반도체공정개론 Homework solutions

Homework #1

1-a)

a) $R = k_1 \frac{\lambda}{n\sin\theta} = k_1 \frac{\lambda}{N_A}$

이 식 사용해서 설명한 경우 모두 정답 처리

1-b)

EUV의 photon energy가 높아서 렌즈에 투과가 아닌 흡수가 되어 열이 발생, 렌즈에 damage 발생되기 때문

1-c)

다음 4가지만 정답 처리

c) ① Double patterning
② phase shift masks
③ optical-proximity correction techniques
④ Double exposure

2-a)

a) A = area
V = volume

$\therefore V = Ax\ cm^3$

$\therefore SiO_2(g) = 2.21Ax(g)$

$SiO_2(mol) = \frac{2.21Ax}{60.08}(mol)$

Si among SiO_2 (g)

$= \frac{2.21Ax}{60.08} \times 28.9(mol)$

$\therefore Si(cm^3) = \frac{2.21Ax}{60.08} \times \frac{28.9}{2.33}$

$= 0.456Ax\ cm^3$

A는 바뀌지 X
$\therefore SiO_2$ 두께 1당 0.456 Si layer 소모됨.

2-b)

0.7hr (그래프 보고 읽으면 됨, 이 외의 값은 오답)

Homework #2

1-a)

a) Table 1 ⇒ $D_0 = 10.5\ cm^2/s$

$E_A = 3.69\ eV$

$D = 10.5 \exp\left(-\frac{3.69}{(8.614\times10^{-5})(1373)}\right)$

$= 2.96\times10^{-13}\ [cm^2/s]$

1-b)

b) Table 1 ⇒ $D = 10.5 \exp\left(-\frac{3.69}{(8.614\times10^{-5})(1423)}\right)$

$= 8.86\times10^{-13}\ cm^2/s$

$(Dt)_{tot} = (2.96\times10^{-13}\ cm^2/s)(7200s) + (8.86\times10^{-13}\ cm^2/s)(18000s)$

$= 1.81\times10^{-8}\ [cm^2]$

1-c) (i)

c) i

Cs , x_j

Figure 2 ⇒ boron의 solid-solubility limited surface concentration ~ $1.1\times10^{20}\ /cm^3$

$N(x) = 1.1\times10^{20}\ \mathrm{erfc}\left(\frac{x}{2\sqrt{Dt_1}}\right)$ boron atoms/cm^3

Junction depth $x_j \Rightarrow N(x) = N_B$ (background concentration)

$3\times10^{16}\ /cm^3$ ~ Figure 3

$\therefore 1.1\times10^{20}\ \mathrm{erfc}\left(\frac{x_j}{2\sqrt{Dt_1}}\right) = 3\times10^{16}$

$x_j = 2\sqrt{Dt_1}\ \mathrm{erfc}^{-1}(0.000273)$ ~ Figure 1

$= 2\sqrt{1.31\times10^{-12}}\,(2.51)\ cm$

$= 0.0589\ \mu m\ (58.9\ nm)$

1-c) (ii)

c) ii

$Q = 2N_0\sqrt{Dt_1/\pi} = 2(1.1\times10^{20})\sqrt{(1.45\times10^{-15})(900)/\pi}$

$\therefore Q = 1.42\times10^{14}$ boron atoms/cm^2

$N(x) = \frac{Q}{\sqrt{\pi Dt_2}} \exp\left(-\frac{x_j}{2\sqrt{Dt_2}}\right)^2$

$= 1.1\times10^{18} \exp\left(-\frac{x_j}{1.47\times10^{-4}}\right)^2$

$N_B = 3\times10^{16}$ ~ Figure 3

$\therefore 1.1\times10^{18} \exp\left(-\frac{x_j}{1.47\times10^{-4}}\right)^2 = 3\times10^{16}$

i) 윗식과 같은 방법으로 풀이함.

$x_j = 1.47\times10^{-4}\times\sqrt{\ln\left(\frac{1.1\times10^{18}}{3\times10^{16}}\right)}$

$= 2.99\ \mu m$

2)

$10\ \mu m = W - 2(300\ \mu m)\cot(54.7^\circ)$

$10\ \mu m \approx W - \sqrt{2}\times(300\ \mu m)$

$W = 434.26\ \mu m$