Problem Set #6

2020 2876
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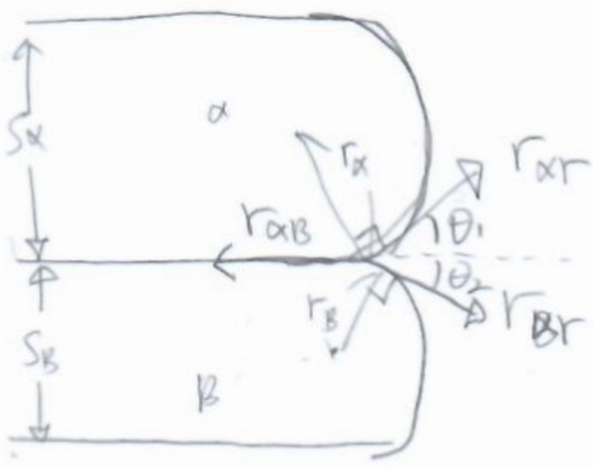
1.



(a) Force balance

x축: $r_{\alpha B} = r_{\alpha r}\cos\theta_1 + r_{Br}\cos\theta_2$, y축 : $r_{\alpha r}\sin\theta_1 = r_{Br}\sin\theta_2$

curvature가 없는 경우 ($\theta_1=\theta_2=90°$)

$r_{\alpha B}=0$, $r_{\alpha r}=r_{Br}$ 이어야 하는데 이 값은 실제로서 존재할 수 없음

curvature를 가져야만 한다

(b) radius of curvature와 layer thickness와의 관계를 식으로 표현

$S_\alpha = 2r_\alpha\cos\theta_1$, $S_B = 2r_B\cos\theta_2$

$r_{\alpha B} = r_{\alpha r}\cos\theta_1 + r_{Br}\cos\theta_2$, $r_{\alpha r}\sin\theta_1 = r_{Br}\sin\theta_2$

$r_{\alpha r}^2\sin^2\theta_1 = r_{Br}^2\sin^2\theta_2$ $r_{\alpha r}^2(1-\cos^2\theta_1) = r_{Br}^2(1-\cos^2\theta_2)$ $\dfrac{r_{\alpha r}^2 - r_{\alpha r}^2\cos^2\theta_1 - r_{Br}^2}{r_{Br}^2} = -\cos^2\theta_2$

$\cos\theta_2 = \dfrac{\sqrt{r_{Br}^2 + r_{\alpha r}^2\cos^2\theta_1 - r_{\alpha r}^2}}{r_{Br}}$ $r_{\alpha B} = r_{\alpha r}\cos\theta_1 + r_{Br}\cdot\dfrac{\sqrt{r_{Br}^2 + r_{\alpha r}^2\cos^2\theta_1 - r_{\alpha r}^2}}{r_{Br}}$

$r_{\alpha B}^2 - 2r_{\alpha B}r_{\alpha r}\cos\theta_1 + r_{\alpha r}^2\cos^2\theta_1 = r_{Br}^2 + r_{\alpha r}^2\cos^2\theta_1 - r_{\alpha r}^2$

$-\dfrac{r_{\alpha B}r_{\alpha r}S_\alpha}{r_\alpha} = r_{Br}^2 - r_{\alpha r}^2 - r_{\alpha B}^2$ $r_\alpha = \dfrac{r_{\alpha B}r_{\alpha r}S_\alpha}{r_{\alpha B}^2 + r_{\alpha r}^2 - r_{Br}^2}$

마찬가지로 계산하면

$r_B = \dfrac{S_B r_{\alpha B} r_{Br}}{r_{\alpha B}^2 - r_{\alpha r}^2 + r_{Br}^2}$

(c). capillary effect에 의한 ΔG를 계산하기

$\Delta G = \dfrac{r_{\alpha r}}{r_\alpha}V_\alpha + \dfrac{r_{Br}}{r_B}V_B = \dfrac{(r_{\alpha B}^2 + r_{\alpha r}^2 - r_{Br}^2)V_\alpha}{r_{\alpha B}S_\alpha} + \dfrac{(r_{\alpha B}^2 - r_{\alpha r}^2 + r_{Br}^2)V_B}{r_{\alpha B}S_B}$

$V_\alpha = \dfrac{S_\alpha}{S}V_m^2$ $V_B = \dfrac{S_B}{S}V_m^2$

$\Delta G = \dfrac{V_m^2}{S}\left(\dfrac{2r_{\alpha B}^2}{r_{\alpha B}}\right) = \dfrac{2r_{\alpha B}}{S}V_m^2 = \Delta G_{IF}$