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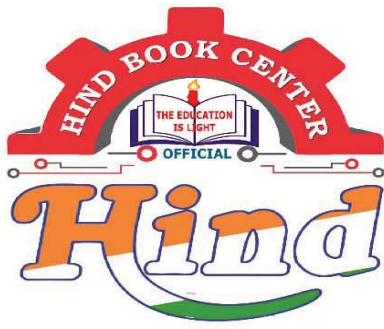
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CRYSTAL STRUCTURE

- 1) Atomic Arrangement in Solids.
- 2) Cubic Crystal System.
- 3) Miller Indices.
- 4) Bravais crystal structure.
- 5) Structural Imperfections.

* ATOMIC ARRANGEMENT IN SOLIDS:

CRYSTAL: It is a solid material in which atomic or molecular arrangement is periodic.

* This property of crystal is known as CRYSTALLINITY.

* SINGLE CRYSTAL MATERIAL:

* If material is having only one type of periodical arrangement then material is called single crystal.

* These materials are ANISOTROPIC MATERIALS. For eg QUARTZ.

* POLYCRYSTALLINE MATERIAL:

* These materials are divided into no. of small regions. These regions are called GRAINS.

* Within each grain atomic or molecular arrangement is PERIODIC but this arrangement varies from one grain to the other.

For eg POLYCRYSTALLINE SILICON.

* These materials are ISOTROPIC MATERIALS.

Note: (Anisotropic & Isotropic material):-

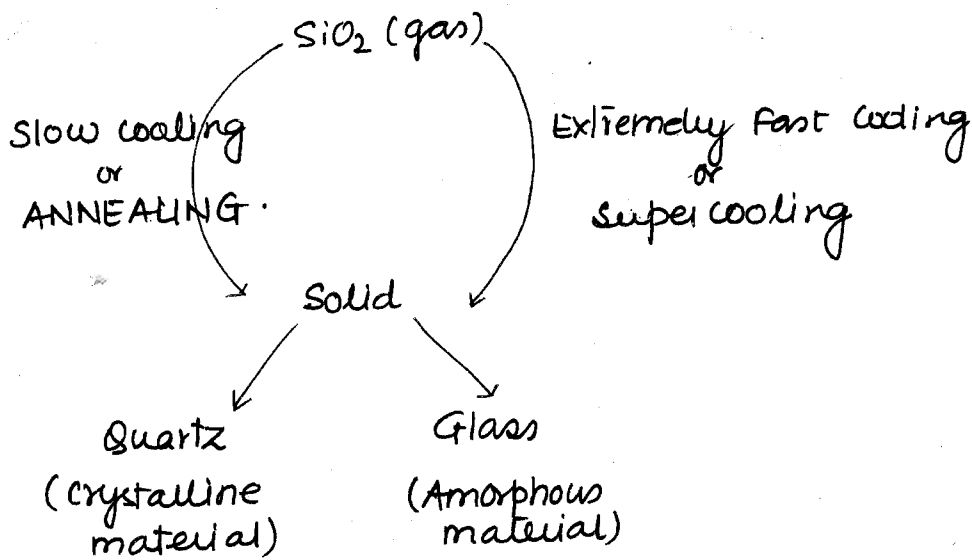
* ANISOTROPIC MATERIAL :-

A material is called ANISOTROPIC if properties of material depends on the direction in which they are measured.

* ISOTROPIC MATERIAL :-

* A material is called ISOTROPIC if properties of material are direction independent.

AMORPHOUS MATERIAL:



*When Atoms or molecules are not given opportunity to arrange in regular or periodic manner, an AMORPHOUS MATERIAL may be formed.

For eg: Supercooled state of SiO_2 is known as GLASS. (AMORPHOUS MATERIAL).

*Whereas on ANNEALING, SiO_2 may crystallize into QUARTZ. (CRYSTALLINE MATERIAL).

• In other cases, molecules may be extremely long and irregular in shape so that periodical arrangement may not be obtained as in the case of POLYMERS.

EPITAXIAL PROCESS:

*The process of growth of a layer of Silicon on a substrate is known as EPITAXIAL PROCESS.

