
Experiment No. 1 **Date:-** 02/03/2021

(Module 1) **STUDY OF CUBIC LATTICES**

FEC102.1:- Interpret the crystal structure using XRD and relate the importance of defects on the material properties which is prerequisite for the research of Material Science & Technology.

AIM: - To study i) different cubic lattices ii) crystal directions and planes.

APPARATUS: - Crystal models, Meter scales.

THEORY:-Crystals are made up of regular and periodic three dimensional patterns of atoms in space. The regularity in the arrangement of atoms allows us to visualize certain 'building blocks' of the crystal structure, called 'unit cell'. A close stacking of the unit cells over each other gives rise to the full crystal. Because the arrangement of the atoms in the crystal has to be completely regular and perfect, only a limited number of cell patterns are possible. The simplest and the most-symmetric unit cell is the cubic one. Depending on the actual arrangement of the atoms, there can be three types of cubic unit cell. These are: (i) simple cubic (SC); (ii) body centered cubic (BCC); and (iii) face centered cubic (FCC). In a crystal there exists parallel direction and parallel planes. It is necessary to use some convention to specify these geometrical features. For this purpose, the system devised by Miller is widely used. If (hkl) are the Miller indices of a crystal plane, then the distance between two successive (hkl) planes, i.e., the interplanar separation, is given by

$$d_{hkl} = \frac{a}{\sqrt{h^2 + k^2 + l^2}},$$

where 'a' is the length of one edge of the unit cell.

PROCEDURE:-

i) Draw (100) (110) (111) crystal planes with reference to a unit cell.

ii) Take a simple cubic crystal model. Measure the length of the edge of the cube. Calculate the length of the body diagonal and the face diagonal. Find the numbers of (100) planes within one edge length, of (110) planes within one face diagonal length, and 0f (111) planes within one body diagonal length. Calculate d_{100}, d_{110}, and d_{111}, and hence the ratio $d_{100}:d_{110}:d_{111}$. Repeat the procedure with face centered cubic and body centered cubic models.

OBSERVATIONS

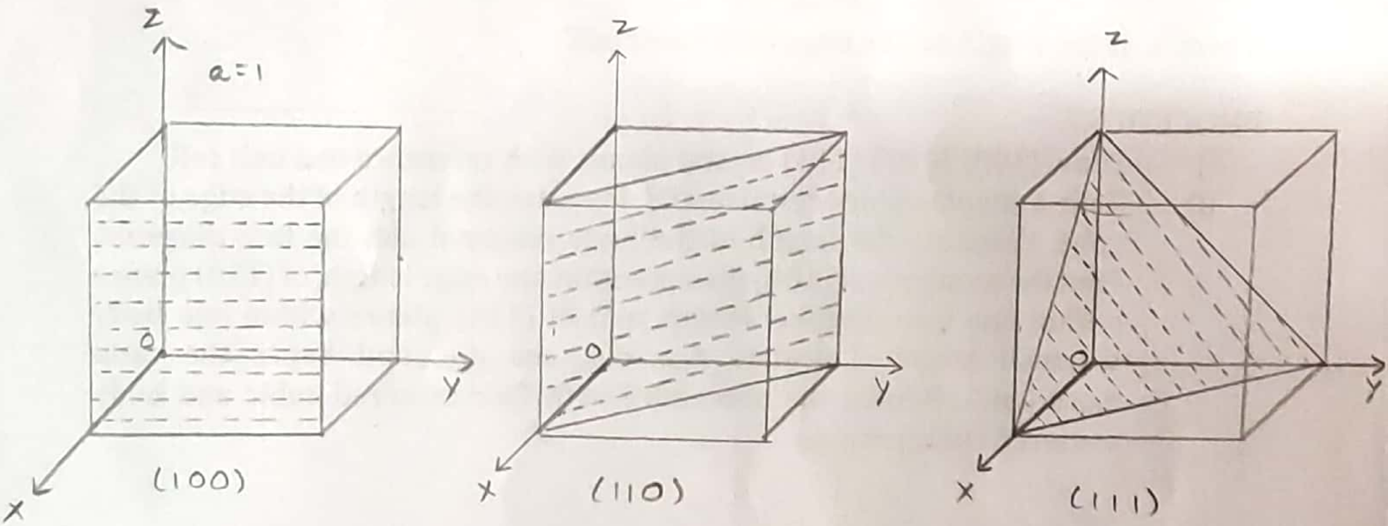
1) Determination of the ratio $d_{100}:d_{110}:d_{111}$.

