

# Homework #5

(문제는 성락해드립니다).

①

1)

(a) Fe 결정 자기 이방성 계수

$$K_1 = 0.48 \times 10^5 \text{ Joule/m}^3$$

$$K_2 = 0.05 \times 10^5 \text{ Joule/m}^3$$

$$\text{i) } <100> \quad d_1 = 1 \quad d_2 = d_3 = 0 \quad \therefore E_a = K_0$$

$$\text{ii) } <110> \quad d_1 = d_2 = \frac{1}{\sqrt{2}}, \quad d_3 = 0 \quad \therefore E_a = K_0 + K_1/4$$

$$= K_0 + 0.120 \times 10^5 (\text{J/m}^3)$$

$$\text{iii) } <111> \quad d_1 = d_2 = d_3 = \frac{1}{\sqrt{3}}$$

$$\therefore E_a = K_0 + \frac{k_1}{3} + \frac{k_2}{27} = K_0 + 1.162 \times 10^5 (\text{J/m}^3)$$

b).  $E_{100} < E_{110} < E_{111}$  이므로 E가 가장 높은  $E_{100}$  o) easy axis  
o/2 E가 가장 높은  $E_{111}$  o) hard axis이다.

2)

a) base plane saturation 시기는데  $H_a$ を求め자.

: hard axis  $\theta = 90^\circ$  saturation 시기는데  $H_a$ 求め자.

$$H_a = \frac{2K_u \sin \theta}{M_o M_s} \quad M_o H_a (\beta) = \frac{2K_u \sin \theta}{M_s}$$

$$H_a = \frac{2 \times 4.1 \times 10^5 \text{ J/m}^3 \times \sin \frac{\pi}{2}}{1.42 \times 10^6 \text{ A/m} \times 1.257 \times 10^{-6} \text{ T/m}} = 4.59 \times 10^5 \text{ A/m}$$

b).  $45^\circ$  from the hexagonal axis.

$$M_o H_a (\beta) = \frac{2K_u \sin \theta}{M_s} = \frac{2 \times 4.1 \times 10^5 \times \sin \frac{\pi}{4}}{1.42 \times 10^6 \text{ A/m}} = \frac{\sqrt{2} \times 4.1 \times 10^5}{1.42 \times 10^6 \text{ A/m}}$$

$$H_a = \frac{\sqrt{2} \times 4.1 \times 10^5}{1.42 \times 10^6 \text{ A/m} \times 1.257 \times 10^{-6} \text{ A/m}} = 3.248 \times 10^5 \text{ A/m}$$

# Home work #5.

②

3

a) Saturation magnetostriiction of  $\mu_B$   $M_s$  et  $\lambda_s$ 의 방향이 같다.

$$\therefore (\alpha_1 \alpha_2 \alpha_3) = (\beta_1 \beta_2 \beta_3)$$

$$\therefore (\alpha_1 \alpha_2 \alpha_3) = (\beta_1 \beta_2 \beta_3) \quad \alpha_1 = \cos 45^\circ = \frac{1}{\sqrt{2}}, \alpha_2 = \frac{1}{\sqrt{2}}, \alpha_3 = \cos 90^\circ = 0$$

$$<110> \text{ axis} \quad \alpha_1 = \cos 45^\circ = \frac{1}{\sqrt{2}}, \alpha_2 = \frac{1}{\sqrt{2}}, \alpha_3 = \cos 90^\circ = 0$$

$$\begin{aligned} \therefore \lambda_s &= \frac{3}{2} \lambda_{100} (\alpha_1^4 + \alpha_2^4 + \alpha_3^4 - \frac{1}{3}) + 3\lambda_{111} (\alpha_1^2 \alpha_2^2 + \alpha_2^2 \alpha_3^2 + \alpha_3^2 \alpha_1^2) \\ &= \frac{3}{2} \lambda_{100} \left( 1 - 2(\alpha_1^2 \alpha_2^2 + \alpha_2^2 \alpha_3^2 + \alpha_3^2 \alpha_1^2) - \frac{1}{3} \right) + 3\lambda_{111} (\alpha_1^2 \alpha_2^2 + \alpha_2^2 \alpha_3^2 + \alpha_3^2 \alpha_1^2) \\ &= \lambda_{100} + 3(\lambda_{111} - \lambda_{100}) (\alpha_1^2 \alpha_2^2 + \alpha_2^2 \alpha_3^2 + \alpha_3^2 \alpha_1^2). \end{aligned}$$

