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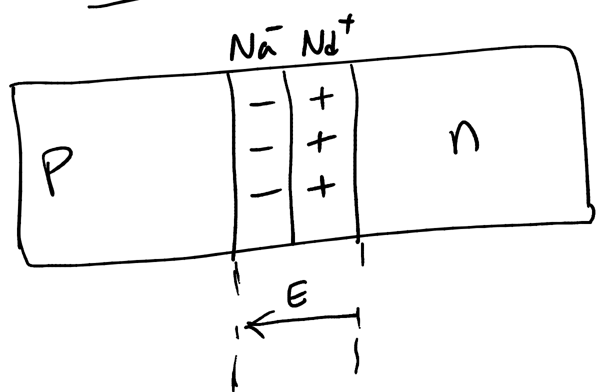
LECTURE-12

PN JUNCTION



TWO TYPES OF CURRENT PHENOMENA

1) DIFFUSION
2) DRIFT

PARTICLE FLOW		CURRENT
→	HOLE DIFFUSION	→
←	HOLE DRIFT	←
←	ELECTRON DIFFUSION	→
→	ELECTRON DRIFT	←

CAUSED BY E FIELD

MINORITY CARRIERS ARE FORMED BY "MAINLY" THERMAL EXCITATIONS

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AT EQUILIBRIUM

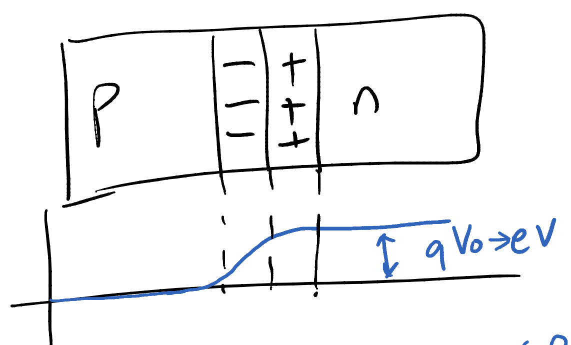
P SIDE $\longrightarrow$ $n_{po} \longrightarrow N_{dp}^{+}$

$p_{po} \longrightarrow N_{ap}^{-}$

n SIDE $\longrightarrow$ $n_{no} \longrightarrow N_{dn}^{+}$

$p_{no} \longrightarrow N_{an}^{-}$

CONTACT POTENTIAL $V_o \longrightarrow$ VOLTS



VOLTS $\leftarrow$ $$V_o = \frac{KT}{q} \ln\left(\frac{n_{no}}{n_{po}}\right) = \frac{KT}{q} \ln\left(\frac{p_{po}}{p_{no}}\right)$$

$$V_o = \frac{KT}{q} \ln\left[\frac{\left(N_{ap}^{-} - N_{dp}^{+}\right)\left(N_{dn}^{+} - N_{an}^{-}\right)}{n_i^2}\right]$$

FOR EXTRINSIC DOPING

$$\left(\frac{n_{no}}{n_{po}}\right) = \left(\frac{p_{po}}{p_{no}}\right) = e^{\left(\frac{qV_o}{KT}\right)}$$

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RELATION TO FERMI LEVELS

ON EACH SIDE OF THE JUNCTION

$$qV_0 = KT \ln\left(\frac{n_{no}}{n_{po}}\right) = KT \ln\left(\frac{n_{no}}{n_i}\,\frac{n_i}{n_{po}}\right)$$

$$= KT\left[\ln\left(\frac{n_{no}}{n_i}\right) + \ln\left(\frac{n_i}{n_{po}}\right)\right]$$

$$= KT \ln\left(\frac{n_{no}}{n_i}\right) - KT \ln\left(\frac{n_{po}}{n_i}\right)$$