1) In a Si Crystal, arrangement of atoms repeats periodically. This material can be classified as:

- Epitaxial & Amorphous.
- Polycrystalline & Amorphous.
- Single crystal & Amorphous (material can't be both).
- Epitaxial & Single crystal.

CRYSTAL SYSTEM:

1) UNIT CELL:

* It is defined as the minimum Area cell in Two dimension or the min^m volume cell in 3-dimension, by repetition of which a crystal may be formed.

2) PARAMETERS OF UNIT CELL:

a) CELL DIMENSION

b) Angle between axis

c) no. of atoms per unit cell.

d) Co-ordination number.

e) Atomic Packing factor (APF).

Mathematically :-

$$\text{APF} = \frac{\text{Total Atomic Volume}}{\text{Vol. of unit Cell.}}$$

$$\text{APF} = \frac{\text{No. of atoms per unit Cell} \times \text{atomic Vol.}}{\text{Vol. of unit Cell.}}$$

* Co-ordination number:

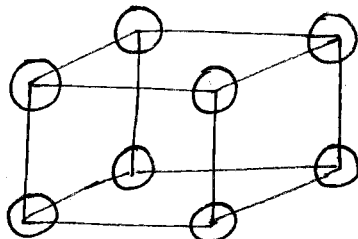
* The no. of atoms which are in physical contact with a particular atoms in a crystal structure, is known as CO-ORDINATION NUMBER:-

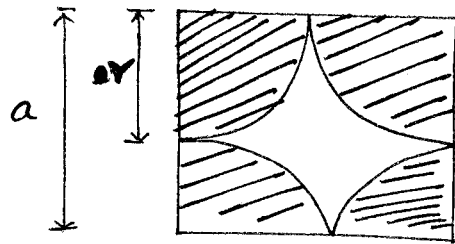
* CUBIC CRYSTAL SYSTEM:

1) SIMPLE CUBIC:

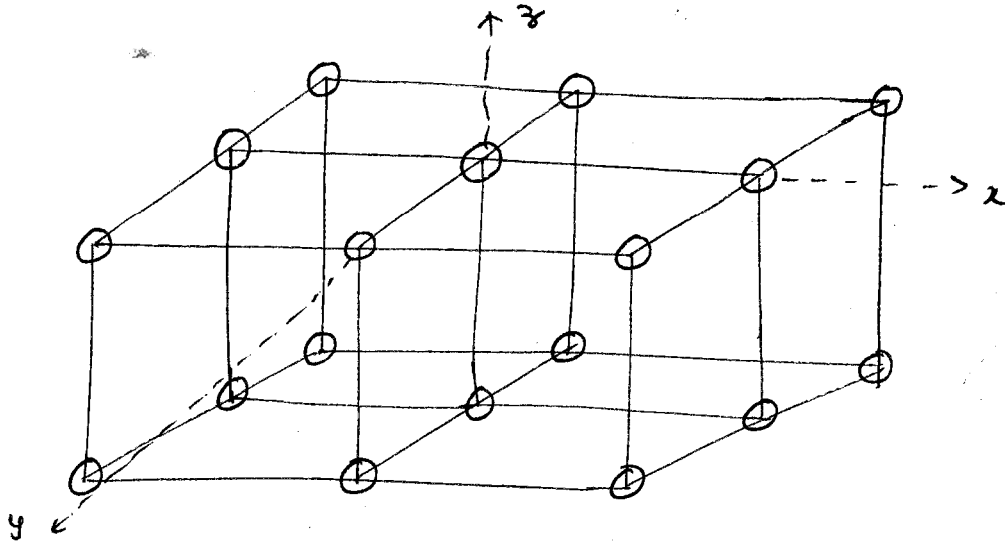
* In Simple cubic there are 8 corner atoms.

* Atoms are in physical contact along EDGE of the cube.





$$a = 2r$$



No. of atoms per unit cell = $8 \times \frac{1}{8} = 1$

$$\text{APF} = \frac{1 \times \frac{4}{3} \pi r^3}{a^3} = 0.52 ; a = 2r$$

Co-ordination number = 6. ← 2 atoms in contact in each direction.

* For eg.:

- i) Manganese
- ii) Fluorspar etc.

1) Body centered cubic (BCC) :-

* In BCC there are 8 corner atoms and 1 Body centered atom.

* Atoms are in physical contact along Body diagonal.