Am-1 2100031090

Q-1 Differentiate between crystalline and Non-crystalline materials ?

⇒ The differentiation among crystalline and Non-crystalline materials is done amongst features like atomic arrangement, melting Point, properities, cleavage planes.

crystalline	Non-Crystalline
i) Ordered atomic arrangement where the lattice structure is repetitive.	i) Random and unordered atomic arrangement.
ii) sharp and defined melting Point.	ii) Gradual softening of M;P over a range of temperature.
iii) cleave planes exist and all well defined.	iii) cleavage planes are absent.
iv) Anistrophic properties.	iv) Isotropic properties.
v) Ex; salt, diamond.	v) Ex; Glass, rubber, honey.

Q-2 Define nearest neighbour distance, atomic radius and packaging fraction?

⇒ Nearest Neighbour Distance :-

It is defined as the distance between the centres of the two closely neighbouring atom or molecules.

Atomic Radius :-

It is defined as the distance measured from the nucleus to the outermost electron of an atom in its ground state.

Packaging Fraction :-

It is the ~~measure~~ measure of efficiency of the atoms in filling the empty space in a crystall structure.

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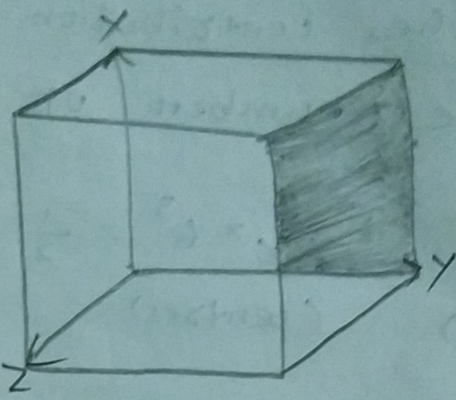
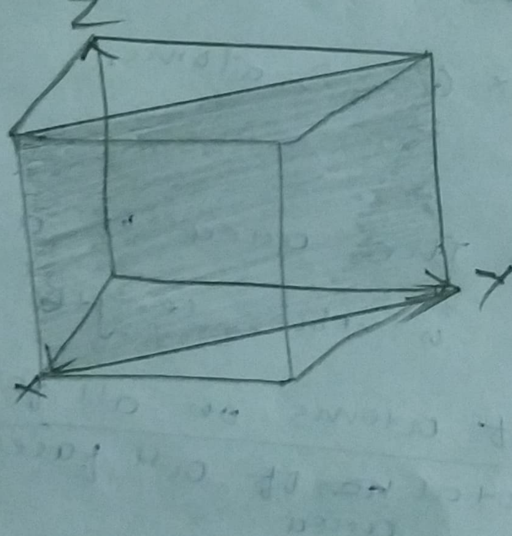
Q-1) Sketch the planes (0,1,0) (1,1,0) and (1,1,1).

⇒

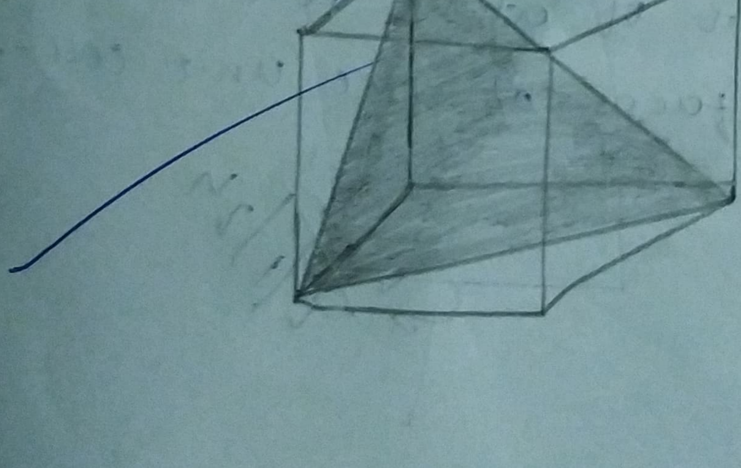
(0,1,0) →



(1,1,0) →



(1,1,1) →



Q-2

Calculate the number of atoms per unit area on each face of FCC unit cell of a side of a unit?

