ELECTRONICS DEVICES AND CIRCUITS

OBJECTIVE

DRIFT AND DIFFUSION CURRENTS

❖ Drift and Diffusion

- We now have some idea of the number density of charge carriers (electrons and holes) present in a semiconductor material from the work we covered in the last chapter. Since current is the rate of flow of charge , we shall be able calculate currents flowing in real devices since we know the number of charge carriers. There are two current mechanisms which cause charges to move in semiconductors. The two mechanisms we shall study in this chapter are *drift and diffusion*.

❖ Carrier Drift

- Electron and holes will move under the influence of an applied electric field since the field exert a force on charge carriers (electrons and holes).

$$F = qE$$

- These movements result a current of I_d;

$$I_d = nqV_d A$$

I_d : drift current

n : number of charge carriers per unit volume

V_d : drift velocity of charge carrier

q : charge of the electron

A : area of the semiconductor

❖ Carrier Mobility , μ

$$V_d = \mu E$$

E : applied field

μ : mobility of charge carrier

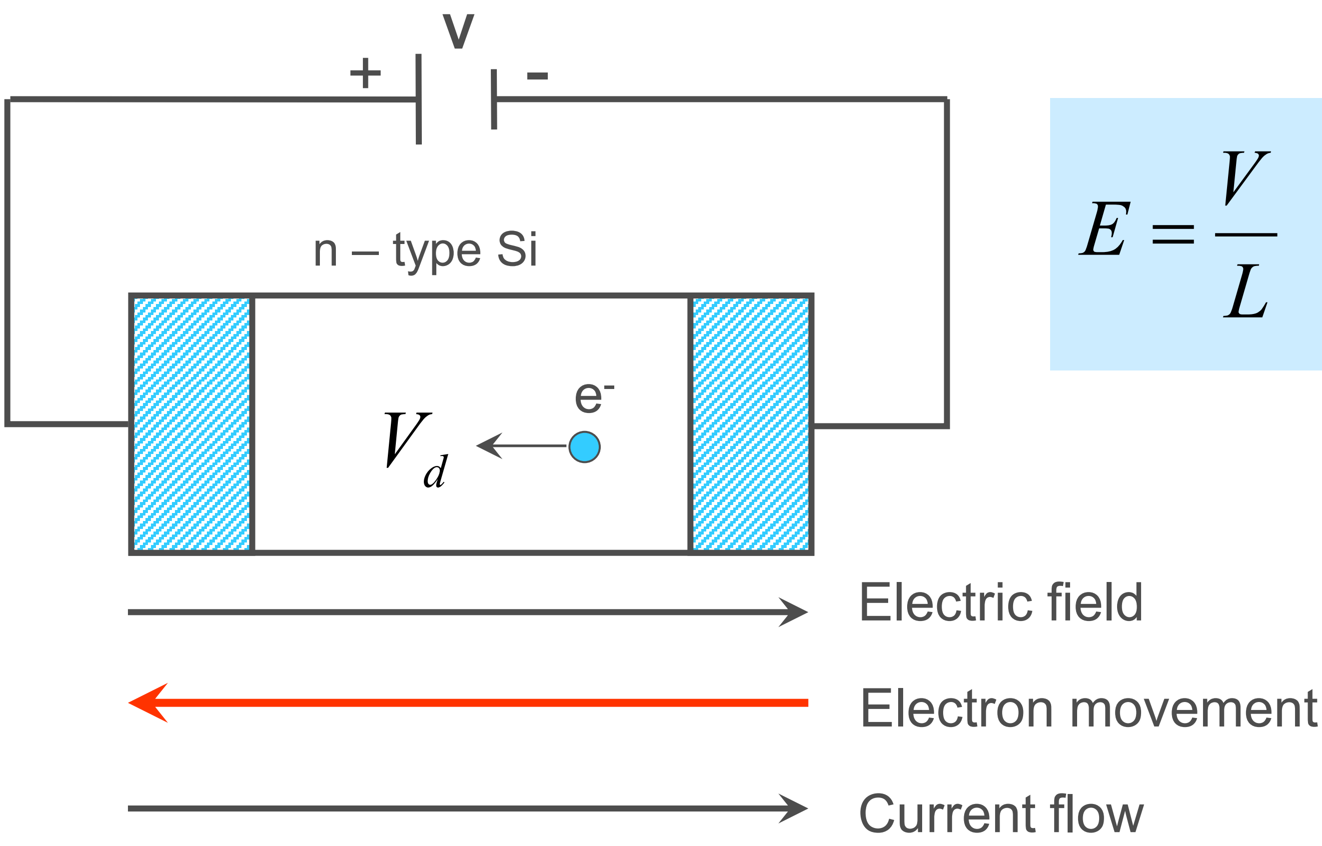
$$[\mu] = \left[\frac{cm^2}{V - Sec}\right]$$

μ is a proportionality factor

$$\mu = \left[\frac{V_d}{E}\right]$$

- So μ is *a measure how easily charge carriers move* under the influence of an applied field or μ determines *how mobile the charge carriers* are.

