Quasi-Fermi Levels

Quasi-Fermi levels are conceptual constructs, defined energy levels that can be used in conjunction with the energy band diagram to specify the carrier concentrations inside a semiconductor under nonequilibrium conditions.

RECALL

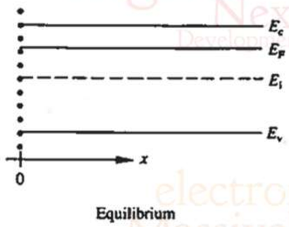
$$n = n_i e^{\frac{E_F - E_{f_i}}{kT}}$$

$$p = n_i e^{\frac{E_{f_i} - E_F}{kT}}$$

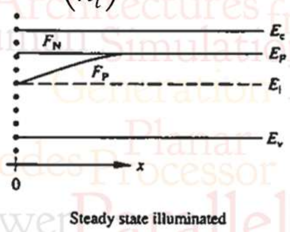
- Two energies, E_{fc}, the quasi Fermi level for electrons, & E_{fv}, the quasi-Fermi level for holes
- These energies are related to the nonequilibrium carrier concentrations in the same way E_f is related to the equilibrium carrier concentrations

$$n = n_i e^{\frac{E_{fc} - E_{fi}}{kT}} \Rightarrow E_{fc} = E_{fi} + kTln\left(\frac{n}{n_i}\right)$$

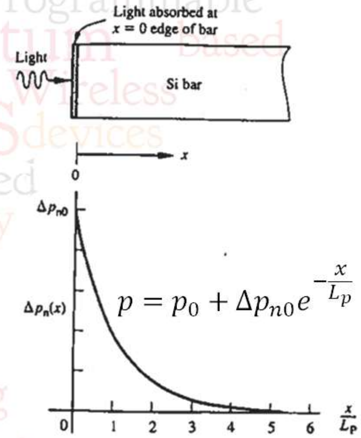
$$p = n_i e^{\frac{E_{fi} - E_{fv}}{kT}} \Rightarrow E_{fv} = E_{fi} - kTln\left(\frac{p}{n_i}\right)$$



Equilibrium



Steady state illuminated



$$p = p_0 + \Delta p_{n0} e^{-\frac{x}{L_p}}$$

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Example Problem

A uniformly donor-doped silicon wafer maintained at room temperature is suddenly illuminated with light at time t = 0. Assuming $N_D = 10^{15}\ cm^{-3}$, $\tau_p = 10^{-6} sec$, and a light induced creation of 10^{17} EHPs/s, throughout the semiconductor, determine $\Delta p_n(t)$ for $t > 0$.

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