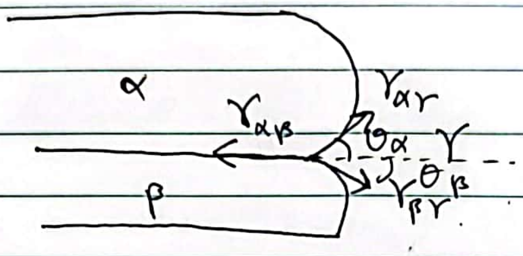
HW6 정대훈

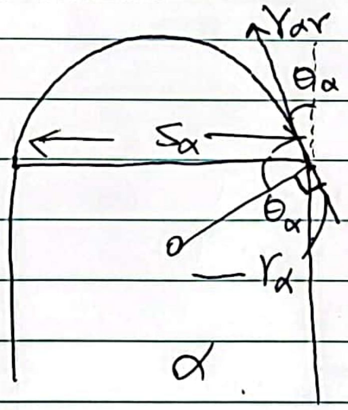
1\. a) A curvature is required to satisfy the force balance among the interfaces.



$$\Sigma F = -\gamma_{\alpha\beta} + \gamma_{\alpha\gamma}\cos\theta_\alpha + \gamma_{\beta\gamma}\cos\theta_\beta = 0.$$

$$\underline{\gamma_{\alpha\beta} = \gamma_{\alpha\gamma}\cos\theta_\alpha + \gamma_{\beta\gamma}\cos\theta_\beta} \quad \cdots ①$$

b)



$$S_\alpha = 2 r_\alpha \cos\theta_\alpha$$

$$\therefore r_\alpha = \frac{S_\alpha}{2\cos\theta_\alpha}$$

$$r_\beta = \frac{S_\beta}{2\cos\theta_\beta}$$

c) $\Delta G_r^\alpha = \dfrac{\gamma^{\alpha\gamma}}{r_\alpha} V_m^\alpha \qquad \Delta G_r^\beta = \dfrac{\gamma^{\beta\gamma}}{r_\beta} V_m^\beta$

the total gibbs energy increase is

$$\Delta G = \frac{n_\alpha}{n}\Delta G_r^\alpha + \frac{n_\beta}{n}\Delta G_r^\beta \qquad \left(n = \frac{Slh}{V_m^L},\ n_\alpha = \frac{S_\alpha l h}{V_m^\alpha},\ n_\beta = \frac{S_\beta l h}{V_m^\beta} \right)$$

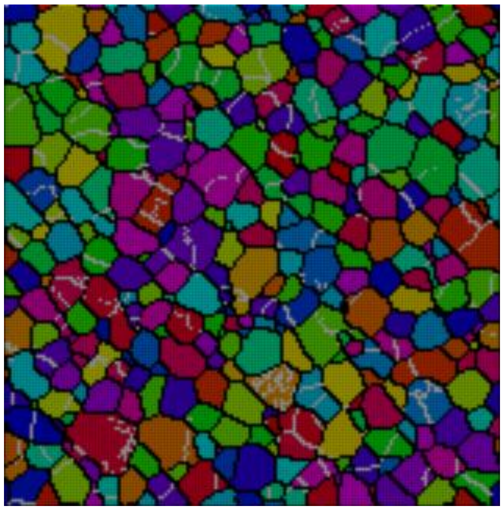
$$= \frac{S^\alpha V_m^L}{S V_m^\alpha} \times \frac{\gamma^{\alpha\gamma}}{r_\alpha} V_m^\alpha + \frac{S^\beta V_m^L}{S V_m^\beta} \times \frac{\gamma^{\beta\gamma}}{r_\beta} V_m^\beta$$

$$= \frac{2V_m^L}{S}\left(S_\alpha \times \frac{\gamma^{\alpha\gamma}\cos\theta_\alpha}{S_\alpha} + S_\beta \times \frac{\gamma^{\beta\gamma}\cos\theta_\beta}{S_\beta} \right)$$

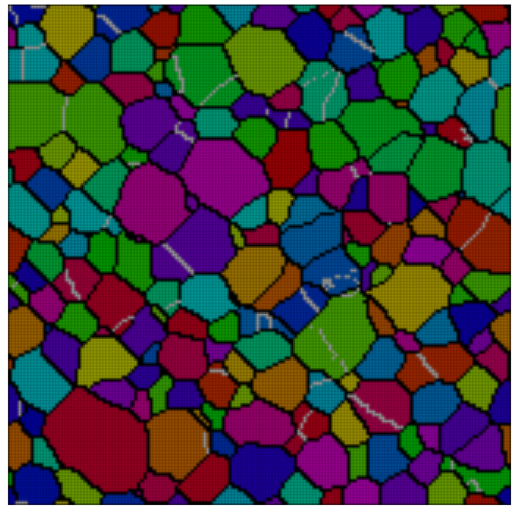
$$= \underline{\frac{2\gamma_{\alpha\beta}}{S} \cdot V_m^L} \qquad (\text{from equation } ①)$$

