B.Sc. (Chemistry) Hons - III

21st lecture

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Solid State

Crystal Classes

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There are 32 possible combinations of symmetry operations that define the external symmetry of crystals. These 32 possible combinations result in the 32 crystal classes. These are also referred to as the 32 point groups. Each crystal classes will have crystal faces that uniquely define the symmetry of the class These faces or groups of faces are Called crystal forms. You are not expected to memorise the crystal classes, their names or the symmetry associated with each class but expected to determine the symmetry content of crystal models.

In this lecture we will go over some of the crystal classes and their symmetry. It is not possible to cover all the 32 classes.

32 crystal classes are divided into 6 crystal systems:-

1) Triclinic system has only 1-fold or 1-fold rotoinversion axis
2) Monoclinic system has only mirror plane or a single 2-fold axis.
3) Orthorhombic system has only two fold axis or a 2-fold axis and 2 mirror Plane
4) Tetragonal system has either a single 4-fold or 4-fold rotoinversion axis.
5) Hexagonal system has no 4-fold axis but has at least 1 6-fold or 3-fold axis.
6) Isometric system has either 4 3-fold axis or 4 3-fold rotoinversion axis.

Indexing of Crystal Planes

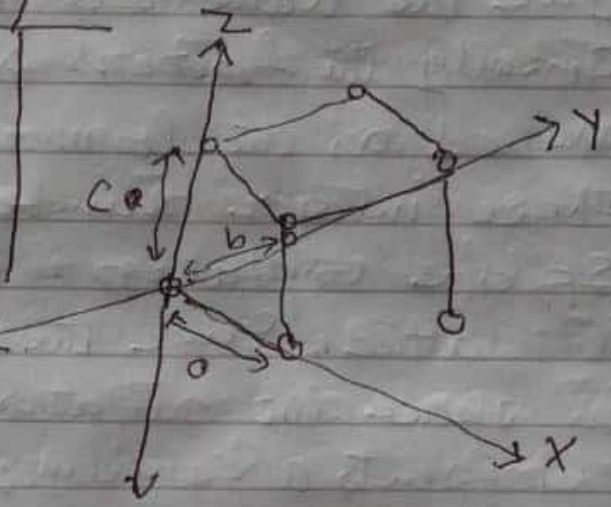
Crystal planes are defined as some imaginary planes inside a crystal in which large concentration of atoms are present. Crystal Planes and directions can be represented by a set of three small integers called Miller indices.

Miller Indices

Any set of three numbers or letters used to indicate the

Position of a face or internal plane of a crystal and determined on the basis of the reciprocal of the intercept of the face or plane on the crystallographic axis.

	a	b	c
intercept length	1	1	1
reciprocal	1/1	1/1	1/1
cleared fraction	1	1	1
miller indices	(111)		



Miller indices are a symbolic vector representation for the orientation of an atomic plane in a crystal lattice and are defined as the reciprocals of the fractional intercepts which the plane makes with the crystallographic axis. Miller indices are represented by a set of 3 integer numbers.

Example of (111) Plane

If we want to describe the orientation of a crystal face or a plane of atoms within a crystal lattice then there are series of steps that will lead to its notation using miller indices.

(1) In the above figure the plane intercepts each axis at exact one unit length.

(2) Steps two involves taking the reciprocal of the fractional intercept of each unit length for each axis. In the above figure the values are all 1/1.

(3) Finally the fractions are cleared i.e. make 1 as the common denominator.

4) These integer numbers are specific crystallographic plane within the lattice. Since the unit cell repeats in space the notation actually represents a family of planes all with the same orientation. So in the above figure the miller indices for the plane in (111).

X—X