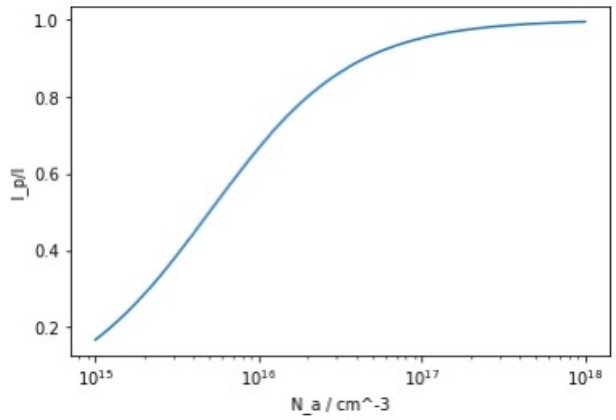
VE320 HW7 周雅翔 5180219110 39

1. $\frac{I_p}{I} = \frac{J_p}{J_n+J_p} = \frac{1}{1+\frac{N_d}{N_a}\sqrt{\frac{D_n\tau_{p0}}{D_p\tau_{n0}}}} = \frac{1}{1+\frac{1}{2}\cdot\frac{N_d}{N_a}}$



2. (a). $I_S = A\cdot J_S = Aen_i^2\left[\frac{1}{N_a}\sqrt{\frac{D_n}{\tau_{n0}}} + \frac{1}{N_d}\sqrt{\frac{D_p}{\tau_{p0}}}\right] = 2.32\times10^{-15}\ A$

(b). $I_r = \frac{Aen_iW}{2\tau_0}$

$V_{bi} = 0.0259\ln\left(\frac{(4\times10^{16})^2}{(1.5\times10^{10})^2}\right) = 0.77\ V$

$W = \sqrt{\frac{2\varepsilon_S(V_{bi}+V_R)}{e}\left(\frac{N_a+N_d}{N_aN_d}\right)} = 6.11\times10^{-5}\ cm$

$I_r = \frac{10^{-4}\times1.6\times10^{-19}\times1.5\times10^{10}\times6.11\times10^{-5}}{2\times10^{-7}} = 7.33\times10^{-11}\ A$

(c). $\frac{I_r}{I_S} = 3.16\times10^{4}$

3. (a). (i). $D_n = \frac{\mu_n kT}{e} = 5500\times0.0259 = 142.45$

$D_p = 220\times0.0259 = 5.698$

$I_S = Aen_i^2\left[\frac{1}{N_a}\sqrt{\frac{D_n}{\tau_{n0}}} + \frac{1}{N_d}\sqrt{\frac{D_p}{\tau_{p0}}}\right] = 1.50\times10^{-22}\ A.$

(ii). $I_D = I_S\left[\exp\left(\frac{0.6}{0.0259}\right)-1\right] = 1.73\times10^{-12}\ A$

(iii). $I_D = I_S\left[\exp\left(\frac{0.8}{0.0259}\right)-1\right] = 3.90\times10^{-9}\ A$

(iv). $I_D = I_S\left[\exp\left(\frac{1.0}{0.0259}\right)-1\right] = 8.79\times10^{-6}\ A$

(b).(i) $I_r = \frac{AeWn_i}{2\tau}$

$V_{bi} = 0.059 \ln \frac{(7\times10^{16})^2}{(1.8\times10^{6})^2} = 1.263 \ V$

$W = \sqrt{\frac{2\varepsilon_s(V_{bi}+V_R)}{e}\left(\frac{N_a+N_d}{N_aN_d}\right)} = 4.2\times10^{-5}$

$I_r = \frac{2\times10^{-4}\times1.6\times10^{-19}\times4.2\times10^{-5}\times1.8\times10^{6}}{2\times2\times10^{-8}} = 6.05\times10^{-14} A.$

