SNS COLLEGE OF ENGINEERING

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Affiliated to Anna University, Chennai

DEPARTMENT OF PHYSICS

COURSE NAME :19PY101-ENGINEERING PHYSICS

I YEAR / I SEMESTER

UNIT 4 – CRYSTAL PHYSICS

TOPIC 6 – DIAMOND STRUCTURES

Think it

Do you know that

1. What is crystal structure?
2. Define miller indices and it’s related to bravias lattices.
3. Define unit cell of crystal structure.
4. Give the characteristic of crystal structure

Diamond lattice structure

The **diamond lattice** (formed by the carbon atoms in a **diamond crystal**) consists of two interpenetrating face centered **cubic** Bravais lattices, displaced along the body diagonal of the **cubic** cell by one quarter the length of the diagonal.

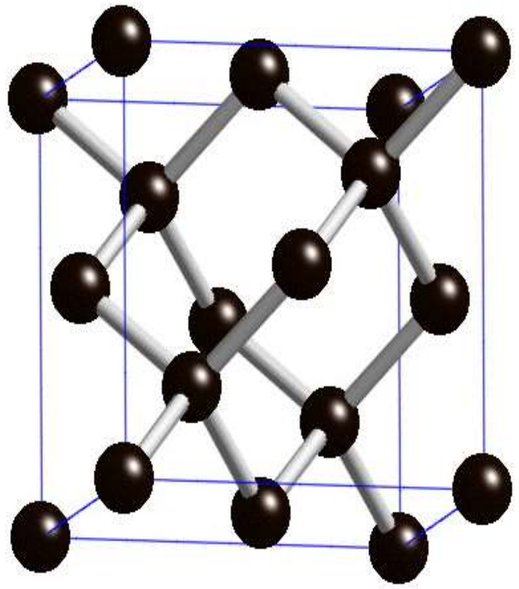
Diamond Cubic structure

Silicon (Si), Germanium (Ge) Carbon (c) and Telurium (Te) possess this structure which is a combination of two interpenetrating FCC sub lattices.

1. Sub – lattice has its origin at (0, 0, 0) and

2. The other at a point of the way along the body diagonal i.e., at (a/4, a/4, a/4) point.

This structure is loosely packed structure since each atom has only 4 nearest neighbours.



Number of Atoms per Unit Cell:

In diamond we have 3 types of atoms viz.,

(i) Corner atoms, represented by ‘c

(ii) Face centered atoms represented by ‘F’

(iii) Four atoms present inside the unit cell

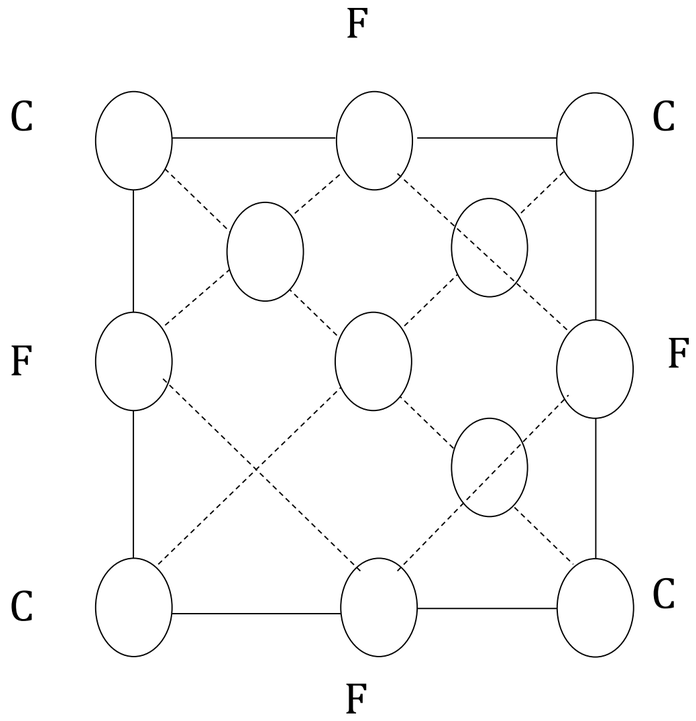
Represented as 1, 2, 3, and 4.

(i) Number of corner atoms per unit cell

Each corner atom is shared by 8 unit cells. Similarly,

8 corners atoms in an unit cell.

Number of corner atoms per unit cell =1/8 x8 =1atom.



(ii) Number of face centered atoms per unit cell

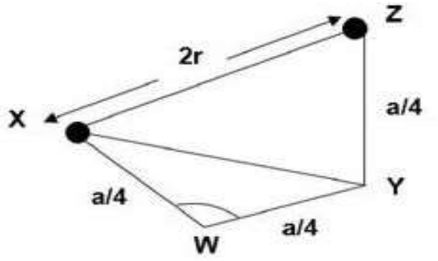
Each face centered atom is shared by 2 unit cell. Similarly, we have 6 face centered atoms.

Number of face centered atoms per unit cell atoms.

(iii) Number of atoms inside the unit cell

Inside the unit cell we have 4 atoms, represented by 1, 2, 3, 4 which is shared by that particular unit cell alone.

Total number of atoms per unit cell = 1 + 3 + 4 = 8 atoms.



$$XY^2 = XW^2 + WY^2 + YZ^2$$

$$= \left(\frac{a}{4}\right)^2 + \left(\frac{a}{4}\right)^2 + \left(\frac{a}{4}\right)^2$$

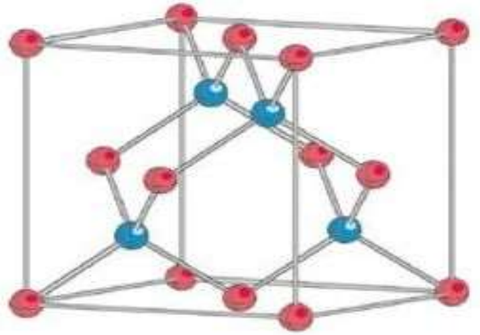
But $XZ = 2r$

$$\therefore (2r)^2 = \frac{3a^2}{16}$$

$$4r^2 = \frac{3a^2}{16}$$

$$r^2 = \frac{3a^2}{64}$$

$$\therefore \text{Atomic radius } r = \frac{\sqrt{3}\ a}{8}$$



# of atoms in unit cell: 8 $\left(= \frac{1}{8} \times 8 + \frac{1}{2} \times 6 + 4\right)$

$$\text{APF} = \frac{v}{V}$$

$$v = 8 \times \frac{4}{3}\pi r^3 = 8 \times \frac{4}{3}\pi\left(\frac{\sqrt{3}a}{8}\right)^3$$

$$\text{APF} = \frac{8 \times 4\pi \times 3\sqrt{3}\ a^3}{3 \times 8^3 \times a^3}$$

$$= 0.34 \quad (34\%)$$

Thus it is a loosely packed structure.

Thus we can say that 34% volume of the unit cell in diamond cubic structure is occupied by atoms and the remaining 66% volume is vacant.

Answer all the think it questions

References

- https://images.app.goo.gl/mb83LqcymPgCPFu38
- https://images.app.goo.gl/9GGgH4hu5PqBi3GZ9