숙제 7 상변태론 2020-2852 철강대학원 김동현

1. (a) $\frac{\partial c}{\partial t} = \tilde{D}\frac{\partial^2 c}{\partial x^2}$

$\frac{\partial c}{\partial t} = R(\beta)\,(12\text{ at\% Au})\exp[R(\beta)t]\cos\beta x$

$\frac{\partial^2 c}{\partial x^2} = -\beta^2\,(12\text{ at\% Au})\exp[R(\beta)t]\cos\beta x$

$\therefore R(\beta)(12\text{ at\% Au})\exp[R(\beta)t]\cos\beta x = -\tilde{D}\beta^2(12\text{ at\% Au})\exp[R(\beta)t]\cos\beta x$

$\therefore R(\beta) = -\tilde{D}\beta^2$

$C_{max} = (38\text{ at\% Au}) + (12\text{ at\% Au})\exp[R(\beta)t]$ at $\beta x = n\pi$ & n is even.

$C_{min} = (38\text{ at\% Au}) - (12\text{ at\% Au})\exp[R(\beta)t]$ at $\beta x = n\pi$ & n is odd

$\Rightarrow$ max difference $= C_{max} - C_{min}$

$= 2(12\text{ at\% Au})\exp[R(\beta)t] = (2\text{ at\% Au})$

$\therefore 12\exp[R(\beta)t] = 1 \Rightarrow 12\exp[-\tilde{D}\beta^2 t] = 1$

$t = \frac{\ln(12)}{\tilde{D}\beta^2} = \frac{\ln(12)}{(10^{-28}\,m^2/s)\left(\frac{\pi}{10^{-9}\,m}\right)^2} \simeq 251\,ns$ //

(b) $\frac{\partial c}{\partial t} = \tilde{D}\frac{\partial^2 c}{\partial x^2} - \frac{2k\tilde{D}}{f''}\frac{\partial^4 c}{\partial x^4}$

$\frac{\partial^4 c}{\partial x^4} = \beta^4 (12\text{ at\% Au}) \exp[R(\beta)t]\cos\beta x$

$\Rightarrow R(\beta)(12\text{ at\% Au})\exp[R(\beta)t]\cos\beta x$

$= -\tilde{D}\beta^2(12\text{at\% Au})\exp[R(\beta)t]\cos\beta x$

$-\frac{2k\tilde{D}}{f''}\beta^4(12\text{at\% Au})\exp[R(\beta)t]\cos\beta x$

$\therefore R(\beta) = -\tilde{D}\beta^2 - \frac{2k\tilde{D}}{f''}\beta^4$

max difference $= 2(12\text{at\% Au})\exp[R(\beta)t] = (2\text{at\% Au})$

$\therefore 12\exp[R(\beta)t] = 12\exp\left[\left(-\tilde{D}\beta^2 - \frac{2k\tilde{D}}{f''}\beta^4\right)t\right] = 1$

$t = \frac{\ln(12)}{\tilde{D}\beta^2 + \frac{2k\tilde{D}}{f''}\beta^4}$

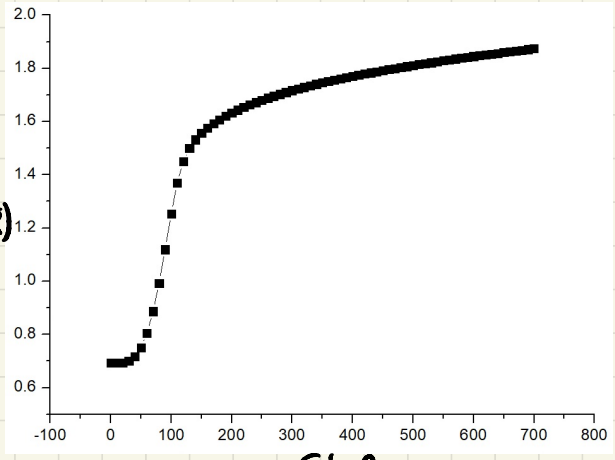
$= \frac{\ln(12)}{(10^{-23}\,m^2/s)\left(\frac{\pi}{10^{-9}\,m}\right)^2 + \frac{2(-2.6\times10^{-11}\,J/m)(10^{-23}\,m^2s^{-1})}{(5\times10^9\,J/m^3)}\left(\frac{\pi}{10^{-9}\,m}\right)^4}$

$\simeq 28057s$

(c) Ag-Au system은 bond를 더 선호하고 negative gradient energy coefficient를 가짐. 계면에너지를 고려할 경우, spinodal decomposition을 덜 선호하는 (b)가 더 적절한 것 같다.

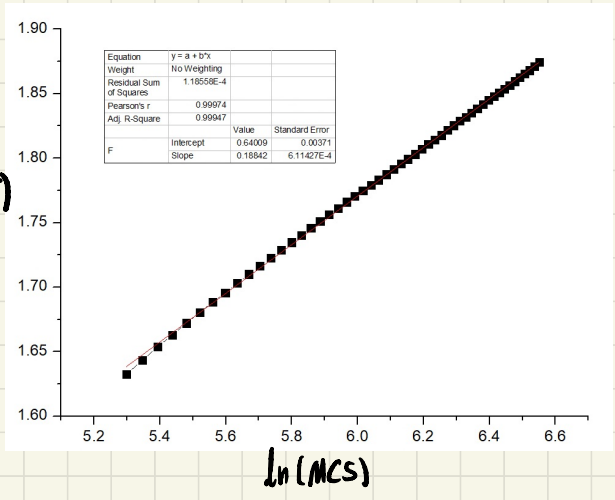
2.

(a)



$R = Rt^n$

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



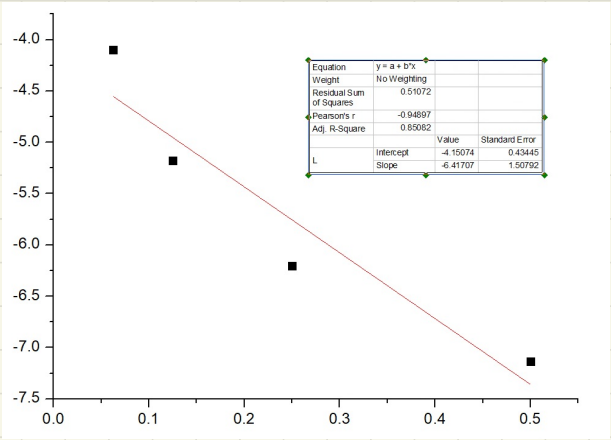
T=4 , $n = 0.1884$

이면

$R = kt^n$ 관계 성립

(b)

T	2	4	8	16
n	0.1515	0.1884	0.2532	0.3533
$\bar{R}$	1.8432	1.8743	1.9441	2.0884



$\ln\left(\frac{n\bar{R}T}{t}\right)$

$\frac{1}{T}$

$$\ln\left(\frac{n\bar{R}T}{t}\right) = \ln C - \frac{\Delta G^*}{R}\cdot\frac{1}{T}$$

$$\frac{\Delta G^*}{R} = 6.4171$$