$$V_o = \frac{kT}{q}\left[\ln \frac{N_A N_D}{n_i^2}\right]$$

$$= 0.0259\left[\ln \frac{N_A \cdot N_D}{\{1.5\times10^{10}\}^2}\right] = 0.6946\ V$$

$$\ln \frac{N_A \cdot N_D}{\{1.5\times10^{10}\}^2} = 26.82$$

$$\frac{N_A \cdot N_D}{\{1.5\times10^{10}\}^2} = e^{26.82} \Rightarrow N_A \cdot N_D = 1.0\times10^{32} \quad [cm^{-6}]$$

$$\Rightarrow N_D = 1.0\times10^{32}/N_A \quad (1)$$

$$W = \sqrt{\frac{2k_s\varepsilon_o}{q}\left(\frac{1}{N_D}+\frac{1}{N_A}\right)V_o} = 9.6\times10^{-5}\ cm$$

$$\frac{2\cdot11.8\cdot8.85\times10^{-14}}{1.6\times10^{-19}}\left(\frac{1}{N_D}+\frac{1}{N_A}\right)\cdot0.6946 = (9.6\times10^{-5})^2\ cm$$

$$\frac{1}{N_D}+\frac{1}{N_A} = 1.01\times10^{-15} \quad [cm^3] \quad -(2)$$

From (1) and (2), $\frac{N_A}{1.0\times10^{32}}+\frac{1}{N_A} = 1.01\times10^{-15}$

$\Rightarrow N_A = 10^{15}\ cm^{-3}$, $N_D = 10^{17}\ cm^{-3}$ ($\because N_D > N_A$)

- Forward bias current

$$I = A\cdot J_o\left(\frac{qV_A}{e^{kT}}-1\right) \quad -(3)$$

$$J_o = (q \cdot n_i^2)\left[\frac{D_p}{N_D L_p} + \frac{D_n}{N_A \cdot L_n}\right]$$

$$D_p = \mu_p \frac{kT}{q}$$

↕ hole diffusion coefficient (cm^2/sec)

μ_p : hole mobility ($Cm^2/V \cdot s$)

$\mu_p = 331\ cm^2/V \cdot s$ for $N_D = 10^{17}\ cm^{-3}$

see graph below

$$D_p = 331 \times 0.0259 = 8.5729\ cm^2/s$$

$$D_n = \mu_n \frac{kT}{q}$$

$\mu_n = 1345 cm^2/V \cdot s$ for $N_D = 10^{15}\ cm^{-3}$

see graph below

$$D_n = 1345 \cdot 0.0259 = 34.836\ cm^2/s$$

$$L_p = \sqrt{D_p \tau} = \sqrt{8.5729 \times 0.0025} = 0.146\ cm$$

↕ Diffusion length for holes

$$L_n = \sqrt{D_n \cdot \tau} = \sqrt{34.836 \times 0.0025} = 0.295\ cm$$

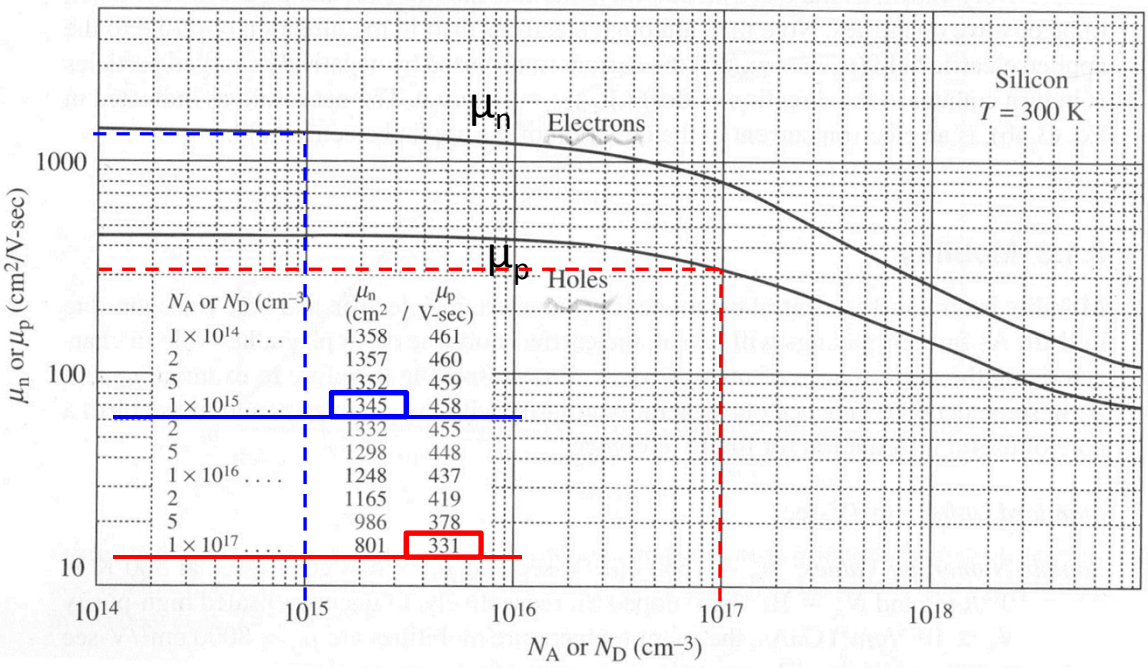
$$J_o = 1.6 \times 10^{-19} \cdot (1.5 \times 10^{10})^2 \cdot \left[\frac{8.5729}{10^{17} \cdot 0.146} + \frac{34.836}{10^{15} \cdot 0.295}\right]$$

$$= 4.27 \times 10^{-12}\ C/cm^2 \cdot s$$

$$I = A \cdot J_o\left(e^{\frac{qV_A}{KT}} - 1\right) = 0.001 \times 4.27 \times 10^{-12} \times \left(e^{\frac{0.65}{0.0259}} - 1\right)$$

$$= 0.3386 mA$$

Solutions



N_A or N_D (cm^{-3})	μ_n (cm^2 / V-sec)	μ_p
1×10^{14}	1358	461
2	1357	460
5	1352	459
1×10^{15}	1345	458
2	1332	455
5	1298	448
1×10^{16}	1248	437
2	1165	419
5	986	378
1×10^{17}	801	331