

ECE 246 Intro to Electronics + Lab.

©

II	III	IV	V	VI
Zn	Ga	C	P	Cd
Cd	Al	Ge	As	Te
⋮	B	Si	Sb	S
	⋮	⋮	N	⋮

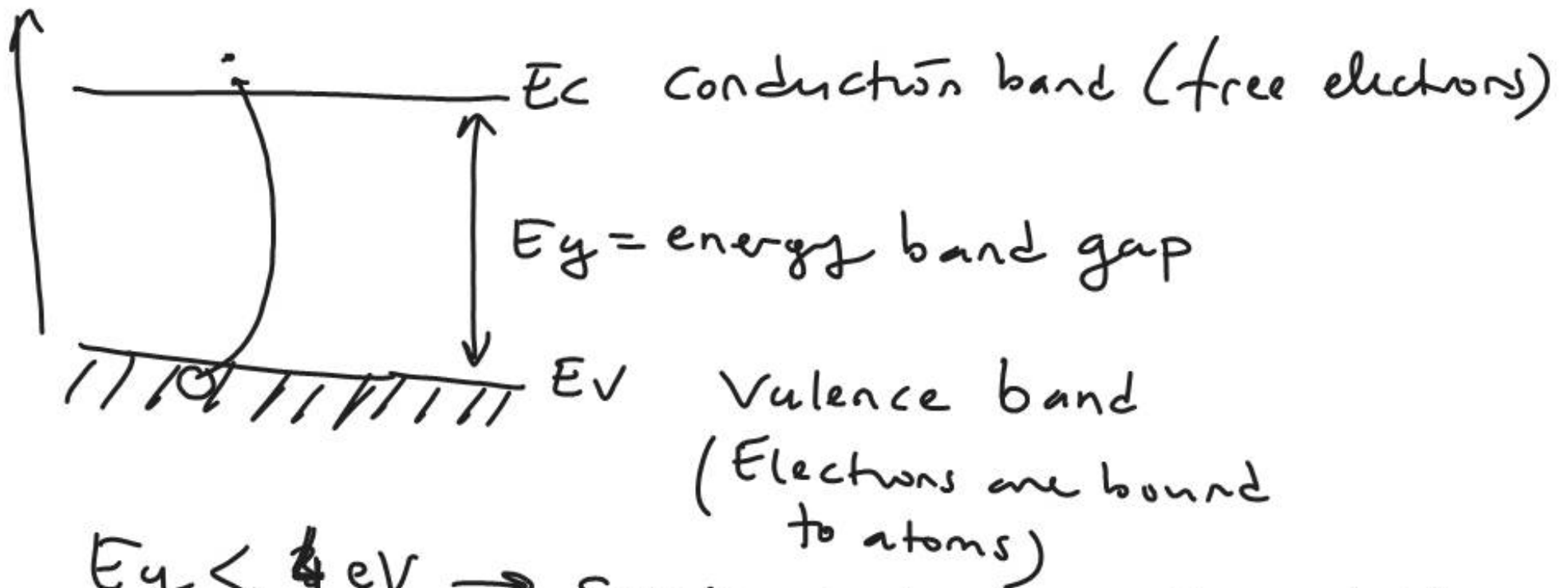
GaAs
AlGaAs
GaN
CdTe
ZnS

} compound semiconductors

LED (Light emitting diodes)
