Crystal Structure

Thermal , Electrical, Mechanical and **Optical** properties of **Solid Crystals** depend on their **structural properties.**

Solids can be classified as

1. **Crystalline**
2. **Non-Crystalline**

Thermal , Electrical, Mechanical and Optical properties of Solid Crystals depend on their structural properties. **The atomic arrangement in a crystal is called crystal structure**.

In **Crystal Solids** atoms are arranged in a **periodic manner** in all the **three direction**

In **Non Crystal Solids** atoms are arranged in **random manner**.

Polycrystalline

Solid may be In a **single crystal** or an **aggregate of many crystals** with in **well defined boundaries**

Non –Crystalline structures are known as **Amorphous substance**

If Non-crystalline structures that **have same physical properties in all the direction** are called **Isotropic** Substance. Isotropic do not have **regular shape** and have **various melting temperature at various point**.

The crystal has regular shape and if broken into piece will also have same regular shape. It has sharp melting point. Since it **has different periodic arrangement** in all three direction they are called **anisotropic substance.**

Crestline solids made up of **metallic crystals** or **non metallic crystals**.

Metallic crystals - Copper, silver, aluminum, tungsten and magnesium

Non metallic crystals – Carbon, crystallized polymers and plastics

Study of Crystals Solids done by – **X-ray diffraction method** and **Neutron diffraction method**

Crystal structure

The space lattices

The atomic arrangement in a crystal is called **crystal structure**. Periodic arrangement of points in space about which atoms are located is called **lattice point**.

Infinite array of points in three dimension in which every point has surroundings identical to that of every other point in the array is called **Space lattice.**

Two dimensional square array points shown

a , b are two vectors on the plane. Magnitude of a and b are equal and it is taken as unity. Angle between then is 90° .

a and b are fundamental translational vectors to generate square array. Take O as origin . If we choose a lattice point P at position r then translation vector

$\mathbf{\check{r} = la + mb}$ where l and m are integers. Here $l = 2$ and $m = 1$

Thus in three dimension space lattice generated by repeated translation of three

$$\mathbf{\check{r} = la + mb + nc}$$

non- coplanar vector a , b , and c

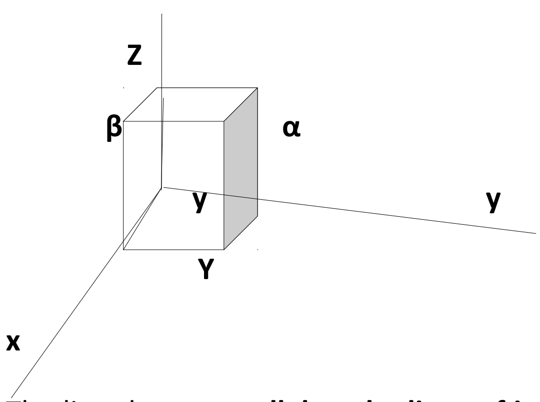
Unit Cell

A space lattice is defined by referring to a **unit cell** . Unit cell is the smallest unit which when repeated in space indefinitely generates the **space lattice**.

A group of atoms or molecules identical in composition called the basis or the **pattern** , Crystal structure generated

Lattice + basis ⟶ **Crystal structure.**

Lattice parameter of a unit cell



The line drawn **parallel to the lines of intersection** of any **three faces of a unit cell** that **does not lie in the same plane** are called **Crystallographic axis**.

The **three translational vectors** a , b and c lie **along the crystallographic axes**. Unit cell is defined with three crystallographic axes x,y,z. The intercepts **a,b and c defined** the **dimensions** of an **unit cell** are known as its **primitives**.

The **interfacial angles** are defined **between transnational vectors** a , b and c are α. **alpha**, β **beta**, and γ **Gama** .

Basic lattice parameters are **primitive** a, b and c and **the interfacial angles** α , β and γ are **basic lattice parameters**. They determine the **form** and actual size of an **unit cell**.

Primitive cell is one which is **formed by primitives** a , b and c and it will **have only one lattice point.**

It there are two or more lattice points, then it is not a primitive cell and **various crystal lattice contain two or more lattice points** and so most of unit cell are **not primitive cell**.