⇒ FCC, the contribution of each face to the number of atoms is;

$$\underset{\text{(corners)}}{\frac{1}{8}\times 8} + \underset{\text{(centres)}}{\frac{1}{\cancel{2}}\times \cancel{6}^{3}} = \frac{1}{2} \text{ atoms}$$

The total contribution from all faces is given as;

$$\frac{1}{2}\times 6 = 3 \text{ atoms.}$$

$A = a^2$ → The area of a square face where 'a' is the length of the side.

$$N = \frac{\text{no. of atoms on all faces}}{\text{Total area of all faces}}$$

$$= \frac{3}{6a^2} = \frac{1}{2a^2}$$

∴ The number of atoms per unit area on each face of FCC unit cell $= \frac{1}{2a^2}$

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Q-1 classify crystal defects based on geometry and sketch all point defects?

⇒ Crystall defects are irregularities or deviations from the ideal ordered structured of a crystal lattice. These defects are classified into several categories based on geometry.

* Point Defects: These defects have atomic dimensions so that they occur around a single lattice point. They are not extended in space in any dimension.

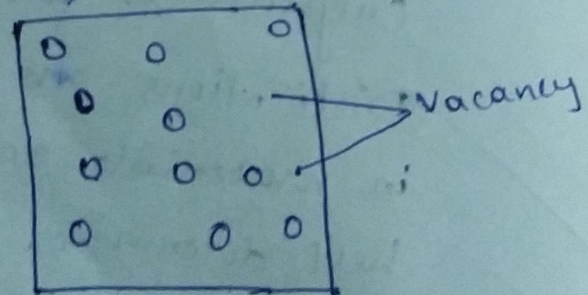
* Line Defects: Line defects are called dislocation and occurs only in crystalline materials only. Dislocations are especially important in materials science as they help determine the mechanical strength of materials.

* **Plane Defects:** This defect is a discontinuity of the perfect crystal structure across a plane. Interfacial defects exists at an angle between any two of a crystal or crystal forms.

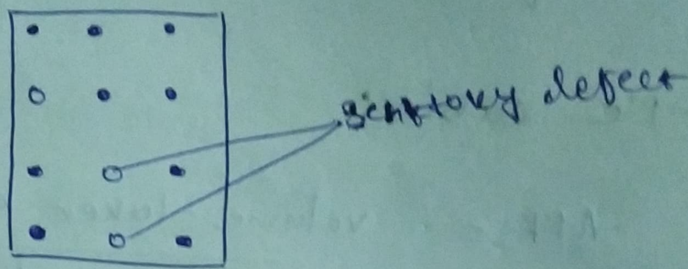
* **Volume Defects:** It is also known as bulk defects, all the irregularities or deviations from ideal crystal structure within the volume of the crystalline material.

Types:-

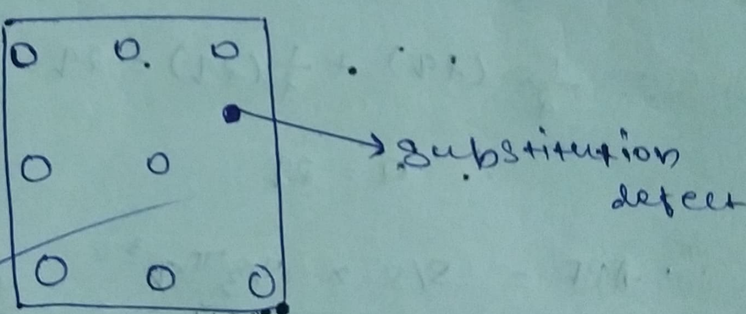
→ Vacancy Defect: These defects results from a missing atom in a lattice position.



→ **Schottky Defect:** This defect from when oppositely charged ions leave their lattice sites creating vacancies.



