Website : www.tcetmumbai.in

Estd. in 2001

Zagdu Singh Charitable Trust's (Regd.)
THAKUR COLLEGE OF ENGINEERING & TECHNOLOGY
Autonomous College Affiliated to University of Mumbai
Approved by All India Council for Technical Education(AICTE) and Government of Maharashtra(GoM)
Conferred Autonomous Status by University Grants Commission (UGC) for 10 years w.e.f. A.Y 2019-20
Amongst Top 200 Colleges in the Country, Ranked 193rd in NIRF India Ranking 2019 in Engineering College category
• ISO 9001:2015 Certified • Programmes Accredited by National Board of Accreditation (NBA), New Delhi
• Institute Accredited by National Assessment and Accreditation Council (NAAC), Bangalore

Subject :- PHYSICS Experiment / ~~Tutorial~~ / ~~Assignment~~ No. :- 1 Page :- 01 Date :- 11 / 01 / 2022

* Experiment NO: 1 → STUDY OF CRYSTAL STRUCTURES *

AIM :- To study different crystal structure of the cubic System and diamond crystal using crystal model.

Objective :- After performing the practical, the learner will be able to :

1: Understand the characterisfics of cubic Crystal Structure simple Cubic (SC), Body centred Cubic (BCC), face Centred (FCC).

2: Calculate different parameters related to characteristics of SC, BCC and FCC.

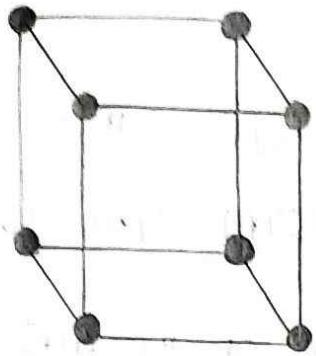
3: ~~Formulate~~ and Calculate atomic radii, number of Units per volume and density of Unit cell from data given in table 2 for γ-fe, α-fe and Po element.

4: Calculate the number of atoms in one Unit cell, Coordination number, packing fraction, density and relation between r and a in all structure.

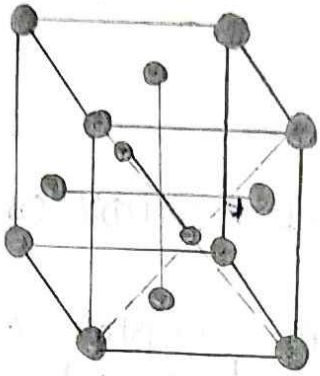
Apparatus :- Crystal Models of SC, BCC, FCC, Structure and Diamond Structure.

Formulae :-

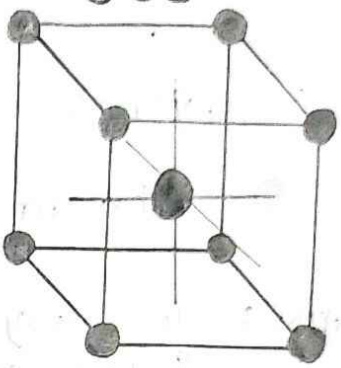
SC



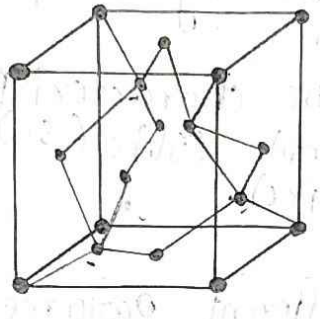
FCC



BCC



DIAMOND STRUCTURE:-



OBSERVATION TABLE :-

DATA I :

TABLE I

Sr. NO	PRO I	PRO 2		
	Characteristics	SC	BCC	FCC
1.)	Atom per unit cell(n)	1	2	4
2.)	Atomic Radius (r)	$a/2$	$\frac{\sqrt{3}a}{4}$	$\frac{\sqrt{2}a}{4}$
3.)	Nearest neighbour distance [2r]	a	$\frac{\sqrt{3}a}{2}$	$\frac{\sqrt{2}a}{2}$
4.)	Coordination number	6	8	12
5.)	Atomic packing fraction	0.52	0.68	0.74

Subject :- PHYSICS Experiment / ~~Tutorial~~ / ~~Assignment~~ No. :- 1 Page :- 02 Date :- 11 / 01 / 2022

1) Number of atoms per Unit cell $(n) = (N_C) \times \frac{1}{8} + (N_F) \times \frac{1}{2} + (N_B) \times 1$

2) Atomic radius (r)

for SC, $r = \frac{a}{2}$

for BCC, $r = \frac{a\sqrt{3}}{4}$

for FCC, $r = \frac{a\sqrt{2}}{4}$

Atomic packing fraction $= \frac{n \times \frac{4}{3}\pi r^3}{a^3}$

Result and Disussion :-

PRO 1 : In PRO 1, We Understood the different characteristics of the crystal structure and face cubic Structure. Through This, we knew important properties such as atom per unit cell, atomic radius, nearest neighbour distance, co-ordination number and atomic packing fraction of different Crystal structures of the cubic System.