(ii). $I = I_r \exp\left(\frac{0.6}{2\times0.059}\right) = 6.44\times10^{-9} A$

(iii) $I = I_r \exp\left(\frac{0.8}{2\times0.059}\right) = 3.06\times10^{-7} A$

(iv). $I = I_r \exp\left(\frac{1}{2\times0.059}\right) = 1.45\times10^{-5} A$

4.(a).(i). $e\phi_B = 0.63 \ eV$

$I_{ST} = A \cdot J_{ST} = 10^{-4} A^* T^2 \exp\left(\frac{-e\phi_{B0}}{kT}\right) = 2.95\times10^{-8} A$

$V_a = V_t \ln\left(\frac{I}{I_{st}}+1\right) = 0.059 \ln\left(\frac{10\times10^{-6}}{2.95\times10^{-8}}+1\right) = 0.15 \ V$

(ii). $V_a = 0.21 \ V$

(iii). $V_a = 0.27 \ V$

(b).(i). $I_{ST} = A \cdot J_{ST} = 10^{-4} A^* T^2 \exp\left(\frac{-e\phi_{B0}}{kT\times350/300}\right) = 1.30\times10^{-6} A$

$V_a = V_t \ln\left(\frac{I}{I_{ST}}+1\right) = 0.065 \ V$

(ii). $V_a = 0.13 \ V$

(ii). $V_a = 0.20 \ V$

5. (a). (i). $R = \frac{R_c}{A} = 5\,\Omega$

$V = IR = 5\,mV$

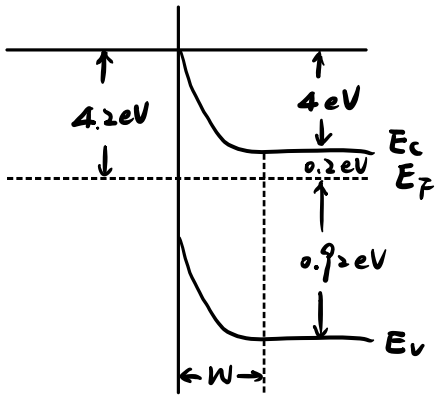
(ii). $V = IR = 0.5\,mV$

(b). (i). $R = \frac{R_c}{A} = 50\,\Omega$

$V = IR = 50\,mV$

(ii). $V = IR = 5\,mV$

6. (a).



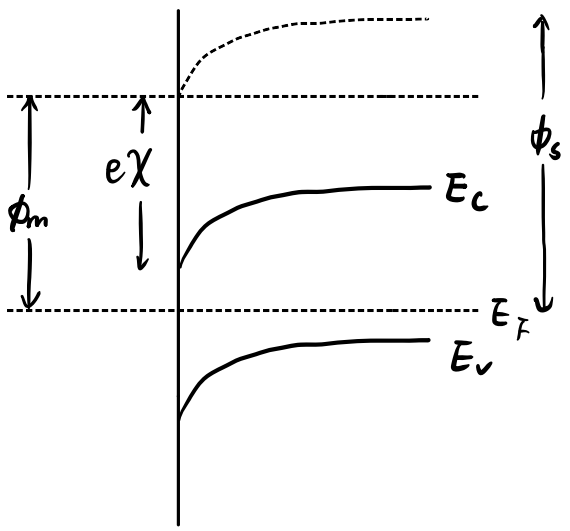
(b). $\phi_n = \phi_m - \chi = 0.2\,V$

$0.2 = V_t \ln\left(\frac{N_c}{N_d}\right)$

$N_d = 1.24 \times 10^{16}\ cm^{-3}$

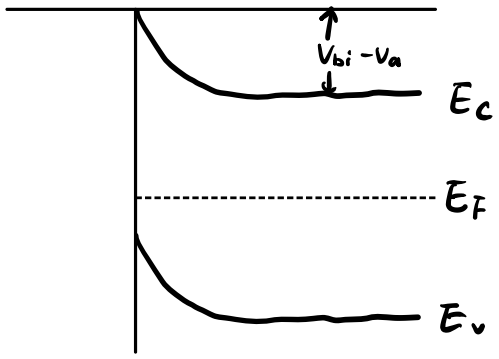
(c). $0.2\,V$

7. (a).



(b) $\phi_{B0} = 4.3eV - 4.0eV = 0.3eV$

(c)



(d)