2020 2255
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1. $C(x,0) = (38\text{ at\% Au}) + (12\text{ at\% Au})\cos\beta x$

$C(x,t) = (38\text{ at\% Au}) + (12\text{ at\% Au})\exp[R(\beta)t]\cdot\cos\beta x$

(a) Fick's ~~law~~ second law

$$\frac{\partial c}{\partial t} = \tilde{D}\frac{\partial^2 c}{\partial x^2}$$

$$\frac{\partial c}{\partial t} = R(\beta)(C - C_0) = R(\beta)\cdot(12\text{at\% Au})\cdot\exp[R(\beta)t]\cos\beta x$$

$$\frac{\partial^2 c}{\partial x^2} = -\beta^2(C - C_0) = -\beta^2\cdot(12\text{at\% Au})\exp[R(\beta)t]\cdot\cos\beta x.$$

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

∘ C_{max} correlate with $\cos\beta x = 1 \Rightarrow \beta x = n\pi$ (n is even)

$C_{max} = (38\text{at\% Au}) + (12\text{ at\% Au})\exp[R(\beta)t]$

$C_{min} = (38\text{ at\% Au}) - (12\text{ at\% Au})\exp[R(\beta)\cdot t]$

∘ maximum composition difference

$\therefore C_{max} - C_{min} = 2\times(12\text{ at\% Au})\exp[R(\beta)\cdot t] = 2\%$

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

$\Rightarrow \exp(-\tilde{D}\beta^2\cdot t) = \frac{1}{12}$

$$\Rightarrow t = \frac{\ln(\frac{1}{12})}{-\tilde{D}\beta^2} = \frac{\ln(12)}{\tilde{D}\beta^2} = \frac{\ln(12)}{(10^{-23}m^2s^{-1})(\pi/10^{-9}m)^2} \simeq 25177.4\text{ s}$$

(b) Cahn's modified diffusion equation

$$\frac{\partial c}{\partial t} = \tilde{D}\frac{\partial^2 c}{\partial x^2} - \frac{2K\tilde{D}}{f''}\frac{\partial^4 c}{\partial x^4}$$

$$\frac{\partial c}{\partial t} = R(\beta)(C - C_0) = R(\beta)\cdot(12\text{at\% Au})\cdot\exp[R(\beta)t]\cos\beta x$$

$$\frac{\partial^2 c}{\partial x^2} = -\beta^2(C - C_0) = -\beta^2\cdot(12\text{at\% Au})\exp[R(\beta)t]\cdot\cos\beta x.$$

$$\frac{\partial^4 c}{\partial x^4} = \beta^4(C - C_0) = \beta^4\cdot(12\text{at\% Au})\exp[R(\beta)t]\cdot\cos\beta x$$

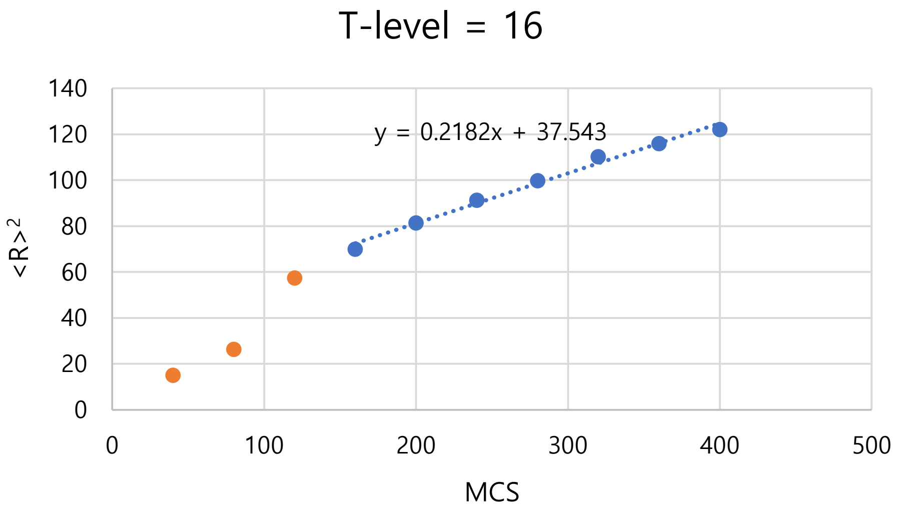
$$\therefore R(\beta) = -\tilde{D}\beta^2 - \frac{2K\tilde{D}}{f''}\cdot\beta^4$$

