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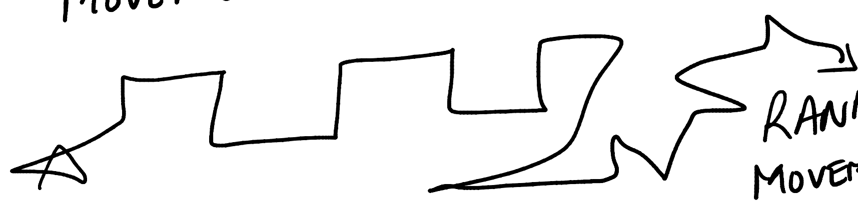
LECTURE - 10

CARRIER DRIFT IN SEMI CONDUCTORS

DRIFT → APPLIED OR DEVELOPED E FIELD

↳ NET MOVEMENT OF CHARGE DUE TO E

$E = 0$



RANDOM MOVEMENT

E FINITE

$\longrightarrow E$

$\longleftarrow \vartheta_x$

ELECTRONS MOVE IN A DIRECTION WITH A VELOCITY ϑ_x

ELECTRONS $\vartheta = -\mu_n E$ OPPOSITE DIRECTION w.r.t E

HOLES $\vartheta = \mu_p E$ (SAME DIRECTION)

$\longrightarrow E$

$\longleftarrow e$

$\longrightarrow h$

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$\mu_n \longrightarrow$ MOBILITY OF ELECTRONS
$\mu_p \longrightarrow$ " " HOLES
UNITS cm^2/Vs

DEFINE $J \Rightarrow$ CURRENT DENSITY A/cm^2

$$J_n = -q\, n_0 (-\mu_n E) = q\, n_0 \mu_n E$$

$$J_p = +q\, p_0 (\mu_p E) = q\, p_0 \mu_p E$$

TOTAL $J = J_n + J_p$

$$= q\,(n_0 \mu_n + p_0 \mu_p) E = \sigma E$$

$\sigma \rightarrow$ CONDUCTIVITY

$$\boxed{\sigma = q\,(n_0 \mu_n + p_0 \mu_p) \quad (\Omega\, cm)^{-1}}$$

MOBILITY $\longrightarrow$ MEASURE OF HOW EASILY THE CARRIERS MOVE THROUGH THE MATERIAL

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n AND P HAVE DIFFERENT
QUANTUM MECHANICAL ENVIRONMENTS

$$\mu_n \neq \mu_p$$

* DRIFT CURRENT IS CAUSED BY E

* $\mu_n > \mu_p$ $\because$ ELECTRONS MOVE EASILY THAN HOLES

* μ_n (N DOPANTS = 0) > μ_n (N DOPANTS > 0)
  μ_p (N DOPANTS = 0) > μ_p (N DOPANTS > 0)

$\therefore$ INCREASING THE CONCENTRATION DECREASES μ

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CARRIER DIFFUSION

→ NET MOVEMENT OF CHARGE DUE TO CONCENTRATION GRADIENT

→ MOVEMENT FROM HIGH CONCENTRATION TO LOW CONCENTRATION

1D CASE

$$J_n = (-q)(D_n)\left(-\frac{dn}{dx}\right)$$

$$= q D_n \frac{dn}{dx}$$

* J_n IS POSITIVE → CURRENT IS IN THE SAME DIRECTION AS GRADIENT

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$$J_p = q\, D_p \left(-\frac{dp}{dx}\right)$$

$$= -q\, D_p \frac{dp}{dx}$$

* J_p IS NEGATIVE, CURRENT IS ~~IS~~ IN THE OPPOSITE DIRECTION AS THE GRADIENT

$D_n, D_p \longrightarrow$ DIFFUSION COEFFICENTS cm^2/s

$$\left. J = q\, D_n \frac{dn}{dx} - q\, D_p \frac{dp}{dx} \right\}$$ 1-D CASE!

$$\boxed{\begin{aligned} \frac{D_n}{\mu_n} &= \frac{KT}{q} \\ \frac{D_p}{\mu_p} &= \frac{KT}{q} \end{aligned}}$$

~~DA~~

D IS RELATED TO μ