PRO 2 : In PRO 2, we learnt about different values and parameters of SC, BCC and FCC respectively, regarding the characteristics of crystal Structure such as, atomic radii, coordination no, etc

DATA II :- The crystal structure of some elements as determined by x-ray analysis is given below with their atomic weights and mass densities

Avogadro's NO(N) = 6.023×10^{23} $Kgmol^{-1}$

Sr. NO	Element	Structure	a in A^0	Atomic Weight
1	γ-Fe	F.C.C	3.5	55.85
2	α-fe	B.C.C	2.8	55.85
3	Po	S.C	3.34	210.00

Using the above data from table 2, Calculated the above elements of similar structures in table 3.

Sr. NO	PRO 3		
	Atomic radii (r) in metre (m)	NO of atom/unit Volume (n/v) in m^{-3}	mass density (ρ) in Kg/m^3
1)	1.23×10^{-10}	9.32×10^{28}	8650
2)	1.21×10^{-10}	9.11×10^{28}	8448
3)	1.67×10^{-10}	2.68×10^{28}	9357

for Diamond → Number of nearest neighbours atom = 4

$$\text{Density } (\rho) = \frac{nM}{N_A V}$$

Avogadro's Number (N_A) = 6.023×10^{23}

Crystal	a(A^0)	M	Atomic radii	A.P.f	Density (g/cc)
C	3.567	12.0107	7.72×10^{-9} cm	0.339	3.515
Si	5.430	28.08	1.175×10^{-8} cm	0.34	2.32
Ge	5.658	72.64	1.22×10^{-8} cm	0.34	5.326
Sn	6.49	118.70	1.4×10^{-8} cm	0.339	5.76

Subject :- PHYSICS Experiment / ~~Tutorial~~ / ~~Assignment~~ No. :- 31 Page :- 3 Date :- 11 / 01 / 2022

PRO 3 :- In this we studied about elements of similar structure and also we Calculate atomic radii, number of Units per volume and density of Unit Cell from data given for γ-fe, α-fe and Po element.

PRO 4 :- Here we Studied about diamond structure and it's properties. We Calculated atomic radii, atomic packing fraction and density for Crystals like Carbon, Silicon, germanium and Tin.

Conclusion :- We Studied about Cubic Crystal Structures and also we Studied their different properties or characteristics like atomic radii, atomic packing fraction, density, etc. and we Calculate different parameters related to S.C, F.C.C and B.C.C Structure Then we Calculated atomic radii, density of unit cell for γ-fe, α-fe and Po element. We saw diamond Structure and Studied about it's properties and Calculated its atomic radii, APf and density of Various Crystals.

calculation :-

1) for SC :- [Po element]

Atomic radius $(r) = \frac{a}{2} = \frac{3.34}{2} \times 10^{-10} = 1.67 \times 10^{-10}$ m

No. of atoms per unit volume $\left(\frac{n}{V}\right) = \frac{1}{(3.34 \times 10^{-10})^3} = 2.63 \times 10^{28}$

Mass density $(\rho) = \frac{1 \times 210}{6.023 \times 10^{23} \times (3.34 \times 10^{-10})^3} = 9357$

2) for BCC :- [α-Fe element]

Atomic radius $(r) = \frac{a\sqrt{3}}{4} = \frac{2.8 \times 10^{-10} \times \sqrt{3}}{4} = 1.21 \times 10^{-10}$ m

No. of atoms per unit volume $\left(\frac{n}{V}\right) = \frac{2}{(2.8 \times 10^{-10})^3} = 9.11 \times 10^{28}$

Mass density $(\rho) = \frac{2 \times 55.85}{6.023 \times 10^{23} \times (2.8 \times 10^{-10})^3} = 8448$

3) for fcc :- [γ-fe element]

Atomic radius $(r) = \frac{a\sqrt{2}}{4} = \frac{3.5 \times \sqrt{2} \times 10^{-10}}{4} = 1.23 \times 10^{-10}$ m

No. of atoms per unit volume $\left(\frac{n}{V}\right) = \frac{4}{(3.5 \times 10^{-10})^3} = 9.32 \times 10^{28}$

Mass density $(\rho) = \frac{4 \times 55.85}{6.032 \times 10^{23} \times (3.5 \times 10^{-10})^3} = 8650$

for Diamond

1) Carbon

radius $= \frac{\sqrt{3}a}{8} = \frac{\sqrt{3}}{8} \times 3.567 \times 10^{-8} = 7.72 \times 10^{-9}$

$APF = \frac{n \times \frac{4}{3}\pi r^3}{a^3} = 0.339$

Density $= 3.515$

Lupin Singh Charitable Trust's (Regd.)
THAKUR COLLEGE OF ENGINEERING & TECHNOLOGY
Autonomous College Affiliated to University of Mumbai
Approved by All India Council for Technical Education(AICTE) and Government of Maharashtra(GoM)
Conferred Autonomous Status by University Grants Commission (UGC) for 10 years w.e.f. A.Y. 2019-20
Amongst Top 200 Colleges in the Country, Ranked 195th in NIRF India Ranking 2019 in Engineering College category
• ISO 9001:2015 Certified • Programmes Accredited by National Board of Accreditation (NBA), New Delhi
• Institute Accredited by National Assessment and Accreditation Council (NAAC), Bangalore
Estd. in 2001

Subject :- PHYSICS Experiment / ~~Tutorial / Assignment~~ No. :- 1 Page :- 4 Date :- 18/01/2022

Objective	PRO 1	PRO 2	PRO 3	PRO 4	Total score	ES & H Department TCET
weightage						Date of performance :-
points						Date of Correction :-
Score						Roll No :-
						MARKS :-
						Signature of faculty