Øving 1 TFE4182 Abdullah

[1] a) The material is an n-type semiconducter

b) Arsenic consentration : $4 \cdot 10^{25}$ atoms / m^3
carrier concentration (n_i): $1,5 \cdot 10^{16}$ carriers / m^3

$$n_p = \frac{n_i^2}{N_A} e^{V_D/V_T} \quad , \quad P_n = \frac{n_i^2}{N_D} e^{V_D/V_T}$$

free e^- => negative carrier
free holes => postive carriers

When n-type is used => the totel number of negalive carriers or electron is almost the same as the doping concentratio and is much grather than the number of free e^-

n_n = free-e^- concentration in n-type and
N_D = doping concentration

$\underset{\text{n-type}}{n_n}$ ← concentration of e^- $\underset{\text{n-typ}}{P_A}$ ← concentration of holes

$$P_{in} = \frac{\text{carrier concentratio}^2}{e^- \text{ concentration}} = \frac{(1,5 \cdot 10^{16})^2}{4 \cdot 10^{25}} = 5,63 \cdot 10^6 \; e^+/m^3$$

n_A = ~~it's~~ given by Arsenic concentration = $4 \cdot 10^{25}$ atoms/m^3

c) The number of carriers approxmately doubles for every 11 c' increas in temperature

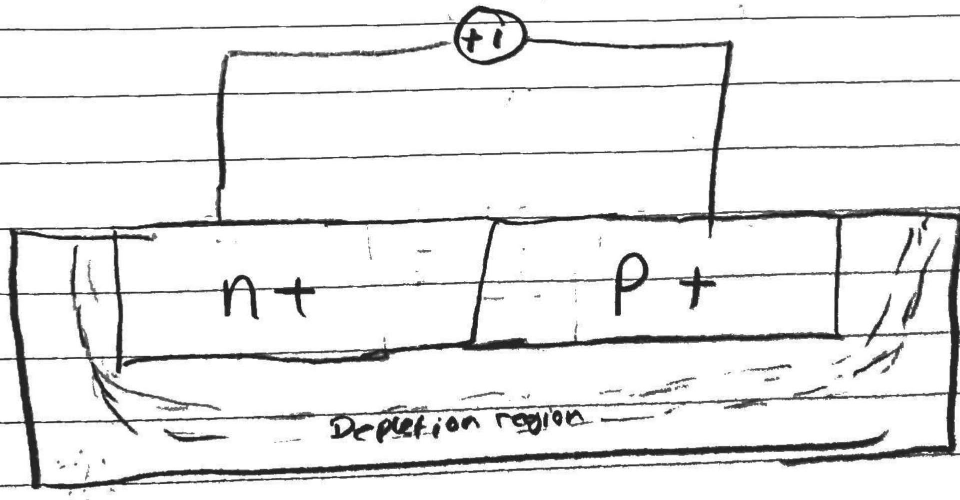
d) 1) conductivity will increase with temperature

2) number of carriors will stay the same => conductivity wil not increase with temperature

[2] a) mask: 100 $\mu m \times 100 \mu m$
pn-junction: Backward bias 5V
thermal generation: $3.2 \cdot 10^7$ e^- holes/s

The leakage curren of a reversed biased junction:

$$I_{lk} = \frac{q A_j n_i}{2\tau_0} X_d$$



2 a) $q = 1{,}6 \cdot 10^{-19}\ C\ [As]$

leakage current:

$3{,}2 \cdot 10^{7} \cdot \frac{\text{ladning}}{s}$

$I_{lk} = 3{,}2 \cdot 10^{7} \cdot 1{,}6 \cdot 10^{-19} = \underline{\underline{5{,}12 \cdot 10^{-12}\ A}}$

b) If a diode is reverse-biased, current flow is primarily due to thermally generated carriers in the depletion region, and its extremely small Although this reverse-bias current is only weakly dependent on the applied voltage.
The leakage current is not depend on the reverse bias voltage. Because there wont be generated a current through n+ and p+. There will be a barrier between n+ and p+ because of the reverse-biased voltage.

c) The current will increase with temperature because you will find more electron in the conduction band and the electrone-hole pair will increase. Also from 1.128 from the book we can see that I_{lk} is proportional with n_i and n_i will increase with temperature

d) The reverse-biased current is directly proportional to the area of the diode junction. Also from eq. 1.128 we can se that with a bigger mask we get higher current The reverse leakage curren is 4 times more with a 200 μm x 200 μm mask

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$N_D = 10^{25}$ e/m^3

$N_A = 5 \cdot 10^{22}$ holes/m^3

$T = 300$ k

$n_i = 1{,}1 \cdot 10^{16}$ carries/m^3

From eq (1.6) from the book

$$\Phi_0 = V_T \cdot \ln\left(\frac{N_A N_D}{(n_i)^2}\right), \quad V_T = \frac{KT}{q}, \quad K = \text{boltzmann constant}$$

$$\Phi_0 = \frac{(1{,}38 \cdot 10^{-23}\ \mathrm{JK^{-1}}) \cdot 300\ \mathrm{k}}{1{,}602 \cdot 10^{-19}\ \mathrm{c}} \cdot \ln\left(\frac{10^{25}\ \mathrm{e/m^3} \cdot 5 \cdot 10^{22}\ \mathrm{holes/m^3}}{\left(1{,}1 \cdot 10^{16}\ \frac{\mathrm{carriers}}{\mathrm{m^3}}\right)^2}\right)$$

$$\Phi_0 = -2{,}14 \cdot 10^{24}$$

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