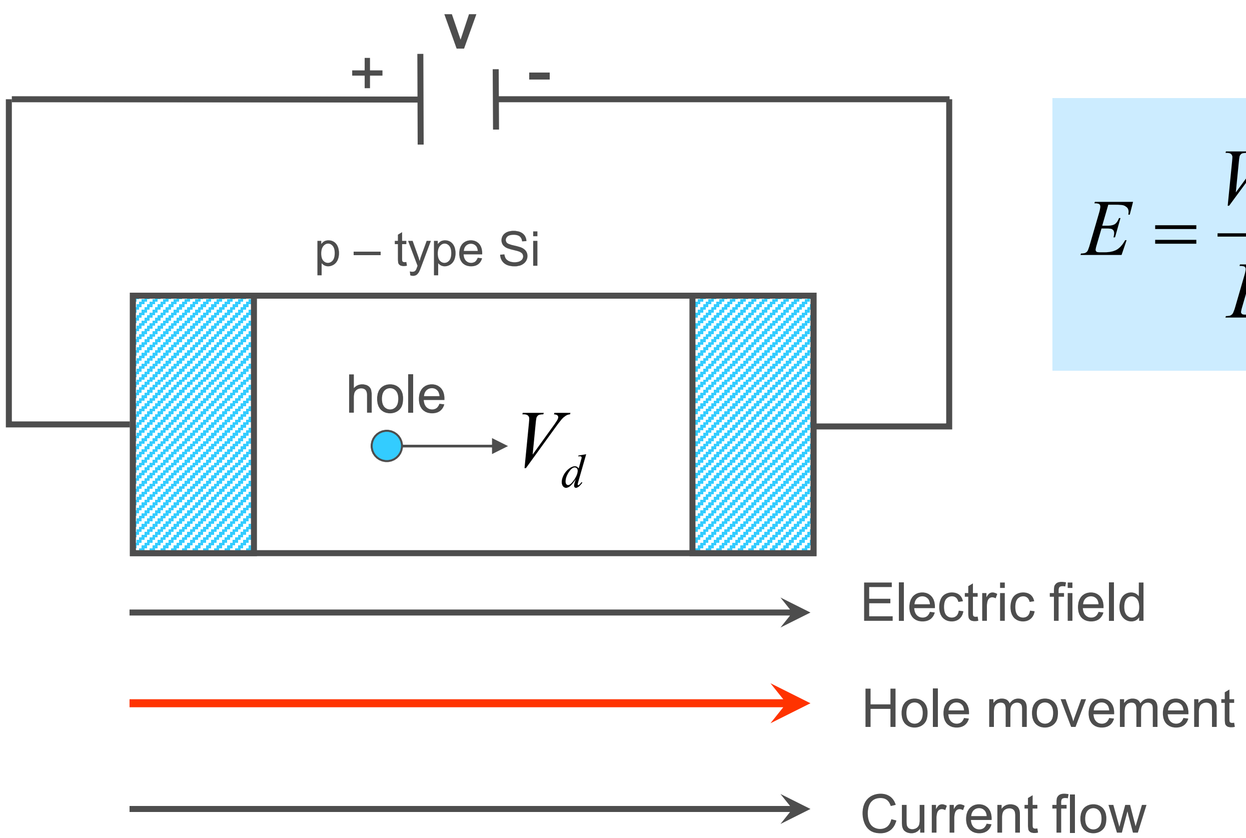
❖ n - type Si



$$E = \frac{V}{L}$$

Current carriers are mostly electrons.

❖ p - type Si



$$E = \frac{V}{L}$$

Current carriers are mostly holes.

❖ Carrier Mobility

Macroscopic understanding

$$\mu = \frac{V_d}{E}$$

In a perfect Crystal

$$\rho = 0$$

$$\sigma \to \infty$$

It is a superconductor

Microscopic understanding? (what the carriers themselves are doing?)

$$\mu = \frac{q\tau}{m^*}$$

$$m_e^* \langle m_h^* \quad in\ general$$

$$m_e^*;\ n-type$$

$$m_h^*;\ p-type$$