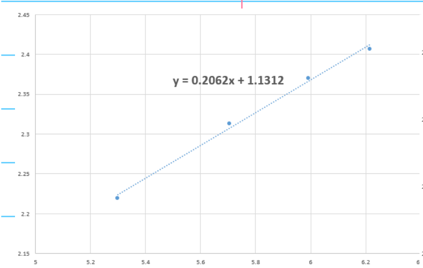
#2

평균 grain size ($\bar{R}$) = $k \cdot t^n$

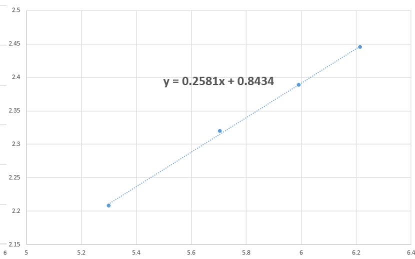
~~선형방정식 표현하기 위해 자연로그 씌우면~~ $\ln\bar{R} = n \cdot \ln t + \ln k$.

• 온도별 n값 구하기 (x축 : $\ln t$, y축 : $\ln\bar{R}$)

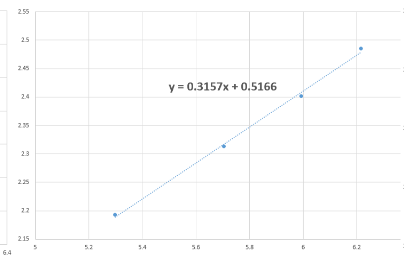
① $T=5$



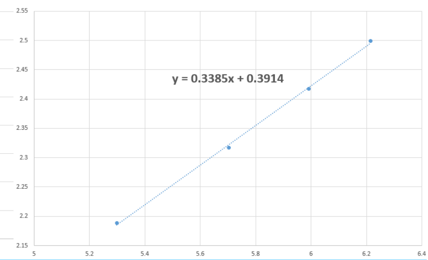
② $T=10$



③ $T=15$

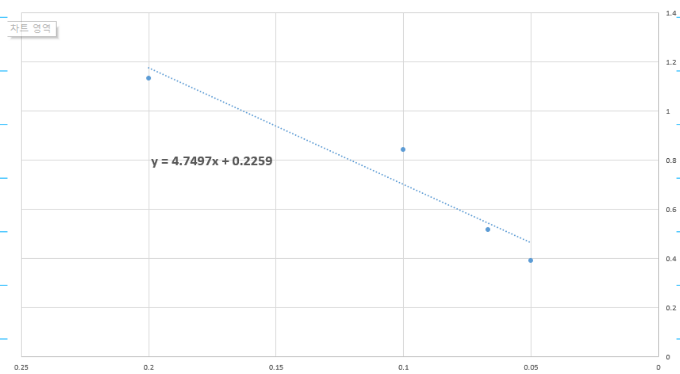


④ $T=20$



• $k = k_0 \cdot \exp(-\frac{Q}{RT}) \rightarrow \ln k = \frac{Q}{R}(-\frac{1}{T}) + \ln k_0$

lnk와 1/T plot 의 기울기가 $+\frac{Q}{R}$ 이용.



$\Rightarrow \frac{Q}{R} = 4.7497.$