GaN → Green
GaAs → red, IR

Energy Bands

E Intrinsic semiconductor



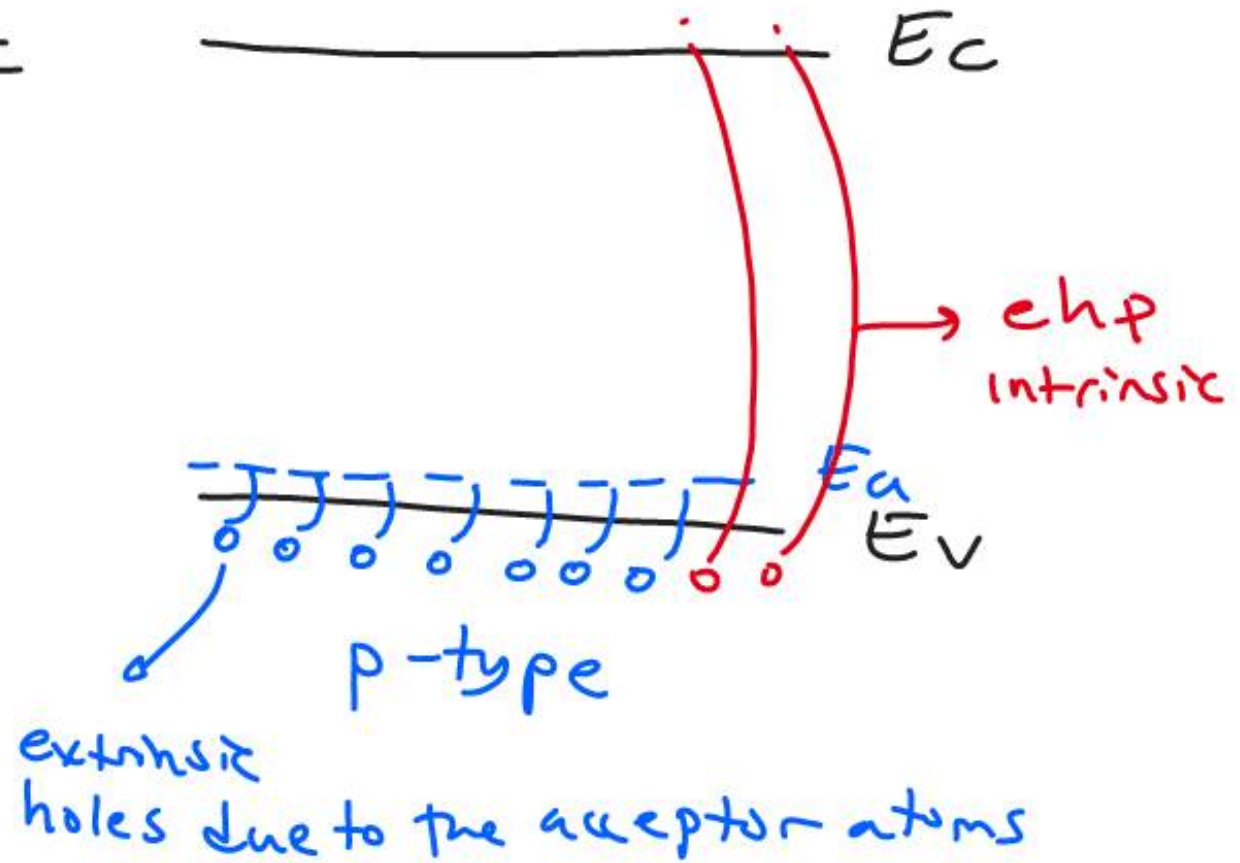
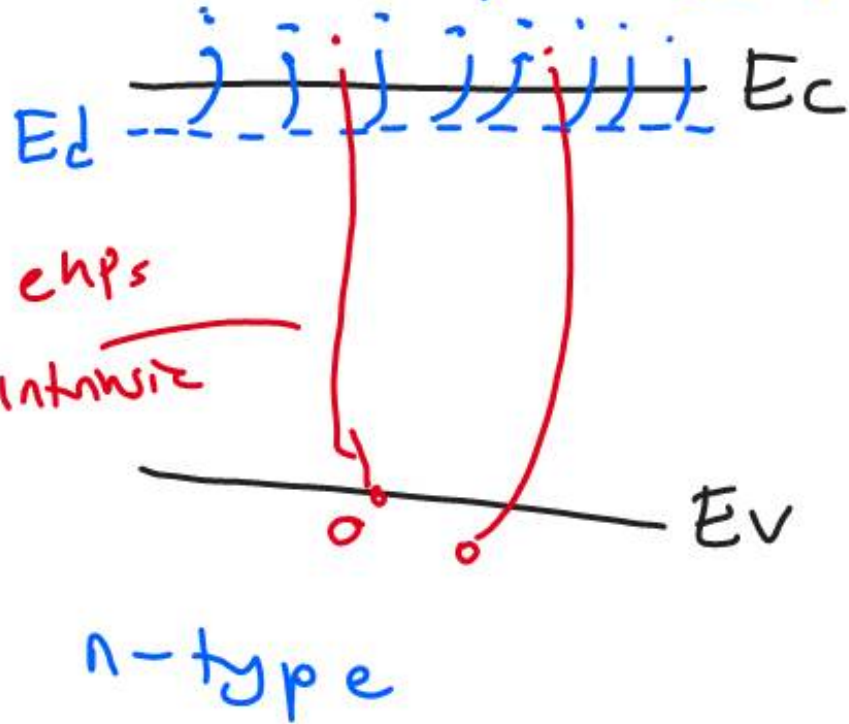
$E_g < 4 \text{ eV} \rightarrow$ Semiconductor \rightarrow

