Further Bonding

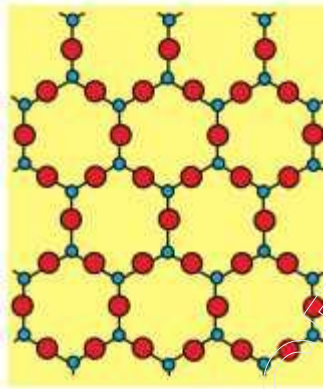
Solids and their physical properties

- Solid:

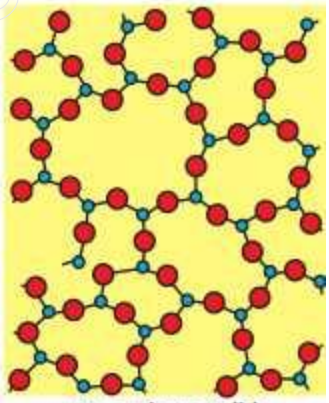
  Solid is a state of matter in which the constituting particles are arranged very closely. The constituent particles can be atoms, molecules or ions.

- Properties of solids:
  a) They have definite mass, volume and shape.
  b) They are incompressible and rigid.
  c) Intermolecular distances are short and hence the intermolecular forces are strong.
  d) Their constituent particles have fixed positions and can only oscillate about their mean positions.

- Classification of on the basis of the arrangement of constituent particles:
  a) Crystalline solids: The arrangement of constituent particles is a regular orderly arrangement. Example: iron, copper, diamond, graphite etc.
  b) Amorphous solids: The arrangement of constituent particles is an irregular arrangement. Example: Glass, plastics, rubber etc.

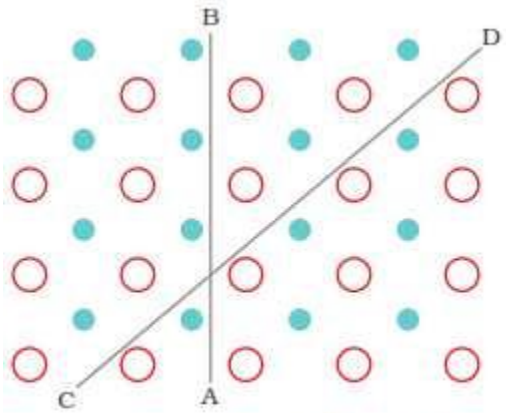


Crystalline Solids



Amorphous Solids

- Properties of crystalline solids:
  c) They have a definite characteristic geometrical shape.
  d) They have a long range order.
  e) They have a sharp melting point.
  f) They are anisotropic in nature i.e. their physical properties show different values when measured along different directions in the same crystal.
  g) They have a definite and characteristic heat of fusion.
  h) They are called true solids.
  i) When cut with a sharp edged tool, they split into two pieces and the newly generated surfaces are plain and smooth.



Anisotropic nature of crystalline solids

- Polymorphic forms or polymorphs:
  The different crystalline forms of a substance are known as polymorphic forms or polymorphs. For example: graphite and diamond.
- Characteristics of amorphous solids:
  a) They have an irregular shape.
  b) They have a short range order.
  c) They gradually soften over a range of temperature.
  d) They are isotropic in nature i.e. their physical properties are the same in all directions.
  e) When cut with a sharp edged tool, they cut into two pieces with irregular surfaces.
  f) They do not have definite heat of fusion.
  g) They are called pseudo solids or super cooled liquids. This is because they have a tendency to flow, though very slowly.

Types of crystalline solids:

A. Molecular Solids
Constituent Particles: Molecules

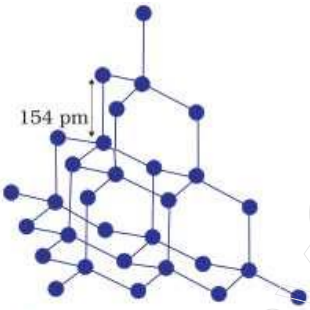
Type of Solid	Constituent Particles	Bonding/ Attractive Forces	Electrical conductivity	Physical nature	Melting point	Examples
Non-polar solids	Molecules	Dispersion or London forces	Insulator	Soft	Very low	Ar, CCl_4, H_2, I_2, CO_2
Polar solids	Molecules	Dipole- dipole interactions	Insulator	Soft	Low	HCl, solid solid NH_3
Hydrogen bonded	Molecules	Hydrogen bonding	Insulator	Hard	Low	H_2O (ice)

B. Ionic Solids
Constituent Particles: Ions

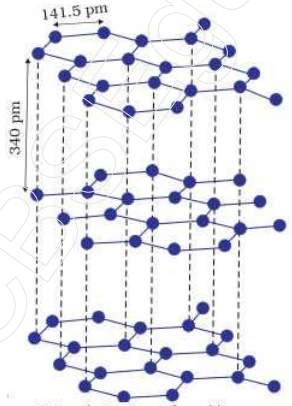
Bonding/Attractive Forces: Coulombic or Electrostatic
Electrical Conductivity: Insulators in solid state but conducts in molten state and in aqueous solutions
Physical Nature: Hard but brittle
Melting Point: High
Examples: CaF_2, ZnS, MgO, NaCl

C. Metallic Solids
Constituent Particles: Positive ions in a sea of delocalised electrons
Bonding/Attractive Forces: Metallic bonding
Electrical Conductivity: Conductors in solid state as well as in molten state
Physical Nature: Hard but malleable and ductile
Melting Point: Fairly high
Examples: Fe, Cu, Ag, Mg

D. Covalent or Network Solids
Constituent Particles: Atoms
Bonding/Attractive Forces: Covalent bonding
Electrical Conductivity: Conductors in solid state as well as in molten state
Physical Nature: Hard but malleable and ductile
Melting Point: Fairly high
Examples: SiO_2, (quartz), SiC, C (diamond), C(graphite)



Network structure of diamond



Network structure of graphite

- Crystal lattice:

  A regular ordered arrangement of constituent particles in three dimensions is called crystal lattice.

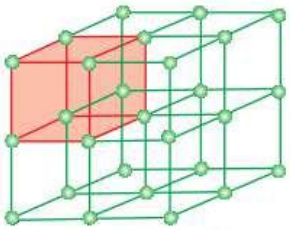


Diagram showing a portion of 3Dcubic lattice and its unit cell

- Lattice points or lattice sites: