

VIVEKANANDA COLLEGE
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NAAC ACCREDITED 'A' GRADE



Topic: CRYSTAL STRUCTURE-1

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Name of the Department: Chemistry

CRYSTAL STRUCTURE-1

Crystal Physics or *Crystallography* is a branch of physics that deals with the study of all possible types of crystals and the physical properties of crystalline solids by the determination of their actual structure by using X-rays, neutron beams and electron beams.

Solids can broadly be classified into two types based on the arrangement of units of matter. The units of matter may be atoms, molecules or ions. They are,
Crystalline solids and (ii) Non-crystalline (or) Amorphous solids

CRYSTALLINE SOLIDS

A crystalline material can either be a single (mono) crystal or a polycrystal. A single crystal consists of only one crystal, whereas the polycrystalline material consists of many crystals separated by well-defined boundaries. Examples Metallic crystals – Cu, Ag, Al, Mg etc, Non-metallic crystals – Carbon, Silicon, Germanium

NON CRYSTALLINE SOLIDS

In amorphous solids, particles are arranged in an orderly manner. They are randomly distributed. They do not have directional properties and so they are called as 'isotropic' substances.

They have wide range of melting point and do not possess a regular shape. Examples: Glass, Plastics, Rubber etc.

SINGLE CRYSTALS

Single crystals have a periodic atomic structure across its whole volume.

At long range length scales, each atom is related to every other equivalent atom in the structure by translational or rotational symmetry

POLYCRYSTALLINE SOLIDS

Polycrystalline materials are made up of an aggregate of **many small single crystals**. They have a high degree of order over many atomic or molecular dimensions.

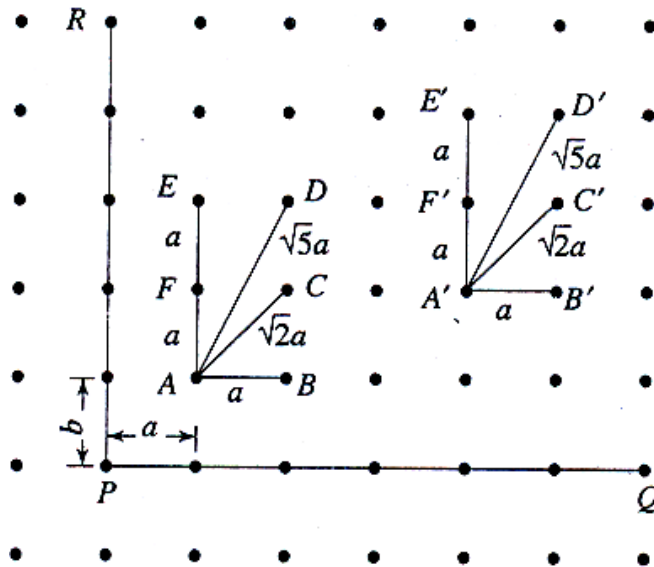
Grains are separated by **grain boundaries**. The atomic order can vary from one domain to the next. The grains are usually **100 nm - 100 microns in diameter**. Polycrystals with grains less than 10 nm in diameter are **nanocrystalline**

SPACE LATTICE

A lattice is a regular and periodic arrangement of points in three dimension. It is defined as an infinite array of points in three dimension in which every point has surroundings

identical to that of every other point in the array. The Space lattice is otherwise called the Crystal lattice

TWO DIMENSIONAL SPACE LATTICE



BASIS

A crystal structure is formed by associating every lattice point with an unit assembly of atoms or molecules identical in composition, arrangement and orientation.

This unit assembly is called the '*basis*'. When the basis is repeated with correct periodicity in all directions, it gives the actual crystal structure. The crystal structure is real, while the lattice is imaginary.

UNIT CELL

A unit cell is defined as a fundamental building block of a crystal structure, which can generate the complete crystal by repeating its own dimensions in various directions.

LATTICE PARAMETERS

The three interfacial angles and their corresponding intercepts are essential. These six parameters are said to be *lattice parameters*.

Similarly the angles between X and Y and Z axes are denoted by α , β and γ respectively as shown in the above figure. These angles α , β and γ are called as *interaxial angles or interfacial angles*.

CRYSTALS SYSTEMS

The seven systems are Cubic, Tetragonal, Orthorhombic, Trigonal(rhombohedral),

Hexagonal, Monoclinic and Triclinic.

Primitive lattice: It has lattice points only at the corners of the unit cell.

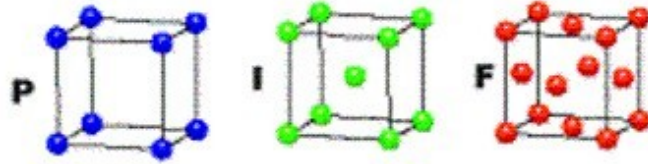
Body centred lattice: It has lattice points at the corners as well as at the body centre of the unit cell.

Face centred lattice :It has lattice points at the corners as well as at the face centres of the unit cell.

Base centred lattice:It has lattice points at the corners as well as at the top and bottom base centres of the unit cell.

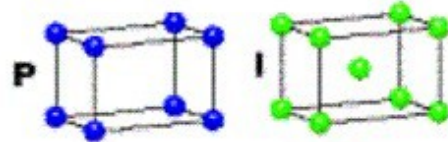
CUBIC

$a = b = c$
 $\alpha = \beta = \gamma = 90^\circ$



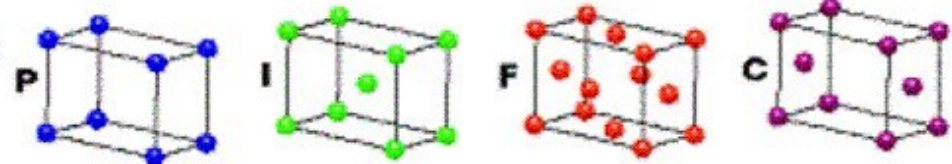
TETRAGONAL

$a = b \neq c$
 $\alpha = \beta = \gamma = 90^\circ$



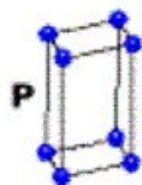
ORTHORHOMBIC

$a \neq b \neq c$
 $\alpha = \beta = \gamma = 90^\circ$



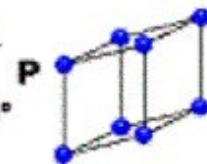
HEXAGONAL

$a = b \neq c$
 $\alpha = \beta = 90^\circ$
 $\gamma = 120^\circ$



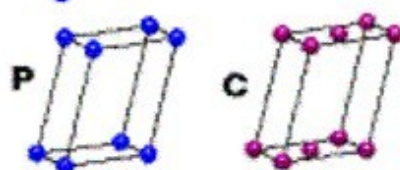
TRIGONAL

$a = b = c$
 $\alpha = \beta = \gamma \neq 90^\circ$



MONOCLINIC

$a \neq b \neq c$
 $\alpha = \gamma = 90^\circ$
 $\beta \neq 120^\circ$



TRICLINIC

$a \neq b \neq c$
 $\alpha \neq \beta \neq \gamma \neq 90^\circ$



4 Types of Unit Cell
P = Primitive
I = Body-Centred
F = Face-Centred
C = Side-Centred
+
7 Crystal Classes
→ 14 Bravais Lattices