Basic Electronics (Lec-2)

Semiconductor

Materials (Electrical Conductivity)
- → Metal (Al, Au, Cu, Fe)
- → Insulator (Plastic, Wood, Oxide) etc.
- → Semiconductor (Si), Ge, GaAs

Si → Atomic number is (14) ←

$Si \Rightarrow 1s^2\, 2s^2\, 2p^6\, \underline{3s^2\, 3p^2}$

$Ge\,(32) \Rightarrow 1s^2\, 2s^2\, 2p^6\, 3s^2\, 3p^6\, 3d^{10}\, \underline{4s^2\, 4p^2}$

Elemental semiconductors → Si, Ge

$AlN + GaN$ → $Al_{0.25}\,Ga_{0.75}\,N$

~~0.25~~ 25% 75%

In periodic table

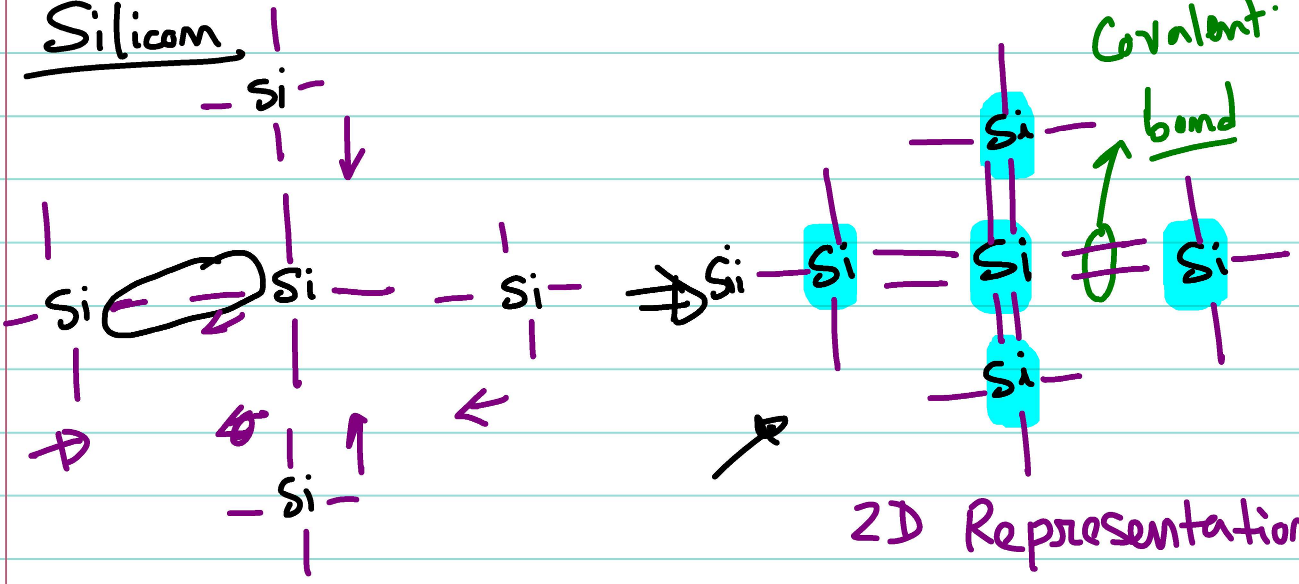
Group III	Group IV	Group V
B	C	N
Al	Si	P
Ga	Ge	As
In		