Bravais lattices

Three dimensional **space lattice** is **generated by repeated translation of three noncoplanar** a,b,and c . In three dimensional space only **fourteen distinguishable ways of point arrangements** is possible. These Fourteen types of point arrangement **in space lattice of seven crystal systems** is called **Bravais lattices**.

seven crystal systems

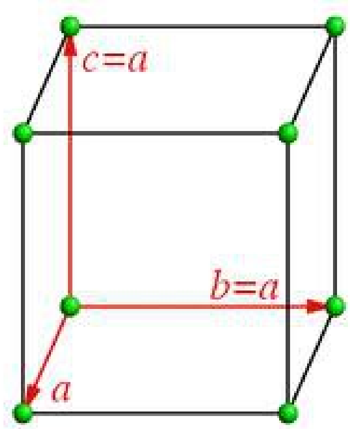
SL.NO	CRYSTAL SYSTEM	UNIT VETOR	ANGLES
1	Cubic	a = b = c	α = β = γ = 90°
2	Tetragonal	a = b ≠ c	α = β = γ = 90°
3	Orthohombic	a ≠ b ≠ c	α = β = γ = 90°
4	Monoclinic	a ≠ b ≠ c	α = β = 90° = ≠ γ
5	Triclinic	a ≠ b ≠ c	α ≠ β ≠ γ ≠ 90°
6	Trigonal	a = b = c	α = β = γ ≠ 90°
7	Hexagonal	a = b ≠ c	α = β = 90° γ = 120°

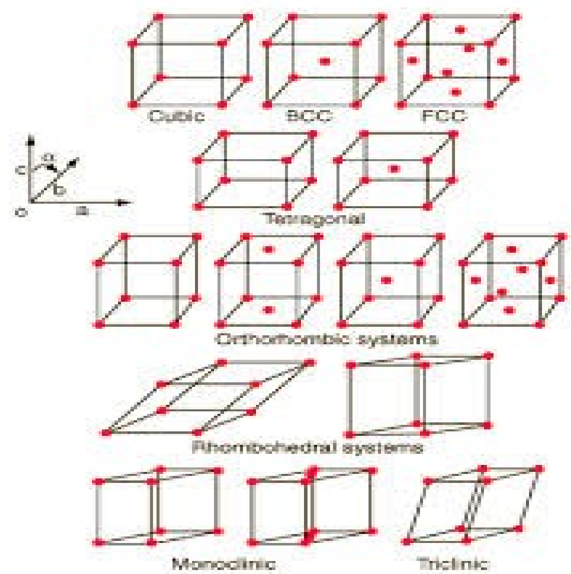
The definite ordered arrangement of the faces and edges of a crystal is known as **Crystal Symmetry**

Crystal possess different symmetries or symmetry elements. They are described by certain operations. A symmetry operation leaves the crystals and its environment invariant. This operation performed on object or pattern that brings absolute indistinguishable position. The seven crystal system by three symmetry element are.

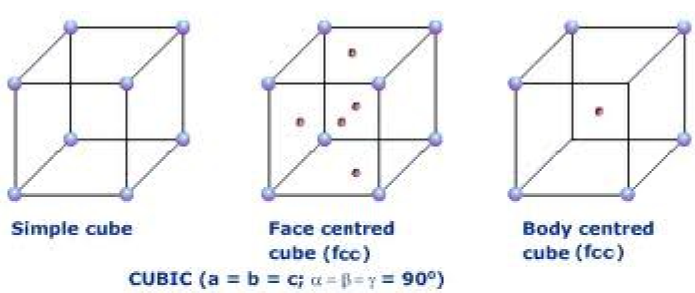
Sl. No.	Crystal Type	Bravais Lattices	Symbol

1	CUBIC	Simple	P
		Body Centered	I
		Face Centered	F
	TETRAGONAL	Simple	P
		Body Centered	I
	ORTHORHOMBIC	Simple	P
		Base-Centered	C
		Body Centered	I
		Face Centered	F
	MONOCLINIC	Simple	F
		Base –centered	C
	TRICLINIC	Simple	P
	TIRGONAL	Simple	P
	HEXAGONAL	Simple	P





The definite ordered arrangement of the faces and edges of a crystal is known as crystal symmetry.Crystal posses different symmetries described by certain operation.Symmetry operation THAT LEAVES THE CRYSTAL AND ITS ENVIORNMENT INVARIANT.



Centre of symmetry

Any line passing through it meets the surface of the crystal at equal distances in both directions and it will occupy the centre point of the unit cell called centre of symmetry.