$\therefore$ at T = 293 K (room temp.), $\underline{\alpha = -7.94\times10^{-2}\ K^{-1}}$

If we can measure the local rate of change of resistance, we can determine the temperature coefficient at that temperature. Hence, we can deduce the temperature from eqn (3).

8.9 For an n-type semiconductor, $N_e \gg N_h$ and $N_e \simeq N_D - N_A$ if all the impurity acceptors are ionized.

$\therefore$ conductivity $\simeq N_e e\mu_e \simeq (N_D - N_A)e\mu_e$

Without the impurity (i.e. $N_A = 0$), resistivity = 0.05 Ωm,

$$\therefore \frac{1}{0.05} = N_D e\mu_e \tag{1}$$

With the impurity, resistivity = 0.06 Ωm.

$$\therefore \frac{1}{0.06} = (N_D - N_A)e\mu_e \tag{2}$$

From eqns (1) and (2),

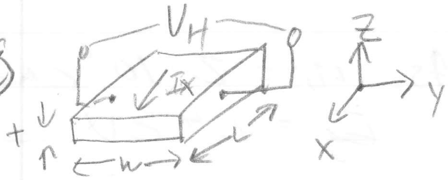
$$N_A = \underline{2.45\times10^{19}\ m^{-3}} \quad \text{and} \quad N_D = \underline{1.47\times10^{20}\ m^{-3}}$$

8.10 For a p-type semiconductor, $N_h \gg N_e$ and $N_h \simeq N_A$

$\therefore$ conductivity $\simeq N_h e\mu_h \simeq N_A e\mu_h$

$\therefore$ $1/10 \simeq 1.6\times10^{-19}\times0.05\ N_A$

giving $N_A = \underline{1.25\times10^{19}\ m^{-3}}$

⑥ 

SILICON HALL SAMPLE

$L = 0.1\ cm$ $I_x = 1.0\ mA$
$W = 0.01\ cm$ $V_x = 12.5\ V$
$t = 0.001\ cm$

$B_Z = 500\ \text{GAUSS} = .05\ T$ $N_A = 1\cdot 10^{16}\ cm^{-3}$
$N_D = 3\cdot 10^{15}\ cm^{-3}$

$$R_x = \frac{V_x}{I_x} = \frac{12.5\ V}{1.0\ mA} = 12.5\ k\Omega$$

$$R = \frac{\rho L}{A} \Rightarrow \rho = \frac{AR}{L} = \frac{(w\cdot t)\cdot R}{L} = \frac{(.01cm\cdot .001cm)12.5k}{(.1cm)}$$

$$\rho = 1.25\ \Omega\cdot cm \Rightarrow \frac{1}{\rho} = \underline{\sigma = .8\ \Omega^{-1}cm^{-1}}$$

SINCE THERE ARE MORE ACCEPTORS THAN DONORS, THERE WILL BE MORE HOLES THAN CONDUCTION ELECTRONS (ALL ELECTRONS FROM DONOR LEVEL WILL DROP TO FILL ACCEPTORS)

SO WE WILL HAVE $p \approx 10\cdot 10^{15} - 3\cdot 10^{15} = \underline{7\cdot 10^{15} cm^{-3}}$

n WILL BE ON THE ORDER OF $\frac{n_i^2}{N_D} \sim 10^5\ cm^{-3}$
SO WE CAN <u>NEGLECT n.</u>

$$\text{SO}\quad \sigma = q\,p\,\mu_p \Rightarrow \mu_p = \frac{\sigma}{q\,p} = \frac{(.8\ \Omega^{-1}cm^{-1})}{(1.6\cdot 10^{-19}\ C)(7\cdot 10^{15}\ cm^{-3})}$$

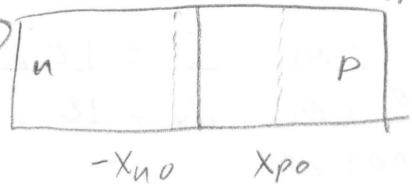
$$\boxed{\mu_p = 714\ cm^2/V\cdot s} \quad p_0 = \frac{I_x B_Z}{q\,t\,V_H} \Rightarrow V_H = \frac{I_x B_Z}{q\,t\,p_0}$$

$$V_H = \frac{(1.0\ mA)(.05\ T)}{(1.6\cdot 10^{-19}\ C)(10^{-5}\ m)(7\cdot 10^{21}\ m^{-3})} = \boxed{4.46\ mV = V_H}$$

POSITIVE SINCE DOMINATED BY HOLES

$N_D = 10^{17}\,cm^{-3}$ $\quad N_A = 10^{16}\,cm^{-3}$ $\quad \epsilon = 13.1\,\epsilon_0$

3) (i)



GaAs, $n_i = 2\cdot 10^{6}\,cm^{-3}$

$E_g = 1.4\,eV$

$$V_0 = \frac{kT}{q}\ln\left(\frac{N_A N_D}{n_i^2}\right) = (.026\,V)\ln\left(\frac{10^{17}\,10^{16}}{4\cdot 10^{12}}\right)$$

$$\boxed{V_0 = 1.22\ V}$$

$$W = \sqrt{\frac{2\epsilon V_0}{q}\left[\frac{N_A + N_D}{N_A N_D}\right]} =$$

$$W = \left[\frac{2\cdot(13.1\cdot 8.85\cdot 10^{-14}\,F/cm)(1.22\,V)}{(1.6\cdot 10^{-19}\,C)}\left[\frac{10^{17}+10^{16}}{10^{33}}\right]cm^3\right]^{1/2}$$

$\underline{W = 441\ nm}$ $\quad x_{n0} + x_{p0} = W$ & $x_{n0} N_D^+ = x_{p0} N_A^-$

$\Rightarrow x_{p0} = 10\cdot x_{n0}$ so $\underline{x_{p0} = \frac{10}{11}\cdot W = 401\ nm}$

$\underline{x_{n0} = \frac{1}{11}\cdot W = 40\ nm}$

(ii)

BEFORE CONTACT

AFTER CONTACT