Table 1: Measurements of a, $\sqrt{2}$a, $\sqrt{3}$a

Lattice	Sr. No.	Length of the cube edge 'a' cm	Mean 'a' cm	$\sqrt{2}$a cm Face diagonal	$\sqrt{3}$a cm Body diagonal
SC	1	10.6	10.6	14.99	18.36
	2	10.6			
	3	10.6			
BCC	1	10.6	10.6	14.99	18.36
	2	10.6			
	3	10.6			
FCC	1	10.6	10.6	14.99	18.36
	2	10.6			
	3	10.6			

Table 2: The interplanar spacing d_{100}, d_{110}, and d_{111}

Lattice	No. of (100) planes within one edge length (m)	d_{100} =a/m cm	No of (110) planes within one face diagonal length (n)	d_{110} =$\sqrt{2}$a/n cm	No of (111) planes within one body diagonal length (p)	d_{111} =$\sqrt{3}$a/p cm
SC	1	10.6	2	7.49	3	6.12
BCC	2	5.3	2	7.49	6	3.06
FCC	2	5.3	4	3.75	3	6.12



RESULTS:-

Lattice	d_{100}	d_{110}	d_{111}	$d_{100}:d_{110}:d_{111}$	
				Experimental	Theoretical
SC	10.6	7.49	6.12	1 : 0.707 : 0.577	$1 : 1/\sqrt{2} : 1/\sqrt{3}$
BCC	5.3	7.49	3.06	1 : 1.414 : 0.577	$1 : \sqrt{2} : 1/\sqrt{3}$
FCC	5.3	3.75	6.12	1 : 0.707 : 1.155	$1 : 1/\sqrt{2} : 2/\sqrt{3}$

COMMENTS:-

1. Why all the parallel crystal planes have same Miller indices?

As the ratio of intercepts is same, all the parallel crystal planes have same miller indices.

2. Draw the following planes with reference to a unit cell (020), (300) and $(03\bar{1})$.

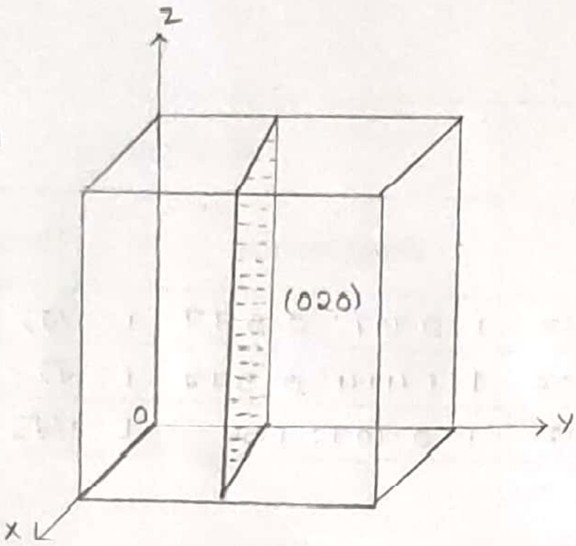
D.J.S.C.E. (Physics)		
Journal		
Knowledge	3	
Documentation	3	
Punctuality	3	
Virtual Lab (Performance & Documentation)	6	
Total	15	

Date	Signature of the faculty

Answers 2)

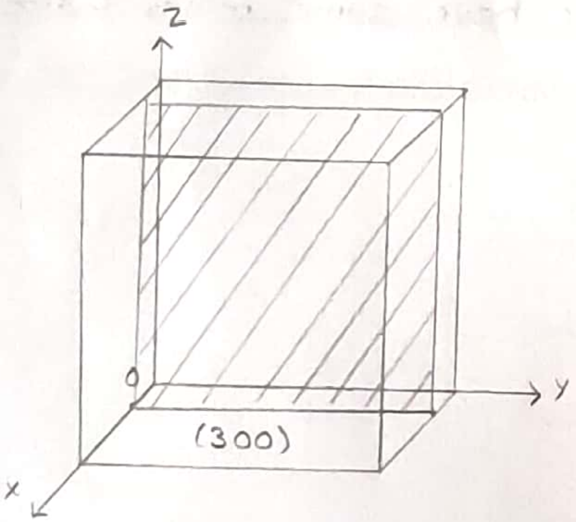
i) (0 2 0)

a=1



ii) (3 0 0)

a=1



iii) $(0\,3\,\bar{1})$

a=1