

P1. We know that $\sigma = 9 \text{ m}\mu\text{m}$

- Reading the graph for Si mobility we have $\mu_n \approx 1100 \text{ cm}^2/\text{Vs}$

- By the level of doping we know $n = 1 \times 10^{16} \text{ a}/\text{cm}^3$

Therefore
$$\sigma_{\text{Si}} = 1,6 \times 10^{-19} * 1 \times 10^{16} * 1100 = 1,76 \text{ S} \rightarrow \rho = \frac{1}{\sigma} = 0,57 \Omega \cdot \text{cm}$$

For GaAs $\mu_n = 7000 \Rightarrow \sigma = 11,2 \text{ S} \rightarrow \rho = 0,09 \Omega \cdot \text{cm}$

P2. According to the problem we know that $t \ll \tau$. Therefore we can apply the table to derive the right coefficient (see table)

So in this case $\rho = 4,532 \frac{\text{V}}{\text{I}} \Rightarrow \rho = 0,27 \Omega \cdot \text{cm}$

P3. We know that the saturation current density (A/cm^2) is

given by
$$I_0 = \frac{q D_n n_i^2}{L_n N_A} + \frac{q D_p n_i^2}{L_p N_D} \quad (\text{aula 5, slide 12})$$

this is in fact a current density !! We should use J_0 (and not I_0)

we also know that $L_n = \sqrt{D_n \tau_n}$ and $L_p = \sqrt{D_p \tau_p}$; $n_i^2 = \frac{n_i^2}{N_D}$ and $n_i^2 = \frac{n_i^2}{N_A}$

$$\Rightarrow J_0 = q n_i^2 \left(\frac{1}{N_D} \sqrt{\frac{D_p}{\tau_p}} + \frac{1}{N_A} \sqrt{\frac{D_n}{\tau_n}} \right)$$

with the given values we find
$$J_0 = 1,6 \times 10^{-19} * (9,65 \times 10^9)^2 \left(\frac{1}{10^{16}} \sqrt{\frac{10}{5 \times 10^{-7}}} + \frac{1}{5 \times 10^{16}} \sqrt{\frac{21}{5 \times 10^{-7}}} \right)$$

$$J_0 = 8,58 \times 10^{-12} \text{ A}/\text{cm}^2$$

Since we have an area $A = 2 \times 10^{-4} \text{ cm}^2$ then

$$I_0 = J_0 * A = 1,72 \times 10^{-15} \text{ A}$$

P4

By reading the excel file and counting the number of photons above the Si bandgap gives us a value of $\approx 45 \text{ mA/cm}^2$

P5

We know $V_{oc} = V_t \ln\left(\frac{I_L}{I_0} + 1\right)$ Awt 5, slide 18

Since from problem 4 the maximum current density is 45 mA/cm^2 we obtain $V_{oc} = 0,15 \text{ V}$

P6. From slide 14 of awt 4 we find

$$\alpha_{500} = 10^4 \text{ cm}^{-1} \text{ and } \alpha_{800} = 10^3 \text{ cm}^{-1}$$

Therefore the absorption length is

$$\alpha_{500}^{-1} (500 \text{ nm}) = 1 \mu\text{m} \text{ and } \alpha_{800}^{-1} (800 \text{ nm}) = 10 \mu\text{m}$$

Using $I = I_0 e^{-\alpha x}$ we know that to absorb 90% $\Rightarrow \frac{I}{I_0} = 0,1$

$$\Rightarrow 0,1 = e^{-\alpha x}$$

for $\lambda = 500 \text{ nm}$ we have $x = 2,3 \mu\text{m}$

for $\lambda = 800 \text{ nm}$ " " $x = 23 \mu\text{m}$