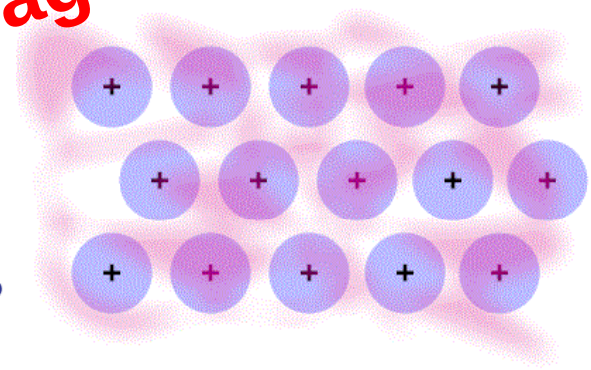
1.3 Classification of Crystalline Solids

Table 1.2: Different Types of Solids

Type of Solid	Constituent Particles	Bonding/ Attractive Forces	Examples	Physical Nature	Electrical Conduc-tivity	Melting Point
(1) Molecular solids (i) Non polar	Molecules	Dispersion or London forces	Ar, CCl_4, H_2, I_2, CO_2	Soft	Insulator	Very low
(ii) Polar		Dipole-dipole interactions	HCl, SO_2	Soft	Insulator	Low
(iii) Hydrogen bonded		Hydrogen bonding	H_2O (ice)	Hard	Insulator	Low
(2) Ionic solids	Ions	Coulombic or electrostatic	NaCl, MgO, ZnS, CaF_2	Hard but brittle	Insulators in solid state but conductors in molten state and in aqueous solutions	High
(3) Metallic solids	Positive ions in a sea of delocalised electrons	Metallic bonding	Fe, Cu, Ag, Mg	Hard but malleable and ductile	Conductors in solid state as well as in molten state	Fairly high
(4) Covalent or network solids	Atoms	Covalent bonding	SiO_2 (quartz), SiC, C (diamond), AlN, C (graphite)	Hard Soft	Insulators Conductor (exception)	Very high

Metallic bond



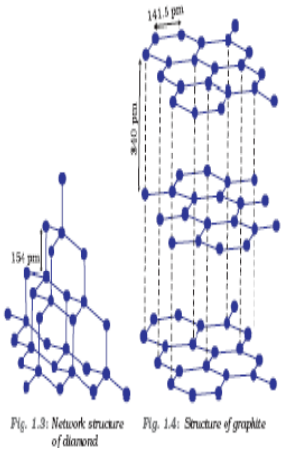
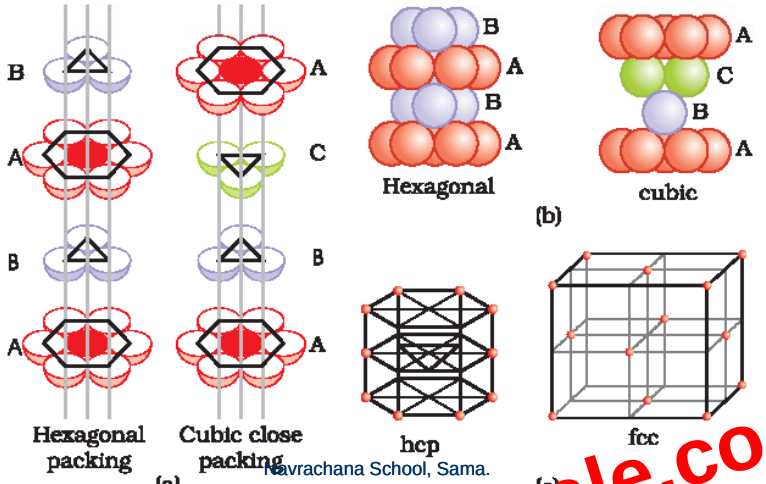


Fig. 1.3: Network structure of diamond Fig. 1.4: Structure of graphite

(b) Placing third layer over the second layer

Covering Tetrahedral Voids:
ABABAB…. (hcp)

Covering Octahedral Voids:
ABCABCABC….(ccp or fcc)



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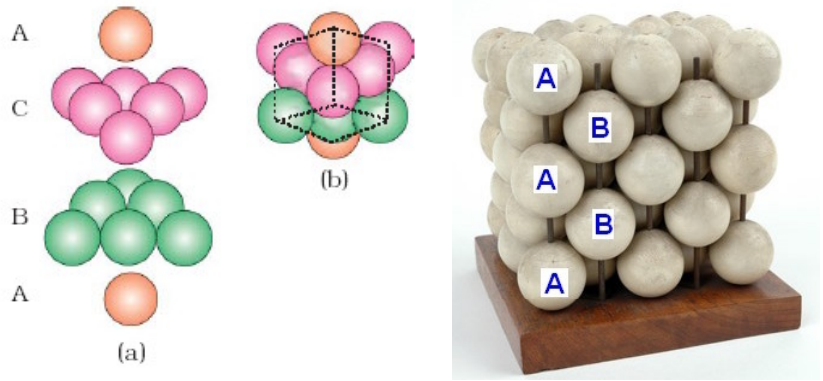
25

Covering octahedral voids
ABCABC...

ccp

Covering tetrahedral voids
ABAB...

hcp



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26

Metal excess defects

Due to extra cations in the interstital

ZnO (White) ---Δ → Zn^{+2} + ½ O_2 + $2e^-$ (yellow)

- O is lost as O_2 reversibly.
- excess of Zn^{+2} occupies the interstitial nearby.
- thus, $Zn_{1+x}O$

Metal deficient defects

Many solids – difficult to prepare in stoichiometric composition
- More anions than metals
- $Fe_{0.93}O$ to $Fe_{0.96}O$
- some $Fe^{+2} \rightarrow Fe^{+3} + e^-$ to maintain the electrical neutrality of the crystal

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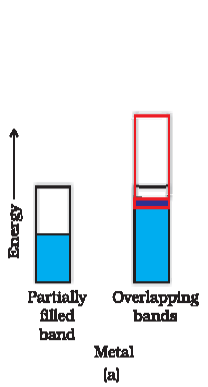
1.10 Electrical properties

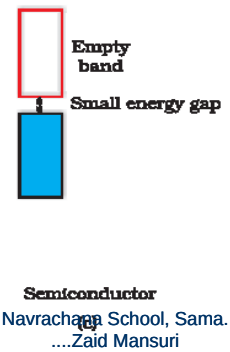
Solids 10^{-20} - 10^7 $ohm^{-1}m^{-1}$

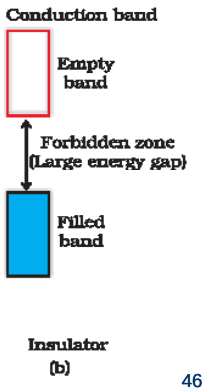
Conductors: 10^4 - 10^7 $ohm^{-1}m^{-1}$ good

Semi-conductors: 10^{-6} -10^4 $ohm^{-1}m^{-1}$

Insulators: 10^{-20} -10^{-10} $ohm^{-1}m^{-1}$







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Ferrimagnetism:

• *the magnetic* moments of the domains in the substance are aligned in parallel and anti-parallel directions in unequal numbers.

• weakly attracted by magnetic field as compared to ferromagnetic substances.

• Examples: Fe_3O_4 (magnetite) and ferrites like $MgFe_2O_4$ and $ZnFe_2O_4$ are examples of such substances.

• These substances also lose ferrimagnetism on heating and become paramagnetic.

End of chapter

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