VIVEKANANDA COLLEGE
THAKURPUKUR
KOLKATA-700063

NAAC ACCREDITED 'A' GRADE

Topic: physics of crystalline solids

Course Title: Applied Physics

Paper: CC-3

Unit:

Semester: 2

Name of the Teacher: Romela Dutta

Name of the Department: Electronics

FEB 2017 17 FRIDAY

07th Wk. 048-317

CC-3

FEBRUARY-2017

		1	2	3	4	5
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27	28					

Solid State physics

Physics of Crystalline Solids

09.00

Atomic packing factor (APF), packing efficiency or packing fraction is the fraction of volume in a crystal structure that is occupied by constituent particles. It is a dimensionless qty and always less than unity. APF is determined by assuming that atoms are rigid spheres. The radius of the spheres is taken to be the maximum value such that the atoms do not overlap.

10.00

11.00

12.00

$$APF = \frac{N_{particle} V_{particle}}{V_{unit\ cell}}$$

01.00

$N_{particle}$ = number of particles in the unit cell

$V_{particle}$ = volume of each particle

$V_{unit\ cell}$ = volume occupied by unit cell.

02.00

* Single component crystal structure

03.00

a) Face centred cubic

04.00

b) Body centered cubic

c) Simple cubic

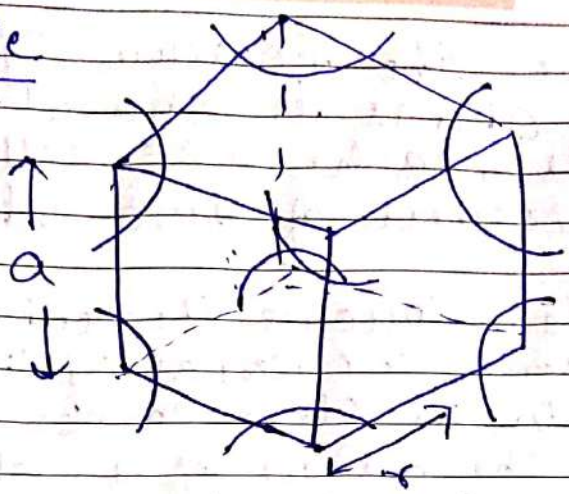
05.00

d) Diamond cubic

06.00

Majority of metals take on either FCC or BCC.

Simple cubic

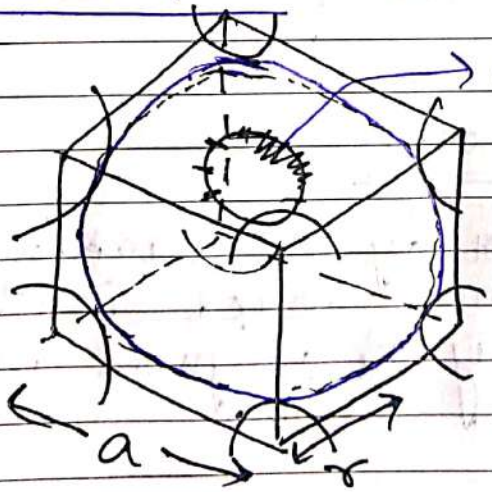


For a simple cubic packing, the no. of atoms per unit cell is one. The side of the unit cell is of $2r$, where r is the radius of the atom.

$$APF = \frac{\text{No atoms} \times \text{Vatoms}}{\text{Vunit cell}} = \frac{1 \cdot \frac{4}{3}\pi r^3}{(2r)^3} = \pi/6$$

$$= 0.5236.$$

Body centered cubic



Sunday 19

The primitive unit cell for the body centered cubic crystal structure contains several fractions taken from nine atoms, one on each corner of the cube and one atom in the center.

09.00 Because the volume of each of the eight corner atoms is shared between eight adjacent cells, each BCC cell contains the equivalent volume of two atoms.

10.00 Each corner atom touches the center atom. A line that is drawn from one corner of the cube through the center and to the other corner passes through 4r, where r is the radius of an atom. By geometry length of diagonal is $a\sqrt{3}$. Therefore length of each side of BCC structure can be related to the radius

11.00 of the atom by

$$a = 4r/\sqrt{3}$$

12.00

01.00 $$\therefore APF = \frac{N_{atoms}\, V_{atom}}{V_{unit\,cell}} = \frac{2 \times \frac{4}{3}\pi r^3}{\left(\frac{4r}{\sqrt{3}}\right)^3} = \frac{\pi\sqrt{3}}{8}$$

02.00 $$= 0.680\ldots$$

03.00 H/W Find the APF for FCC structure.

04.00 ## Packing density

A packing density or packing fraction of a packing in some space is the fraction of the space filled by the figures making up the packing.

05.00

06.00

TUESDAY

08th Wk. 052-313

Miller indices

Miller indices, group of three numbers that indicates the orientation of a plane or a set of parallel planes of atoms in a crystal. If each atom in the crystal is represented by a pt. and these pts. are connected by lines, the resulting lattice may be divided into a number of identical blocks or unit cells, the intersecting edges of one of the unit cells defines a set of crystallographic axes, and Miller indices are determined by the intersection of the plane with these axes. The reciprocal of these intercepts are computed and fractions are cleared to give 3 Miller indices (hkl) For example, a plane parallel to two axes but cutting the 3rd axis at a length equal to one edge of a unit cell has Miller indices of (100), (010), or (001) depending upon the axis cut; and a plane cutting all three axes at lengths equal to the edges of a unit cell has Miller indices of (111). This scheme has the advantage of eliminating all fractions from the notation for a plane.

In the hexagonal system, which has four crystallographic axes, a similar scheme of four ~~crystallographic axes~~ Bravais Miller indices is used.