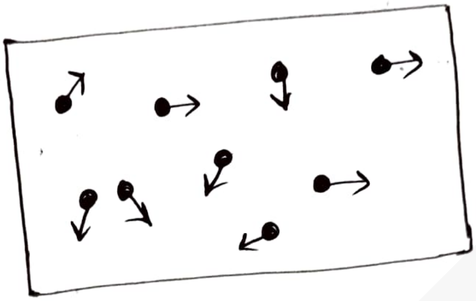
CARRIER TRANSPORT IN SEMICONDUCTOR



Random motion of free e^-s in the absence of electric field.

* In the absence of an e.field, the free e^- move in all directions, colliding with each other and $+^{ve}$ ion core during the motion. This collision is elastic collision. The resultant velocity is zero.

* When an e.field is applied, free e^-s & holes attain drift velocity v_d.

The drift velocity attained by carriers is proportional to e-field strength E

$$v_d \propto E$$

$$\boxed{v_d = \mu E}$$ where μ is the mobility.

MOBILITY : The mobility is defined as the velocity of a charge carrier per unit electric field strength.

$\mu_n \rightarrow$ mobility of electrons

$\mu_p \rightarrow$ mobility of holes

$$\mu_n > \mu_p.$$

eg: $\mu_n = 0.135\ m^2/Vs$ & $\mu_p = 0.048\ m^2/Vs$ for Si at 300K.

$\mu_n = 0.39\ m^2/Vs$ & $\mu_p = 0.19\ m^2/Vs$. for Ge at 300K.

EXPRESSION FOR ELECTRICAL CONDUCTIVITY IN SEMICONDUCTORS

Let, n be the density of free e^-s ~~in the net charge per unit volume.~~

Net charge available per unit volume = ne

When an external e-field is applied the e^-s move with drift velocity v_d.

$$v_{dn} = \mu_n E. \quad —(1)$$

$$J_n = n e v_{dn} \quad —(2)$$

where, J_n is drift current density

from Ohm's law we can write,

$$J_n = \sigma_n E \quad —(3).$$

~~∴ from (2) we get σn = neμn~~

~~Jn~~

from ② & ③ we get

$$\sigma_n E = n e v_{dn}$$

substituting ① in above equation we get,

$$\boxed{\sigma_n = n e \mu_n}$$

$||^{ly}$ $\boxed{\sigma_p = p e \mu_p}$

where σ_p is the conductivity of holes

p is the density of holes

and, μ_p is the mobility of holes in the material.

$$\sigma_{tot} = \sigma_n + \sigma_p = n e \mu_n + p e \mu_p.$$

$$\boxed{\sigma_{tot} = e(n\mu_n + p\mu_p)}$$

for intrinsic semiconductor

$$n = p = n_i$$

$$\therefore \boxed{\sigma_i = e n_i (\mu_n + \mu_p)}$$