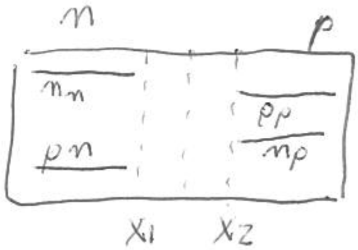
* Junção PN

+ Circuito Aberto

* $\vec{J}_{n\,der} = q\mu_n n \vec{E}$
* $\vec{J}_{p\,der} = q\mu_p p \cdot \vec{E}$
* $\vec{J}_{n\,dif} = qD_n \frac{dn}{dx}$
* $\vec{J}_{p\,dif} = -qD_p \frac{dp}{dx}$

=> Junção em equilíbrio



$$|\vec{J}_{der}| = |\vec{J}_{dif}|$$

↓ Lado p

$$q\mu_p p \cdot E = qD_p \frac{dp}{dx}$$

$$\frac{\mu_p}{D_p} \cdot \left(-\frac{dV}{dx}\right) = \frac{dp}{dx} \cdot \frac{1}{p}$$

$$-\frac{\mu_p}{D_p} \cdot \frac{dV}{dx} = \frac{dp}{dx}$$

$$-\frac{\mu_p}{D_p} \int_{x_1}^{x_2} dV = \int_{p_n}^{p_p} \frac{dp}{p}$$

$$V(x_2) - V(x_1) = -\frac{D_p}{\mu_p} \cdot \ln \frac{p_p}{p_n}$$

$$|V_0| = \frac{KT}{q} \ln \frac{p_p}{p_n}$$

$p_p \to N_A$, $p_n \to \frac{n_i^2}{N_D}$

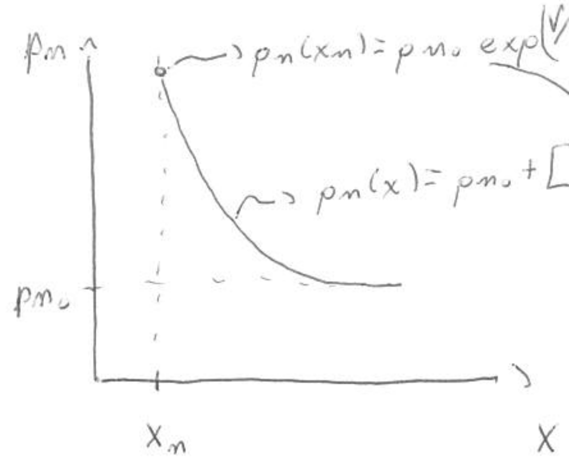
$$\boxed{V_0 = \frac{KT}{q} \ln \frac{N_A N_D}{n_i^2}}$$

$\frac{KT}{q}$: $V_T \to$ tensão termodinâmica

V_0: → Potêncial interno

* Junção PN

+ Polarização Direta



$\rightarrow p_n(x_n) = p_{no}\exp(V/V_T)$

$\rightarrow p_n(x) = p_{no} + [p_n(x_n) - p_{no}]\exp\frac{-(x-x_n)}{L_p}$

$\hookrightarrow$ comprimento de difusão

$* L_p = \sqrt{D_p \cdot \tau_p}$

$\hookrightarrow$ tempo de vida dos portadores minoritários

$$\Rightarrow \begin{cases} J_{p\,dif} = -q D_p \dfrac{dp_n(x)}{dx} \\ p_n(x_n) = p_{no} + \left[p_{no}\exp\left(\dfrac{V}{V_T}\right) - p_{no}\right]\exp\left[\dfrac{-(X-X_n)}{L_p}\right] \end{cases}$$

$$\hookrightarrow p_n(x_n) = p_{no}\left\{1 + \left[\exp\left(\frac{V}{V_T}\right) - 1\right]\exp\left[-\frac{(x-x_n)}{L_p}\right]\right\}$$

$$J_{p\,dif} = -q D_p \cdot p_{no}\left\{\left[\exp\left(\frac{V}{V_T}\right) - 1\right]\cdot\left(-\frac{1}{L_p}\right)\cdot\exp\left[\frac{-(x-x_n)}{L_p}\right]\right\}$$

$$\boxed{J_{p\,dif} = q\frac{D_p}{L_p}\cdot p_{no}\cdot\left[\exp\left(\frac{V}{V_T}\right) - 1\right]\cdot\exp\left[-\frac{(X-x_n)}{L_p}\right]}$$

$$\boxed{J_{p\,dif_{máx}} = q\frac{D_p}{L_p}\cdot p_{no}\cdot\left[\exp\left(\frac{V}{V_T}\right) - 1\right]}$$

$$\boxed{J_{n\,dif_{máx}} = q\frac{D_N}{L_N} n_{po}\cdot\left[\exp\left(\frac{V}{V_T}\right) - 1\right]}$$

+ Corrente Total

$$J_T = J_{p\,dif_{máx}} + J_{n\,dif_{máx}}$$

$$J_T = q\left[\exp\left(\frac{V}{V_T}\right) - 1\right]\cdot\left(\frac{D_p}{L_p}p_{no} + \frac{D_N}{L_N}n_{po}\right)$$

$$I_T = A\cdot q\left[\exp\left(\frac{V}{V_T}\right) - 1\right]\cdot\left(\frac{D_p}{L_p}p_{no} + \frac{D_N}{L_n}\cdot n_{po}\right)$$

$p_{no} = n_i^2 / N_D$

$n_{po} = n_i^2 / N_A$

$$I_T = A q \left[\exp\left(\frac{V}{V_T}\right) - 1 \right] \cdot \left(\frac{D_p}{L_p} \cdot \frac{n_i^2}{N_D} + \frac{D_N}{L_n} \cdot \frac{n_i^2}{N_A} \right)$$

$$I_T = A \cdot q \cdot n_i^2 \left[\exp\left(\frac{V}{V_T}\right) - 1 \right] \cdot \left(\frac{D_p}{L_p N_D} + \frac{D_N}{L_N N_A} \right)$$

$$I_S = A q n_i^2 \left(\frac{D_p}{L_p N_D} + \frac{D_N}{L_N N_A} \right)$$

↳ corrente de saturação reversa

$$I_D = I_S \left[\exp\left(\frac{V_D}{V_T}\right) - 1 \right]$$