

재료공학개론 과제10

2018-12432, Electrical and Computer Engineering department, ParkJeonghyun

11/28/2023

1 Problem 1

1.1 a

전자의 단위 부피당 갯수는 아래와 같다.

$$n_e = 1.3 \times \frac{\rho}{M} \times 6.02 \times 10^{23} \quad (1)$$

$$= 1.3 \times \frac{10.5 \times 10^6}{107.8682} \times 6.02 \times 10^{23} m^{-3} \quad (2)$$

$$= 7.62 \times 10^{28} m^{-3} \quad (3)$$

1.2 b

$$\mu = \frac{\sigma}{ne} \quad (4)$$

$$= \frac{6.8 \times 10^7}{7.62 \times 10^{28} \times 1.602 \times 10^{-19}} m^2/V \cdot s \quad (5)$$

$$= 5.57 \times 10^{-3} m^2/V \cdot s \quad (6)$$

2 Problem 2

2.1 a

As는 15족 원소이므로 n-type이다.

2.2 b

n-type이므로 mobile charge는 electron이므로

$$\sigma = \mu ne \quad (7)$$

$$= 0.1 \times 10^{24} \times 1.602 \times 10^{-19} \Omega^{-1} m^{-1} \quad (8)$$

$$= 1.602 \times 10^4 \Omega^{-1} m^{-1} \quad (9)$$

3 Problem 3

3.1 a

Ge의 $E_g = 0.67eV$ 이므로 아래의 식을 만족한다.

$$\sigma(448.15) = \sigma(298) \times \left(\frac{298}{448.15} \right)^{3/2} \times \exp \left(-\frac{E_g}{2k} \left(\frac{1}{448.15} - \frac{1}{298} \right) \right) \Omega^{-1} m^{-1} \quad (10)$$

$$= 2.2 \times \left(\frac{298}{448.15} \right)^{3/2} \times \exp \left(-\frac{0.67 \times 1.602 \times 10^{-19}}{2 \times 1.38 \times 10^{-23}} \left(\frac{1}{448.15} - \frac{1}{298} \right) \right) \Omega^{-1} m^{-1} \quad (11)$$

$$= 94.5 \Omega^{-1} m^{-1} \quad (12)$$

3.2 b

$$40 \Omega^{-1} m^{-1} = \sigma(298) \times \left(\frac{298}{T} \right)^{3/2} \times \exp \left(-\frac{E_g}{2k} \left(\frac{1}{T} - \frac{1}{298} \right) \right) \quad (13)$$

위의 식을 정리하여 iteration 하면

$$T = \frac{1}{\frac{2k}{E_g} \ln \left(\frac{2.2}{40} \times \left(\frac{298}{T} \right)^{3/2} \right) + \frac{1}{298}} \quad (14)$$

$$\rightarrow 401K \quad (15)$$

401K 대입시

$$\sigma(298) \times \left(\frac{298}{401} \right)^{3/2} \times \exp \left(-\frac{E_g}{2k} \left(\frac{1}{401} - \frac{1}{298} \right) \right) = 40.2 \Omega^{-1} m^{-1} \quad (16)$$

4 Problem 4

4.1 a

$$C = \frac{\varepsilon A}{d} \quad (17)$$

$$= \frac{3.5 \times 8.854 \times 10^{-12} \times 3225 \times 10^{-6}}{10^{-3}} F \quad (18)$$

$$= 99.9 pF \quad (19)$$

4.2 b

$$Q = CV \quad (20)$$

$$= CE d \quad (21)$$

따라서

$$E = \frac{Q}{Cd} \quad (22)$$

$$= \frac{2 \times 10^4}{99.9 \times 10^{-3}} V/m \quad (23)$$

$$= 2.00 V/m \quad (24)$$

5 Problem 5

$$vB = E \quad (25)$$

$$vBl = El = V \quad (26)$$

$$nevBl = IB/d = \frac{\sigma}{\mu} V \quad (27)$$

$$B = \frac{\sigma V d}{\mu I} \quad (28)$$

$$= \frac{1.2 \times 10^7 \times 35 \times 10^{-3} \times 3.5 \times 10^{-7}}{40 \times 0.0050} T \quad (29)$$

$$= 0.735 T \quad (30)$$