GaAs, AlAs, GaN, GaP, AlP

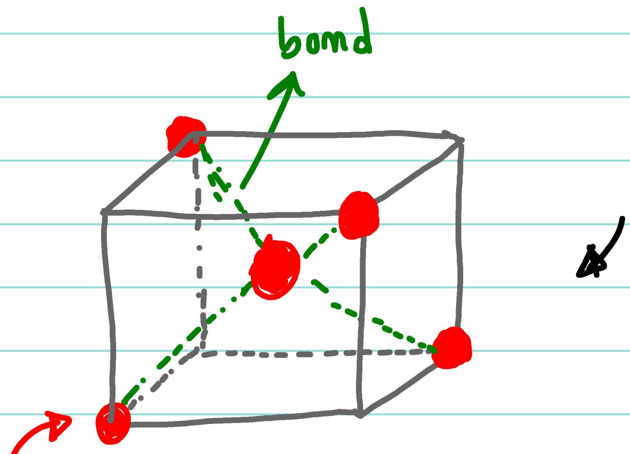
Compound Semiconductors

AlGaN
↓ 0.25 ↓ 0.75

Silicon

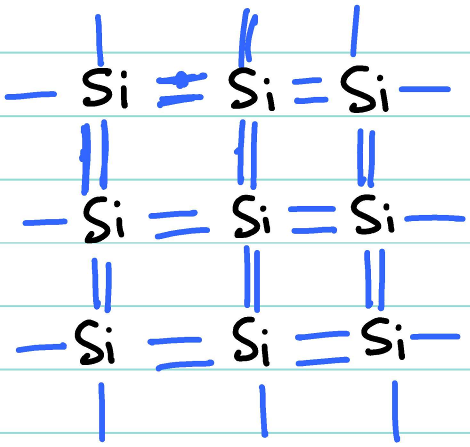


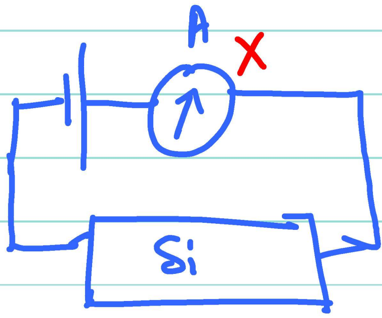
2D Representation



Note: Si-atoms are not in the same plane

"Tetrahedral configuration"



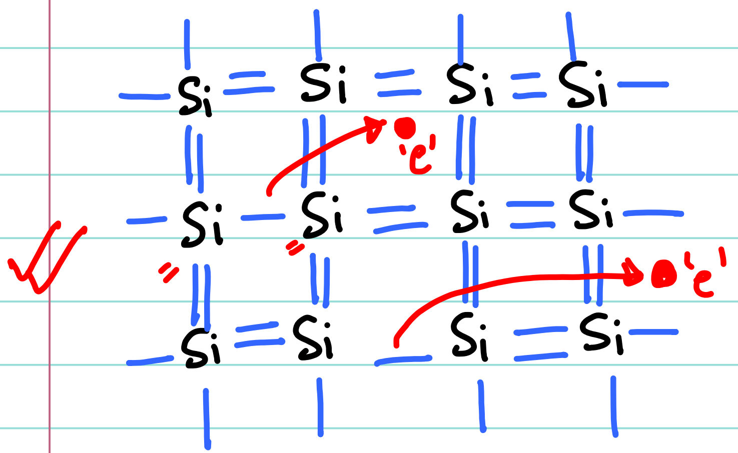


at T=0K

At T=0K, all valance electrons are bound to Si-atoms

'Si' behaves as an insulator

Charged Particles in Semiconductors.

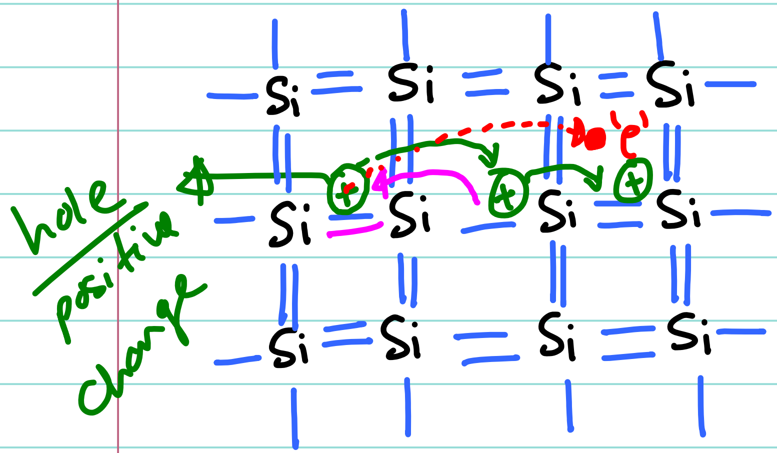


T = 100K

T = 150K

✓ electron (−)