$E_g > 4 \text{ eV} \rightarrow$ insulators
Glass $\sim 5 \text{ eV}$
Rubber

Ge = 0.6 eV
Si = 1.1 eV
GaAs = 1.43 eV

Extrinsic Semiconductor

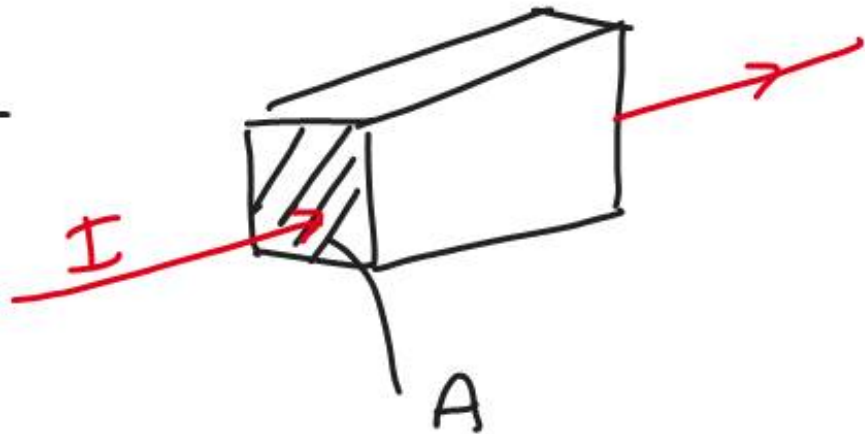
extrinsic electrons
due to the Donor atoms



