Analog Electronics

① Semiconductor Physics
② Diode Circuits
③ BJT → Biasing (EE)
→ Amplifier
→ Freq. response
④ JFET — ESE (not gate)
⑤ MOSFET → only biasing (EE)
⑥ op-amp & application.
⑦ Feedback amplifiers
⑧ Oscillators & 555 timers.
⑨ Power Amplifier. → ESE

Books :

1. Donald neamen
2. Boylestad.

Semiconductor Physics

Materials

- Crystalline
- Amorphous
- Semi-crystalline

Crystalline

When materials have long range order of atoms and they are perfectly arranged the material is called **crystalline**

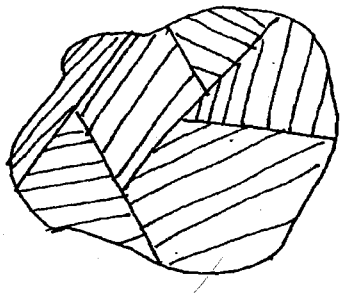
The repeating unit in the crystal is called as **unit cell**

Amorphous

When there is no ordering of atoms or the atoms are at random then material is called as **amorphous**

Semi-Crystalline

The atoms are perfectly arranged but only over short distances, over large distance arrangement is random.



→ grain

The atoms in the grains are arrang in an order but the grains are all differently arrange

Classification Based on electrical conductivity :-

Insulators	Semiconductors	Conductors
	10^6	10^{21}
		carrier concentration C/cm

Based on conductivity materials can be classified in three categories :
- → Insulators.
- → Semiconductors.
- → conductors.

$$\sigma \propto \text{carrier concentration.}$$

σ = conductivity.

conductors :

$$\sigma = \frac{ne^2\tau}{m}$$

n = no. of e^- / cm^3.

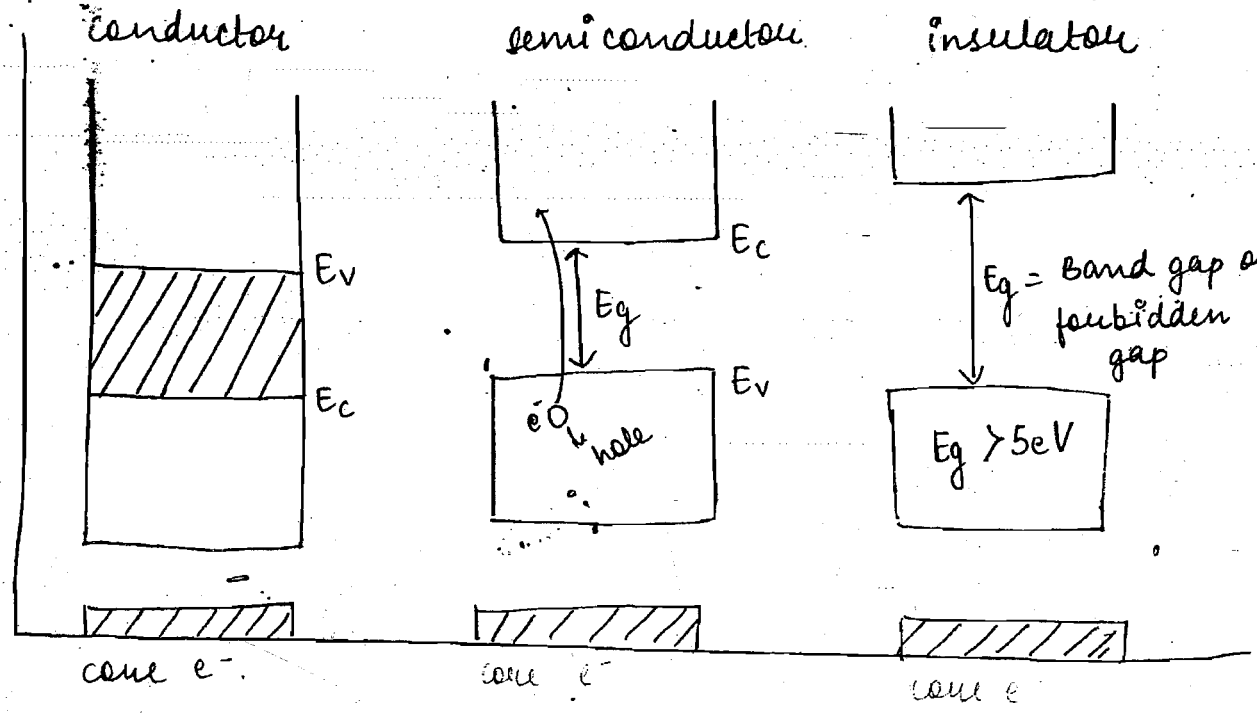
$$\sigma \propto n$$

- In semiconductor materials the conductivity can easily be ~~verif~~ varied over a large range hence semiconductor materials are popular in electronics design.

Band Diagram :

- Every atom contains electron in various state or energy level and when two or more than two atom combine these energy level split and merge to form multiple energy level which are closely spaced and called as Energy Band.

Bond formation ⟶ only outermost e⁻ (valence e⁻).

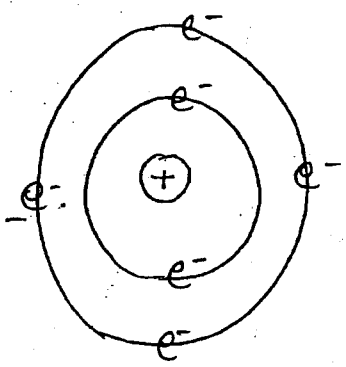


- The e^- that are bound to the nucleus in the outermost shell and donot take part in conduction are said to lie in valence band.
- The e's that are ionised from the atom and are part of conduction are said to lie in conduction band.
- In conductors both V.B and C.B overlap, which means the valence e^- are by default part of conduction.
- In Semi conductors the V.B and C.B are seperated by a small energy gap called as Band gap which is almost $\pm$ eV.
- at T = 0 K, the valence band is completly filled and the conduction band is completly empty but as T↑ e's are promoted from V.B to C.B. so V.B becomes partialy empty and conduction band partialy filled.
- The vacancies left by e's in the V.B. are called as holes and conduction in semi-conductor is due to both electrons and holes.

- In an insulator the energy gap between V.B and C.B is higher than 5eV.

Carbon :

$Z = 6$ (atomic number)

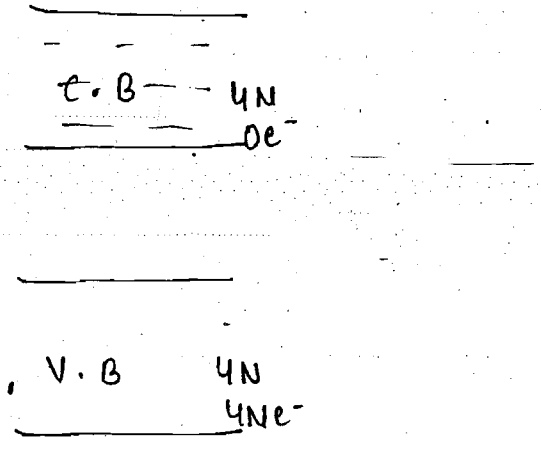


e^- energy : state

outermost orbit : 8 states available

N - atoms : 8N states

we have : $4Ne^-$ (in outermost) in carbon



Classification of Semiconductor:

① Pure Semiconductor:

- The semiconductors in which there are no crystal defect as well as there is no impurity are called as pure semiconductors.

hole concentration	=	e^- concentration
p_0	=	n_0

p_0 = hole concentration at thermal equilibrium.

n_0 = e^- concentration at thermal equilibrium.

electron hole pair (EHP) when $1e^-$ goes from V.B is forms hole in V.B and in C.B there is $1e^-$ and this is called EHP.

Thermal equilibrium → when e^- from V.B goes to C.B and $1e^-$ from CB come's back to V.B (after transient-state).

② Intrinsic Semiconductors:

- The semiconductors in which there is no impurity but there can be crystal defect is called intrinsic semiconductor.

$$n_0 = p_0$$

③ Extrinsic Semi-conductor

- If impurity is added to a crystal structure then it is called as extrinsic semi conductor.

$n_o > p_o \rightarrow$ n-type

$n_o < p_o \rightarrow$ p type.

Classification baised on chemical formula :

① Elemental Semi conductor :

Group IV elements : Si, Ge

② Compound semi conductors :

* Group III / V
- Ga As
- InP

* Group II / VI
- PbS (leadsulphide)
- ZnS (zinc sulphide)