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Material Science

Ref.

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• Crystal Structures

(Glass → supercooled liquid)

1. Material science is basically study of relationship between structure and Properties of Engineering materials.
2. Based on the structure all engineering materials are classified into two basic types: They are Crystalline materials and Amorphous material.
3. Amorphous material which do not exhibit regular, repeated & orderly arrangement of atoms/Ions/molecules
eg: waxes, polymers, glass, charcoal etc.
4. Crystalline materials are those materials which exhibit 3-D, long range, periodicity of arrangement of atom, ions or molecule in the Internal structure.

Crystalline Materials

- ↳ Atomic Solids → Metals
- ↳ Ionic Solids → Ceramics
- ↳ molecular Solids → Crystalline Polymers

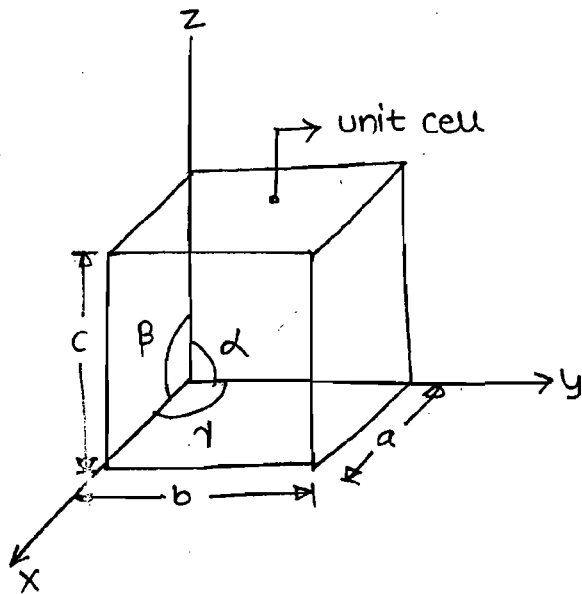
Amorphous materials

- Can exist any state
- Can be converted into Crystalline materials

Crystalline $\xrightarrow{\text{Fast Cooling}}$ Amorphous
Material type

↳ (We cannot judge by Naked eye)

5. Crystal structure of unknown material are determine by X-Ray diffraction technique. This is experimental technique.
6. Based on X-Ray diffraction technique all crystalline materials classified into seven crystal system and these are sub classified into 14 Bravais Lattices
7. The term crystal system refers to basic shape of unit cell whereas Bravais Lattices refers to Atomic Arrangements within a unit cell
8. A unit cell is defined as the smallest representative group of atoms, which when repeated in all the crystallographic direction for infinite number of times results in the development of crystal lattice.



$x, y, z =$ crystallographic axes

$a, b, c =$ Lattice Parameter

$\alpha, \beta, \gamma =$ Interaxial angles

Stability \rightarrow minimization of potential energy

Crystal System	Geometry	Bravais Lattices
Cubic ↳ Metal	$a = b = c$ $\alpha = \beta = \gamma = 90^\circ$	Simple (S), <u>BCC</u> , <u>FCC</u>
Tetragonal	$a = b \neq c$ $\alpha = \beta = \gamma = 90^\circ$	<u>ST</u> , <u>BCT</u>
Orthorhombic	$a \neq b \neq c$ $\alpha = \beta = \gamma = 90^\circ$	<u>SO</u> , <u>BCO</u> , <u>FCO</u> <u>ECO</u>
Rhombohedral	$a = b = c$; $\alpha = \beta = \gamma \neq 90^\circ$	<u>SR</u>
Hexagonal For metal	$a = b \neq c$ $\alpha = \beta = 90^\circ, \gamma = 120^\circ$	<u>SH</u>
Monoclinic	$a \neq b \neq c$ $\alpha = \gamma = 90^\circ \neq \beta$	<u>SM</u> , <u>ECM</u>
Triclinic	$a \neq b \neq c$ $\alpha \neq \beta \neq \gamma \neq 90^\circ$	<u>STr</u>

Simple (S)
Body centered (BC)
Face centered (FC)
End centered (EC)] \rightarrow Generally