CONCEPT MAP

SOLID STATE

A solid is a state of matter which possesses definite shape and volume. They are characterised by compressibility, rigidity and mechanical strength

Classification of Solids

Amorphous Solid : The substances whose constituent particles are not arranged in any regular arrangement are called amorphous solid. These solids have a random, disordered arrangement of constituents. They do not have definite shape.

Crystalline Solid : The substances whose constituent particles are not arranged in a definite geometric pattern in there dimensional space are called crystalline solid. These solids have a definite regular arrangement, having definite shape and high melting point. These are of following types:
1. Molecular Solids
2. Ionic Solids
3. Metallic Solids
4. Covalent Solids

Coordination Number and Packing Efficiency

Type	Simple cubic	bcc	fcc
Coordination number	6	8	12
Packing efficiency	52.4%	68%	74%

Crystal Lattice and Unit Cell

Crystal Lattice : It is a regular arrangement of the constituent particles of a crystalline solid in three dimensional space.

Unit Cell : A unit cell is the smallest repeating unit in space lattice which when repeated over and over again produces the complete crystal lattice.

sc : Particles in *sc* is 1.

fcc : Particles in *fcc* are 4.

bcc : Particles in *bcc* are 2.

Impurity Defects : Arises when foreign atoms are present at the lattice site in place of host atoms.

Non-Stoichiometric Defects :
• Metal excess defect
• Metal deficiency defect

Imperfections (Defects) in Solids

Point Defects : The defects which arise due to the irregularity or deviations from ideal arrangement of atoms around a point or an atom in a crystalline substance are called point defects.

Stoichiometric Defects :
• **Vacancy defect :**
– Arises when some of the lattice sites are vacant.
– Decreases density.
• **Interstitial defect :**
– Arises when some constituent particles occupy an interstitial site.
– Increases density.
• **Schottky Defects :**
– Characterized by missing of equal number of cations and anions from their lattice sites and electrical neutrality is maintained.
• **Frenkel Defects :**
– An ion shifts from its original lattice site to interstitial site.
– Electrical neutrality and stoichiometry are maintained.

Properties of Solids (Crystals)

Electrical Properties : Solids may be classified into three categories depending upon their values of electrical conductivity.

Conductors : The electrical conductivity is of the order of 10^4 to 10^7 ohm^{-1} cm^{-1}.

Insulators : Electrical conductivity is of the order 10^{-20} ohm^{-1} cm^{-1}.

Semiconductors : Electrical conductivity is of the order of 10^{-6} to 10^4 ohm^{-1} cm^{-1}.
• *n*-type semiconductors : Group 14 elements doped with group 15 elements, free electrons increase conductivity.
• *p*-type semiconductors : Group 14 elements doped with group 13 elements, holes increase conductivity.

Magnetic Properties : Solid substances are classified into following categories depending upon their behaviour towards magnetic field.

Diamagnetic substances : Substances which are weakly repelled by external magnetic field *e.g.* N_2, NaCl, Zn, TiO_2, etc.

Paramagnetic substances : Substances which are weakly attracted by external magnetic field *e.g.* O_2, Cr, CO, NO, etc.

Ferrimagnetic Susbtances : These are the substances which possess very small net magnetic moment even though they are having a large number of unpaired electrons *e.g.* Fe_3O_4.

Antiferromagnetic substances : Substances which have zero net dipole moment even though they are having large number of unpaired electrons *e.g.* MnO.

Ferromagnetic substances : Substances which are strongly attracted by external magnetic field *e.g.* Ni, Fe, Co, etc.