$$t = \frac{\ln(\frac{1}{12})}{-\tilde{D}\beta^2 - \frac{2K\tilde{D}}{f''}\beta^4} = \frac{\ln(12)}{(10^{-23}m^2s^{-1})\left(1 + \frac{2\cdot(-2.6\times10^{-11}Jm^{-1})}{5\times10^9 Jm^{-3}}\cdot\left(\frac{\pi}{10^{-9}m}\right)^2\right)}$$

$$\simeq 28051.3\text{ s}$$

(c) Ag-Au system에서 unlike atoms 간의 bonds를 선호할 경우, ~~spinodal~~ spinodal decomposition이 일어나기 힘들어짐. 이는 maximum composition difference가 2%되는데 걸리는 시간이 ~~증가함과~~ 증가함과 연관되어 있음. interfacial energy를 고려한 (b)와 고려하지 않은 (a) ~~의~~의 ~~시간을~~ 값을 비교해 볼때 더 ~~XXX~~ 긴 시간을 가진 (b)가 더 합당한 값이라고 할 수 있다.

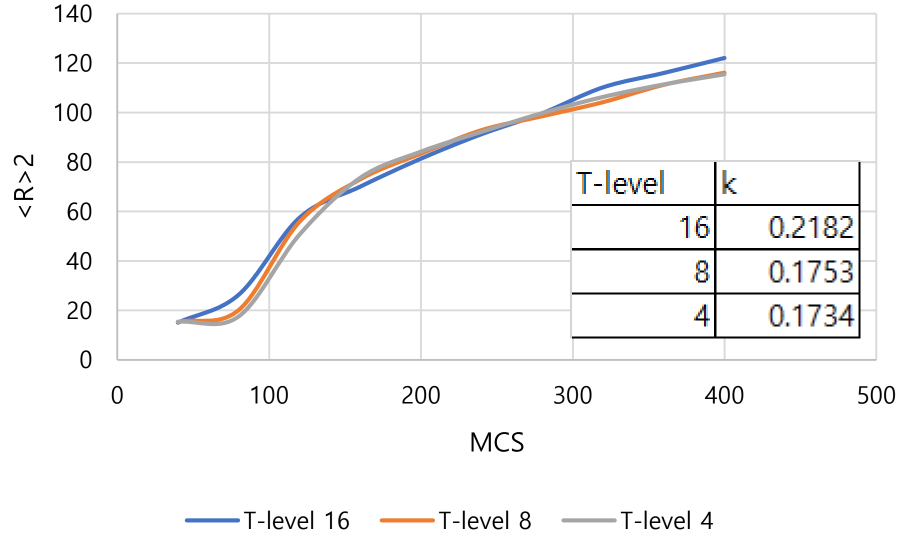
2.a



$\langle R\rangle^2 - \langle R_0\rangle^2 = kt$

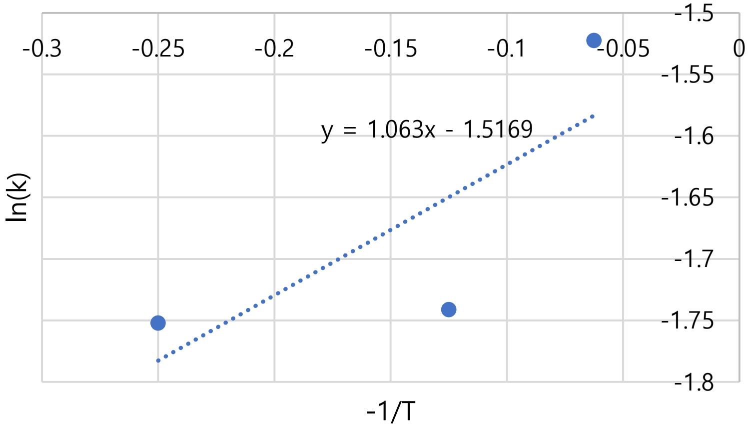
$\langle R\rangle$: grain size
$\langle R_0\rangle$: initial grain size
$k = 0.2182$
(T-level: 16)

2.b



T-level	k
16	0.2182
8	0.1753
4	0.1734

$k = k_0 * \exp(-Q/RT)$
$\ln(k) = Q/R\,(-1/T) + \ln(k_0)$
Q: activation energy



$Q/R = 1.063$