→ **Substitution Defect:** It results from an impurity present at a lattice position.



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Home Assignment - 1

Q-1. Atomic fraction of SC, Body Centred Cubic, face centred cubic?

⇒ Simple cubic:

$$APF = \frac{\text{Volume taken by atoms}}{\text{total volume}}$$

In simple cubic, atoms exists at corners of the structure.

Number of atoms per unit cell = 1

$\therefore \frac{1}{2}(2r) + \frac{1}{2}(2r) = 2r$

$\therefore a = 2r$

$$\therefore APF = \frac{8/8 \times 4/3 \pi r^3}{(2r)^3} = \frac{\frac{4}{3}\pi r^3}{8r^3} = \frac{\pi}{6}$$

$= 52\%$

Body Centred Cubic:

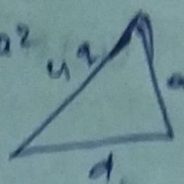
In BCC, the body diagonal is close packed direction

Number of atoms per unit cell = 2

Assuming pythagoras - theorem,

$$a^2 + d^2 = (4q)^2$$

$$a^2 + 2a^2 = (4q)^2 \quad \text{where } d^2 = 2a^2$$



$$3a^2 = (4q)^2 \Rightarrow \frac{4}{\sqrt{3}} a$$

$$APF = (8/8 + 1)\, 4/3 \pi q^3) / (\tfrac{4}{3} e)^3$$

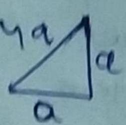
$$= \sqrt{3}\,\pi/8 = 68\%.$$

→ Face centred cubic:

In FCC, any face diagonal is the close packed Number of atoms per unit cell $= 4$.

$$a^2 + a^2 = (4q)^2$$

$$2a^2 = (4q)^2$$



$$\therefore a = 2\sqrt{2}\, q$$

$$\therefore APF = \frac{\left(\frac{8}{8} + \frac{6}{2}\right) \frac{4}{3} \pi q^3}{(2\sqrt{2}\, q)^3} = \frac{\pi}{3\sqrt{2}} \Rightarrow 74\%.$$

Q-2

Illustrate seven crystal system with lattice Parameter conditions:

⇒

Structure	Lattice parameter	Angle Parameter
i) Triclinic System	$a \neq b \neq c$	$\alpha = \beta = \gamma \neq 90^\circ$
ii) Cubic system	$a = b = c$	$\alpha = \beta = \gamma = 90^\circ$
iii) Tetragonal System	$a = b \neq c$	$\alpha = \beta = \gamma = 90^\circ$
iv) Orthorhombic system	$a \neq b \neq c$	$\alpha = \beta = \gamma = 90^\circ$
v) monoclinic system	$a \neq b \neq c$	$\alpha = \gamma = 90^\circ, \beta \neq 90^\circ$
vi) Hexagonal System	$a = b \neq c$	$\alpha = \beta = 90^\circ, \gamma = 120^\circ$
vii) Rhombohedral System	$a = b = c$	$\alpha = \beta = \gamma = 90^\circ$

Important Features

→ uniqueness

→ Symmetry

→ Inter planar spacing

→ x-ray diffraction.

Q-5 Discuss line defects and explain burger vector ?

⇒ **Line Defects :**

These are the disruptions in the regular arrangement of atoms in a crystal lattice. They play a crucial role in the mechanical properties of materials.

Types

→ **Edge:** These defect occurs when an extra plane of atoms is introduced into the crystall lattice creating a region with a deficit of atoms.

→ **Screw:** This defect involves a special spiral motion of the atomic planes around the dislocation line. This results in helical dislocation of the crystal lattice.

→ Burger Vector:

This is a vector that describes the magnitude & direction of the lattice distortion caused by a defect.

→ It represents the closed loop formed by following the atomic arrangement around the defect.

→ For an edge defect, the burger vector is perpendicular to the defect line & for screw defect, the burger vector is parallel to the defect line.

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