Drift and Drift Current

Drift and Drift Current

- Drift
  - Drift velocities

$$\begin{cases} v_{drift} = \mu_p E \\ v_{drift} = -\mu_n E \end{cases}$$

Where μ_p, μ_n are the constants called mobility of holes and electrons respectively.

  - Drift current densities

$$J_{n-drift} = (-qn)\cdot(-\mu_n E) = qn\mu_n E$$

$$J_{p-drift} = qp\cdot\mu_p E$$

- Total drift current density

$$J_{drift} = q\ (n\mu_n + p\mu_p)E$$

- Resistivity

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

- Resistivities for doped semiconductor

$$\rho = 1/q(n\mu_n + p\mu_p) = \begin{cases} 1/qN_D\mu_n & \text{For } n \text{ type} \\ 1/qN_A\mu_p & \text{For } p \text{ type} \end{cases}$$

*

Resistivities are inversely proportional to the concentration of doped impurities.

- Temperature coefficient(TC)

  TC for resistivity of doped semiconductor is positive due to negative TC of mobility

- Resistivity for intrinsic semiconductor

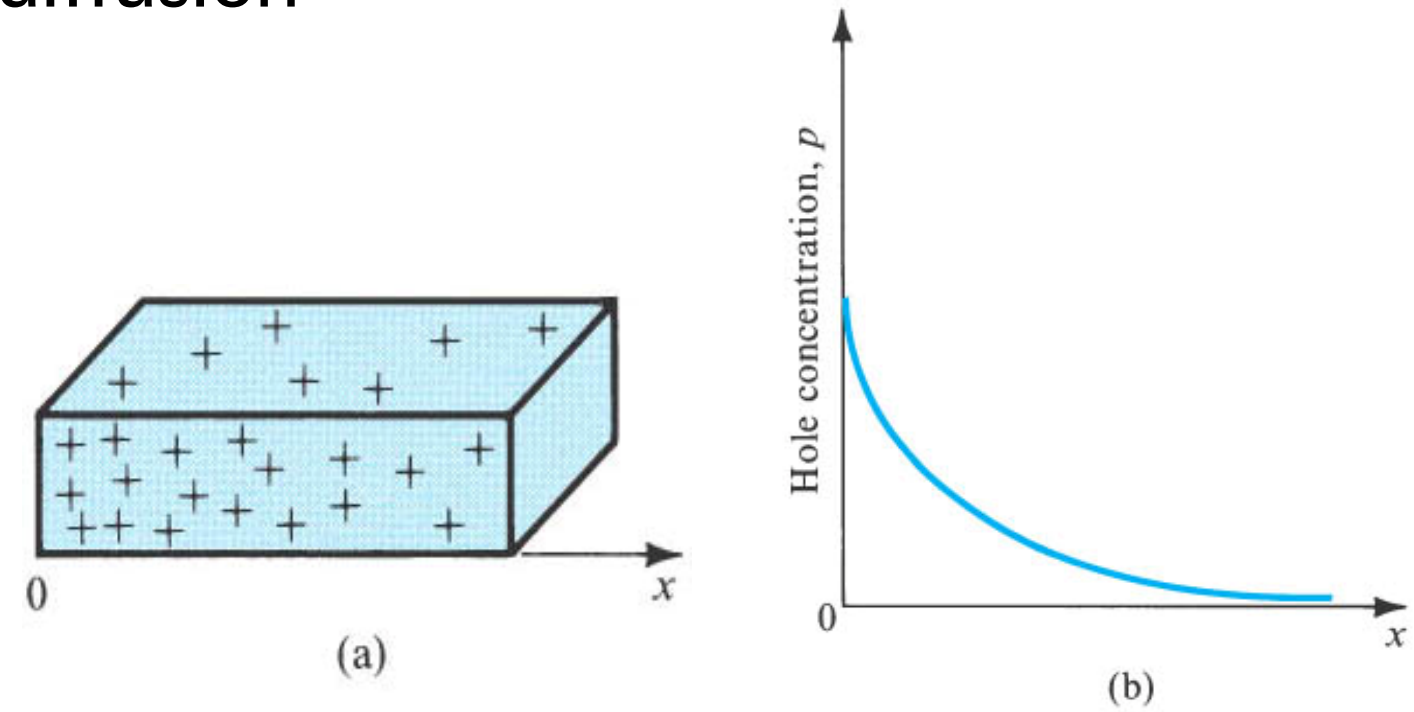
$$\rho = 1/q(n\mu_n + p\mu_p) = 1/qn_i(\mu_n + \mu_p)$$

** Resistivity is inversely proportional to the carrier concentration of intrinsic semiconductor.*

- Temperature coefficient(TC)

  TC for resistivity of intrinsic semiconductor is negative due to positive TC of n_i.

- diffusion



A bar of intrinsic silicon (a) in which the hole concentration profile shown in (b) has been created along the *x*-axis by some unspecified mechanism.

Diffusion and Diffusion Current

$$J_p = -qD_p \cdot \frac{dp(x)}{dx}$$

$$J_n = qD_n \cdot \frac{dn(x)}{dx}$$

where D_p, D_n are the diffusion constants or diffusivities for hole and electron respectively.

* *The diffusion current density is proportional to the slope of the the concentration curve, or the concentration gradient.*

Einstein Relationship

Einstein relationship exists between the carrier diffusivity and mobility:

$$\frac{D_n}{\mu_n} = \frac{D_p}{\mu_p} = V_T = \frac{kT}{q}$$

Where V_T is Thermal voltage.

At room temperature,

$$V_T = 25\ mv$$