$$qV_0 = (E_F - E_{in}) - (E_F - E_{ip})$$

$$qV_0 = E_{ip} - E_{in}$$

$$qV_0 = (E_F - E_{in}) + (E_{ip} - E_F)$$

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ABRUPT Si P-n JUNCTION

Ex

$p_{p0} \leftarrow N_a = 10^{18}\ cm^{-3}$ ON P SIDE

$n_{n0} \leftarrow N_d = 5 \times 10^{15}\ cm^{-3}$ ON n SIDE

FIND FERMI LEVELS AT 300°K
ON P AND n REGIONS

$n_i = 1.5 \times 10^{10}\ cm^{-3}$

$$E_F - E_{in} = KT \ln\left(\frac{n_{n0}}{n_i}\right) = 0.0259 \ln\left(\frac{5 \times 10^{15}}{1.5 \times 10^{10}}\right)$$

$$= 0.329\ eV$$

$$E_{ip} - E_F = KT \ln\left(\frac{n_i}{n_{p0}}\right)$$

$$n_{p0}\, p_{p0} = n_i^2$$

$$n_{p0} = \frac{n_i^2}{p_{p0}}$$

$$E_{ip} - E_F = KT \ln\left(\frac{n_i\, p_{p0}}{n_i^2}\right) = KT \ln\left(\frac{p_{p0}}{n_i}\right)$$

$$= 0.0259 \ln\left(\frac{10^{18}}{1.5 \times 10^{10}}\right) = 0.467\ eV$$

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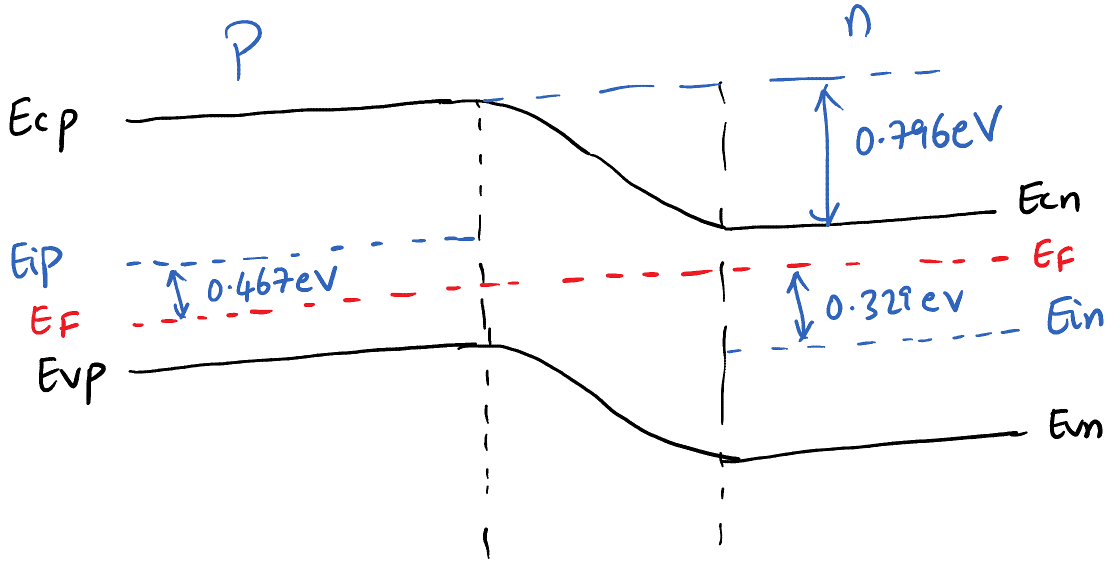
$$qV_0 = (E_F - E_{in}) + (E_{ip} - E_F) = 0.329 + 0.467$$
$$= 0.796 \text{ eV}$$

$$qV_0 = KT \ln\left(\frac{N_a N_d}{n_i^2}\right) = 0.796 \text{ eV}$$



* IF $qV_0 = 0.796 \text{ eV}$

$V_0 = 0.796 \text{ V}$