- **Settings: 1) Time steps = 300, 600, 900, 1200, 1500**

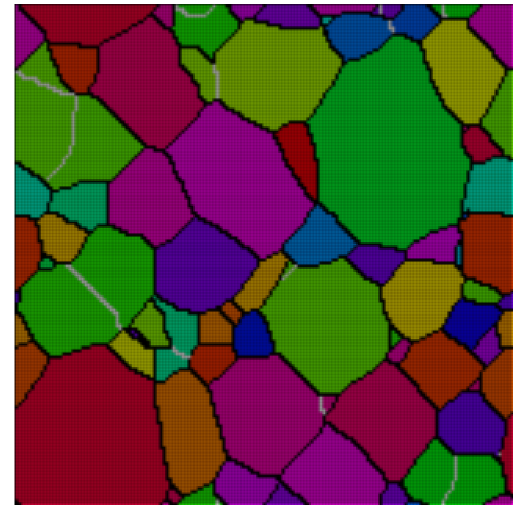
  2) Temperature levels = 5, 10, 15, 20



Initial R_0

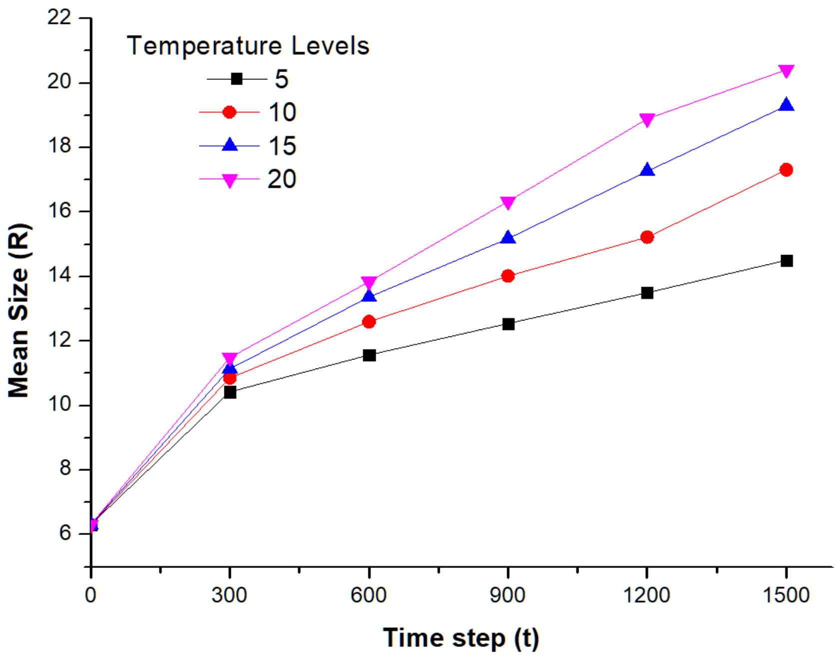


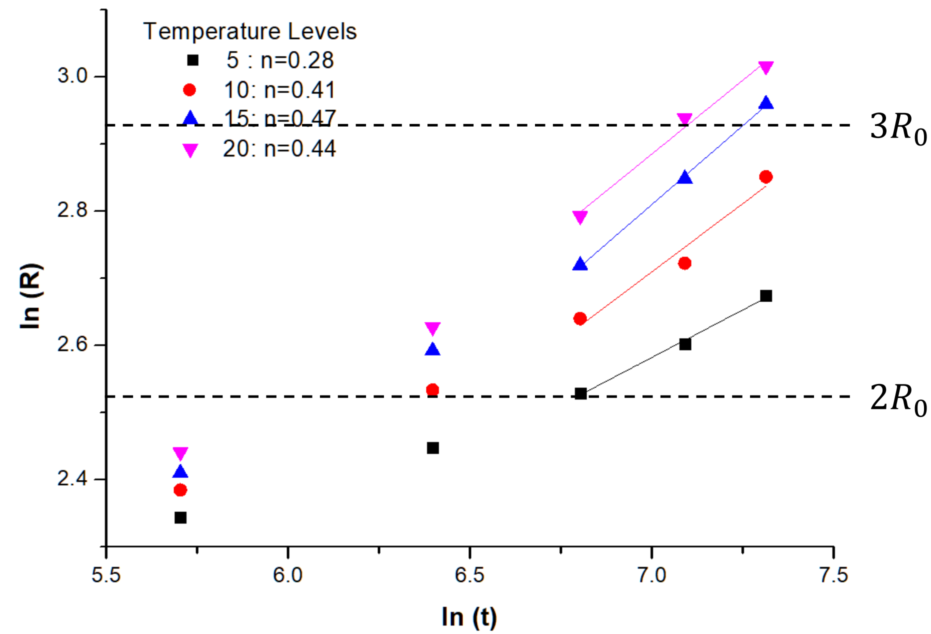
Time: 300, R_1



Time:1500, R_5

$$R^{\frac{1}{n}} - R_0^{\frac{1}{n}} = k \cdot t \;\rightarrow\; R = k \cdot t^n \; (R_0 \ll R)$$