→ negatively charged.



T = 100K

✓ hole (+)

Intrinsic Semiconductors

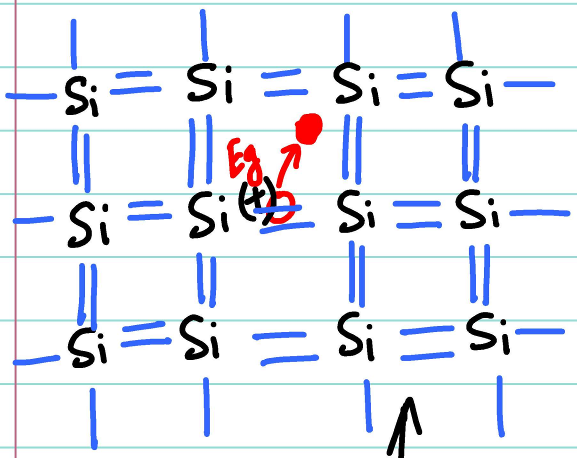
pure semiconductors → without impurity.

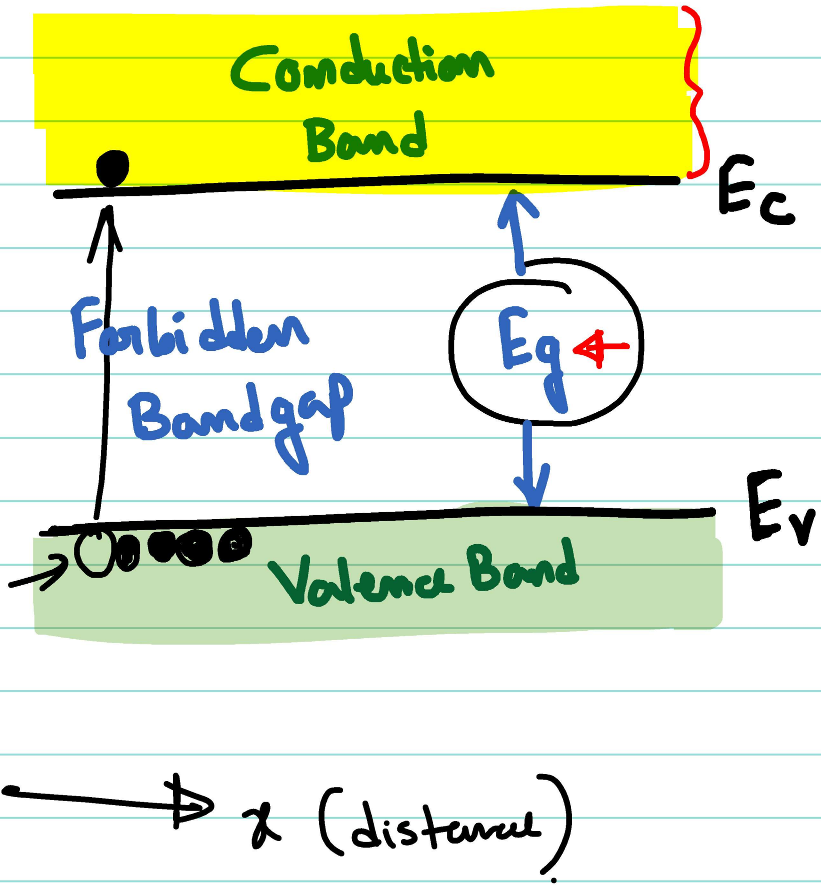
Si → pure Si → only Si atoms.