$$\therefore \lambda_s = \lambda_{100} + 3(\lambda_{111} - \lambda_{100}) \frac{1}{4}$$

$$= -46 \times 10^{-6} + 3(-24 \times 10^{-6} + 46 \times 10^{-6}) \cdot \frac{1}{4}$$

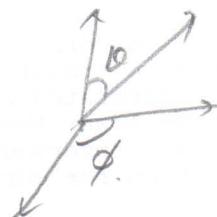
$$= -46 \times 10^{-6} + \frac{3}{2} \times 22 \times 10^{-6} = (-46 + \frac{33}{2}) 10^{-6} = -\frac{59}{2} 10^{-6}$$

b) saturation magnetostriiction의 경우  $(\alpha_1 \alpha_2 \alpha_3) = (\beta_1 \beta_2 \beta_3)$ .

$$\text{if } \theta \quad \lambda_s = \lambda_{100} + 3(\lambda_{111} - \lambda_{100}) (\alpha_1^2 \alpha_2^2 + \alpha_2^2 \alpha_3^2 + \alpha_3^2 \alpha_1^2).$$

$$\alpha_1 = \sin \theta \cos \phi, \alpha_2 = \sin \theta \sin \phi, \alpha_3 = \cos \theta$$

$$\begin{aligned} \lambda_s &= \lambda_{100} + 3(\lambda_{111} - \lambda_{100}) (\sin^4 \theta \cos^2 \phi \sin^2 \phi \\ &\quad + \sin^2 \theta \sin^2 \phi \cos^2 \theta + \sin^2 \theta \cos^2 \phi \cos^2 \theta) \\ &= \lambda_{100} + 3(\lambda_{111} - \lambda_{100}) (\sin^4 \theta \cos^2 \phi \sin^2 \phi \\ &\quad + \sin^2 \theta \cos^2 \theta (\sin^2 \phi + \cos^2 \phi)) \end{aligned}$$



$$\bar{\lambda}_s = \frac{1}{4\pi} \int_0^\pi \int_0^{2\pi} \lambda_s \sin \theta d\phi d\theta$$

$$= \frac{1}{4\pi} \int \int [\lambda_{100} + 3(\lambda_{111} - \lambda_{100}) (\sin^4 \theta \cos^2 \phi \sin^2 \phi + \sin^2 \theta \cos^2 \theta)] \sin \theta d\phi d\theta$$

$$= \lambda_{100} + \frac{3(\lambda_{111} - \lambda_{100})}{4\pi} \int_0^\pi \left( \frac{\pi}{4} - \sin^4 \theta + 2\pi \sin^2 \theta \cos^2 \theta \right) \sin \theta d\theta$$

$$\left( \int_0^{2\pi} \cos^2 \theta \sin^2 \theta d\phi = \frac{1}{4} \int_0^\pi \sin^2 2\phi d\phi = \frac{\pi}{4} \right)$$

Home work #5

(3)

3) 미적

$$b) \cos\theta = t \text{ 를 } \int_0^{\pi} \sin^5 \theta d\theta = \int_{-1}^1 [1-t^2]^2 dt = \int_{-1}^1 1-2t^2+t^4 dt$$

$$= \frac{16}{15}$$

$$\int_0^{\pi} \sin^3 \theta \cos^2 \theta d\theta = \int_{-1}^1 (1-t^2) t^2 dt = \int_{-1}^1 t^2 - t^4 dt = \frac{4}{15}$$

$$= \lambda_{100} + \frac{3(\lambda_{100} - \lambda_{100})}{4\pi} \left( \frac{4\pi}{15} + \frac{8\pi}{15} \right) = \frac{2\lambda_{100} + 3\lambda_{100}}{5}$$