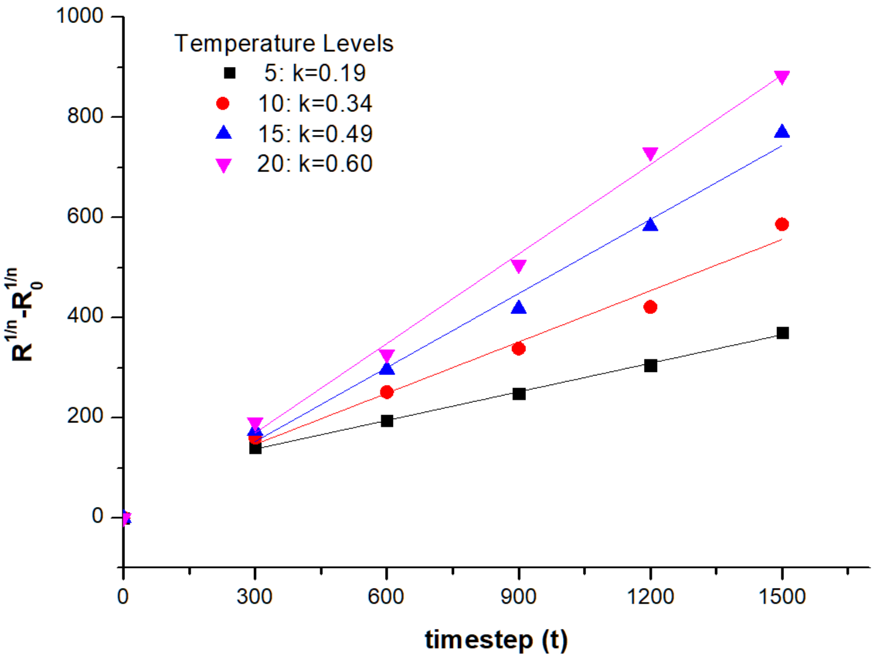


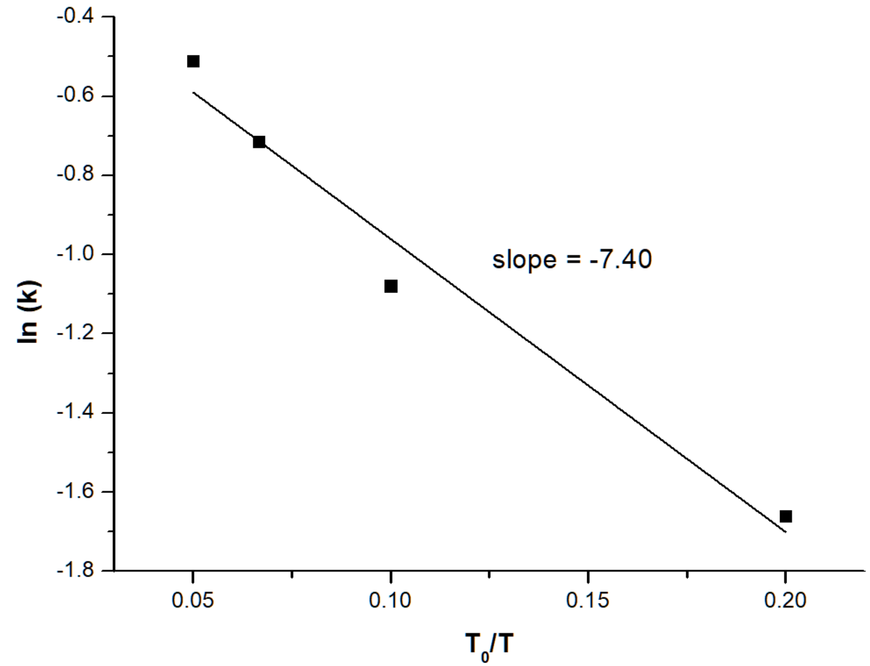


$$R = k \cdot t^n \ (R_0 \ll R)$$

$$\ln(R) = \ln(k) + n \cdot ln(t)$$

- With larger grain sizes, the more accurate value of n is obtained. ($R > 3R_0$)
  - n = 0.44 (T=20) has been selected.





$$R^{\frac{1}{n}} - R_0^{\frac{1}{n}} = k \cdot t \;(\mathrm{n} = 0.44)$$

$$k = k_0 \cdot \exp\left(-\frac{Q}{RT}\right) = k_0 \cdot \exp\left(-\frac{Q}{RT_0} \cdot \frac{T_0}{T}\right)$$

$$\ln(k) = \ln(k_0) - \frac{Q}{RT_0} \cdot \frac{T_0}{T}$$

$$\therefore \; \frac{Q}{RT_0} = 7.40$$