$$R = \frac{V}{I} \quad G = \frac{1}{R} = \frac{I}{V}$$

$$\text{Current density} = \frac{I}{A}$$

$$J = \frac{I}{A} \left(\frac{\text{Amperes}}{\text{m}^2} \right)$$



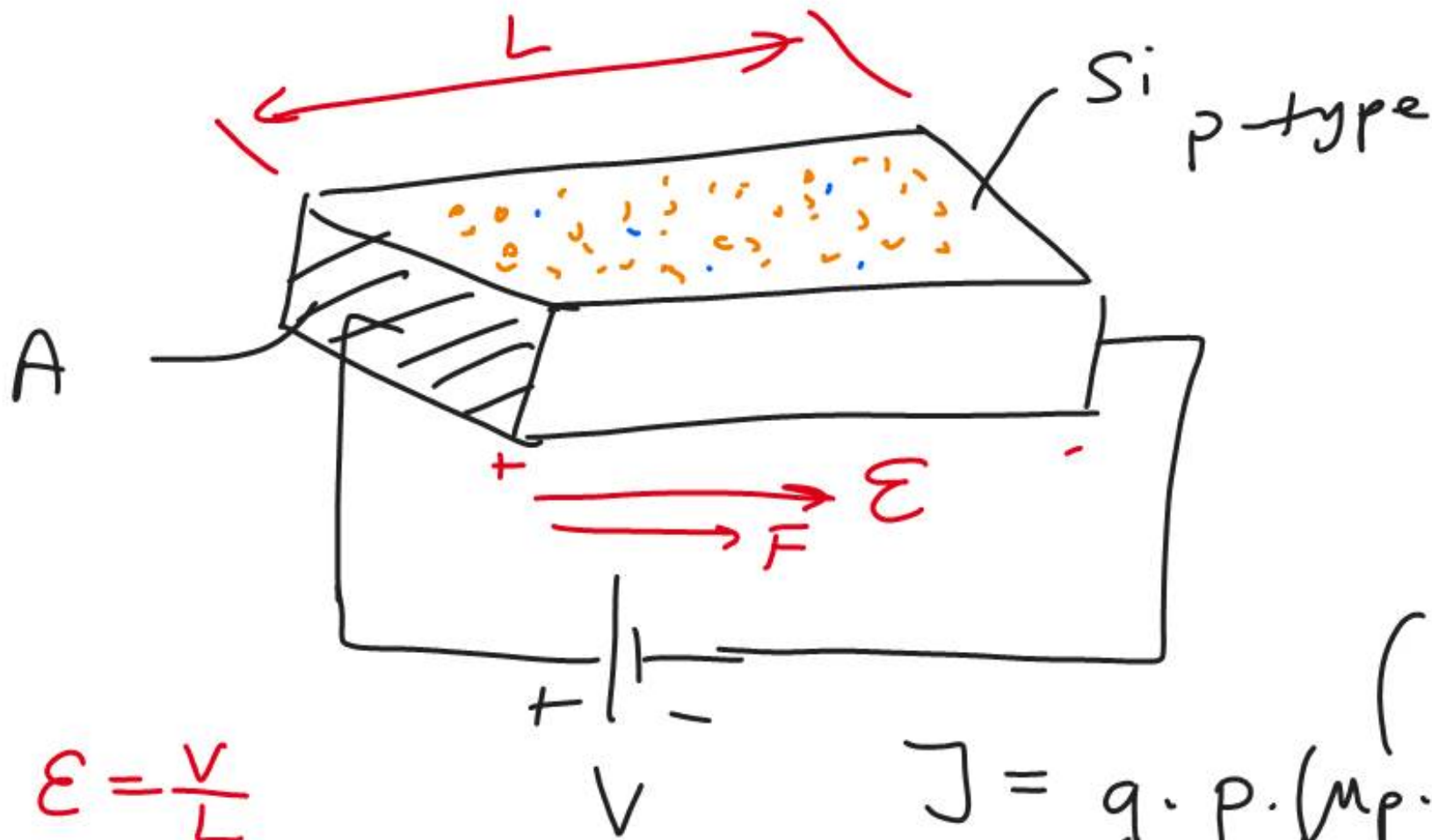
$$J = q \cdot n \cdot v \rightarrow \text{velocity of charge carriers (m/s)}$$

\downarrow Charge \downarrow # of charge carriers
 Coulomb $\frac{\text{m}^3$

$\left(\text{C} \cdot \frac{1}{\text{m}^3} \cdot \frac{\text{m}}{\text{s}} \right)$

$$J = q n (\underbrace{v}_{\text{Drift of carriers}} \epsilon)$$

$$\left(\frac{\text{C}}{\text{s}} \right) \frac{1}{\text{m}^2} \left(\frac{\text{Ampere}}{\text{m}^2} \right) \checkmark$$



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

$$F = q \cdot (\bar{E} + \bar{u} \times \bar{B})$$

$$F = qE \quad B=0$$

$$I = \frac{1}{R} V$$

$$J = \sigma E$$

Conductivity

$$J = q \cdot p \cdot (\mu_p \cdot E)$$

Coulomb

of holes

Area

$$\sigma = q \cdot p \cdot \mu_p$$

mobility of holes

Electric field strength

μ

Si $\rho = \frac{1}{\sigma} \approx 2 \times 10^5 \Omega\text{-m}$
at room temp

Glass $\rho \sim 10^8 \Omega\text{-m}$

Al $\sim 10^{-8} \Omega\text{-m}$