EE - Committee / لجنة الهندسة الكهربائية

ملخص قوانين مادة Electronics(1) للشهر الأول

* $E_g = E_c - E_v$

* $V_{drift/n} = -\mu_n \times \mathcal{E}$ $\qquad V_{drift/p} = \mu_p \mathcal{E}$

$J_{drift/n} = q\, n\, \mu_n \mathcal{E}$ $\qquad J_{drift/p} = q\, p\, \mu_p \mathcal{E}$

$J_{drift} = q(n\mu_n + p\mu_p)\mathcal{E} = \sigma \mathcal{E}$ $\quad ; \ \sigma = q(n \cdot \mu_n + p \cdot \mu_p)$

$J_{diffusion/n} = q D_n \frac{dn}{dx}$ $\qquad J_{diffusion/p} = -q D_p \frac{dp}{dx}$

* $$g_c(E) = \frac{m_n^* \sqrt{2 m_n^* (E - E_c)}}{\pi^2 (\hbar)^3}$$

$$g_v(E) = \frac{m_p^* \sqrt{2 m_p^* (E_v - E)}}{\pi^2 (\hbar)^3}$$

Density of State

$\hbar = \frac{h}{2\pi}$; $h = (6.624)(10^{-34})$ J.s

* $$0 \leq f(E) = \frac{1}{1 + e^{(E - E_F)/kT}} \leq 1$$ [Fermi Function]

* $n = N_c\, e^{(E_F - E_c)/kT}$ $\quad ; \ N_c = 2\left(\frac{2\pi m_n^* kT}{h^2}\right)^{3/2}$

$p = N_v\, e^{(E_v - E_F)/kT}$ $\quad ; \ N_v = 2\left(\frac{2\pi m_p^* kT}{h^2}\right)^{3/2}$

* $n = n_i\, e^{(E_F - E_i)/kT}$ → n-type

$p = n_i\, e^{(E_i - E_F)/kT}$ → p-type

$n \cdot p = n_i^2$

$k = (8.62)(10^{-5})\ eV/°K$

من سلك طريقاً يلتمس فيه علماً سهل الله له به طريقاً إلى الجنة

* $P + N_D - n - N_A$

* $n = \frac{N_D}{2} + \sqrt{\left(\frac{N_D}{2}\right)^2 + n_i^2}$ → n-type

$P = \frac{N_A}{2} + \sqrt{\left(\frac{N_A}{2}\right)^2 + n_i^2}$ → p-type

* $\rho = \frac{1}{\sigma} = \frac{1}{q(n\mu_n + p\mu_p)}$ (Resistivity)

$R = \rho \cdot \frac{L}{A} = \frac{1}{q(n\mu_n + p\mu_p)} \cdot \frac{L}{A}$

* $V = -\frac{1}{q}(E_c - E_{Ref.})$

Electric Field ← $\mathcal{E} = -\frac{dV}{dx} = \frac{1}{q} \cdot \frac{dE_c}{dx} = \frac{1}{q} \cdot \frac{dE_v}{dx} = \frac{1}{q}\frac{dE_i}{dx}$

$J_{drift/n} + J_{diffusion/n} = 0$ (at equilibrium)

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

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

[Einestein Relationship]

PN - JUNCTION

$\epsilon_o = (8.854)(10^{-14})F/cm$
$\epsilon_r = (11.8)$ For S_i

* ρ(Density of Charge) $= \epsilon_o \epsilon_r \frac{d\mathcal{E}}{dx}$

$\rho = q(-n + p + N_D - N_A)$

$\rho(x) = \frac{\epsilon_o \epsilon_r}{q} \frac{d^2 E_i}{dx^2}$

من تواضع لله
رفعه الله

* V_{bi} (Built-in Potential) $= \frac{kT}{q} \ln\left(\frac{N_D N_A}{n_i^2}\right)$

* $\frac{d\mathcal{E}}{dx} = \frac{1}{\epsilon_o \epsilon_r}\rho(x)$

P-side → $\mathcal{E}(x) = \frac{-qN_A}{\epsilon_o \epsilon_r}(x + x_p)$

n-side → $\mathcal{E}(x) = \frac{-qN_D}{\epsilon_o \epsilon_r}(x_n - x)$

$$\frac{x_p}{x_n} = \frac{N_D}{N_A}$$

* $dV(x) = \mathcal{E}(x)dx$

P-side → $V(x) = \frac{qN_A}{2\epsilon_o\epsilon_r}(x_p + x)^2$

n-side → $V(x) = V_{bi} - \frac{qN_D}{2\epsilon_o\epsilon_r}(x_n - x)^2$

* $x_n = \left(\frac{2\epsilon_o\epsilon_r}{q} \cdot V_{bi} \cdot \frac{N_A}{N_D(N_A + N_D)}\right)^{1/2}$

$x_p = \left(\frac{2\epsilon_o\epsilon_r}{q} \cdot V_{bi} \cdot \frac{N_D}{N_A(N_A + N_D)}\right)^{1/2}$

$W = x_n + x_p$

$= \left[\frac{2\epsilon_o\epsilon_r}{q} \cdot V_{bi} \cdot \left(\frac{1}{N_A} + \frac{1}{N_D}\right)\right]^{1/2}$

وفقكم الله إلى
الخير والرشاد

☆ ممثل القسم
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