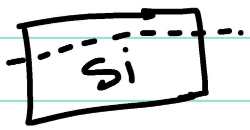
Ge → pure 'Ge' → " Ge "

Concept of Energy Band Diagram (Simplified)

✓







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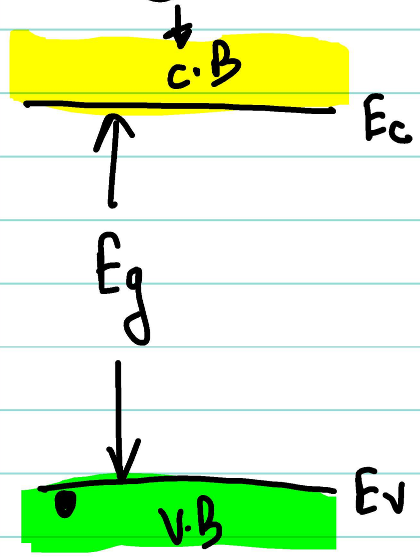
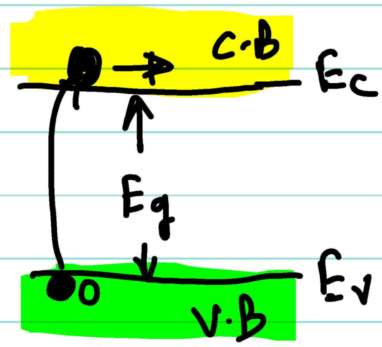
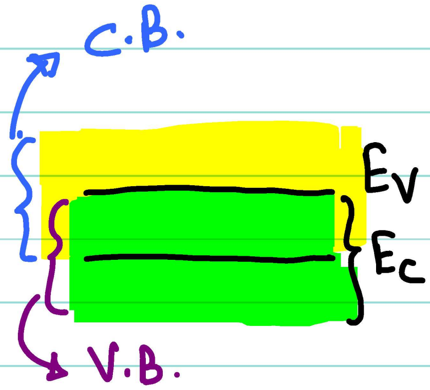






Insulator | Semiconductor | Metal

~~Al_2O_3~~ $\Rightarrow$ $SiO_2 \Rightarrow \sim 11\ eV$

$\boxed{T = 300K}$

$Si \rightarrow 1.1\ eV$

Intrinsic Carrier Concentration (n_i)

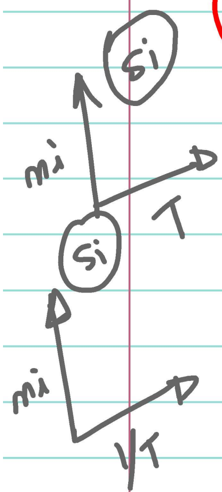
$T = 300K$, unit no/cm^3

T = temp. (K)

E_g = energy bandgap (eV)

k = Boltzmann's const.

$$n_i = B\, T^{3/2} \exp\left(-\frac{E_g}{2kT}\right)$$



B → Semiconductor specific parameter.

n_i → electrons / holes

$n_i \quad T$

$B = 5.23 \times 10^{15}\ cm^{-3}\ K^{-3/2}$ for 'Si'

Electron conc. = Hole conc. = n_i for intrinsic semiconductor

→ $n_i \rightarrow 1.5 \times 10^{10}\ cm^{-3}$

$N_{Si\ atoms} \rightarrow 5 \times 10^{22}\ cm^{-3}$

At T = 300 K

Material	E_g(eV)	n_i(cm^{-3})
Ge	0.66	2.4×10^{13}
[Si	1.1	1.5×10^{10}] for this course.
GaAs	1.4	1.8×10^{6}
* → GaN	3.4	1.9×10^{-10}