# Solid State Chemistry

Out of these three different states of matter, *solids are characterised by definite shape and definite volume. These are highly incompressible and rigid.* The constituent particles (atoms, molecules, ions) in the solids are closely packed as they are held together by strong intermolecular forces. These occupy fixed positions and can only oscillate about their mean positions.

## 3.1 CLASSIFICATION OF SOLIDS

Classification of solids can be based on atomic arrangement, binding energy, physical and chemical properties, or the geometrical aspects of the crystalline structure.

Broadly the solids can be divided into following two classes:

### Crystalline

Crystalline solids are based upon a simple pattern of arrangement of atoms that is repeated many times throughout the molecule. The atoms or group of atoms in the solid are arranged in a regular order. The order is so regular that knowing the arrangement at one point, the arrangement at other site can be predicted. This is called *long range order*. These solids are referred to as the crystalline solids. The regular repeating pattern that the atoms arrange in is called the ***crystalline lattice***. Examples of crystalline solids are ice, methanol, and sodium chloride .

Crystalline substances have the following properties:

- They nave orderly arranged units and are practically incompressible. Crystalline solids also show a definite melting point and so they pass rather sharply from solid to liquid state.
- **Anisotropy:** These solids have different physical properties in different directions. This phenomenon is known as anisotropy.
- Crystalline solids have *definite* geometries.

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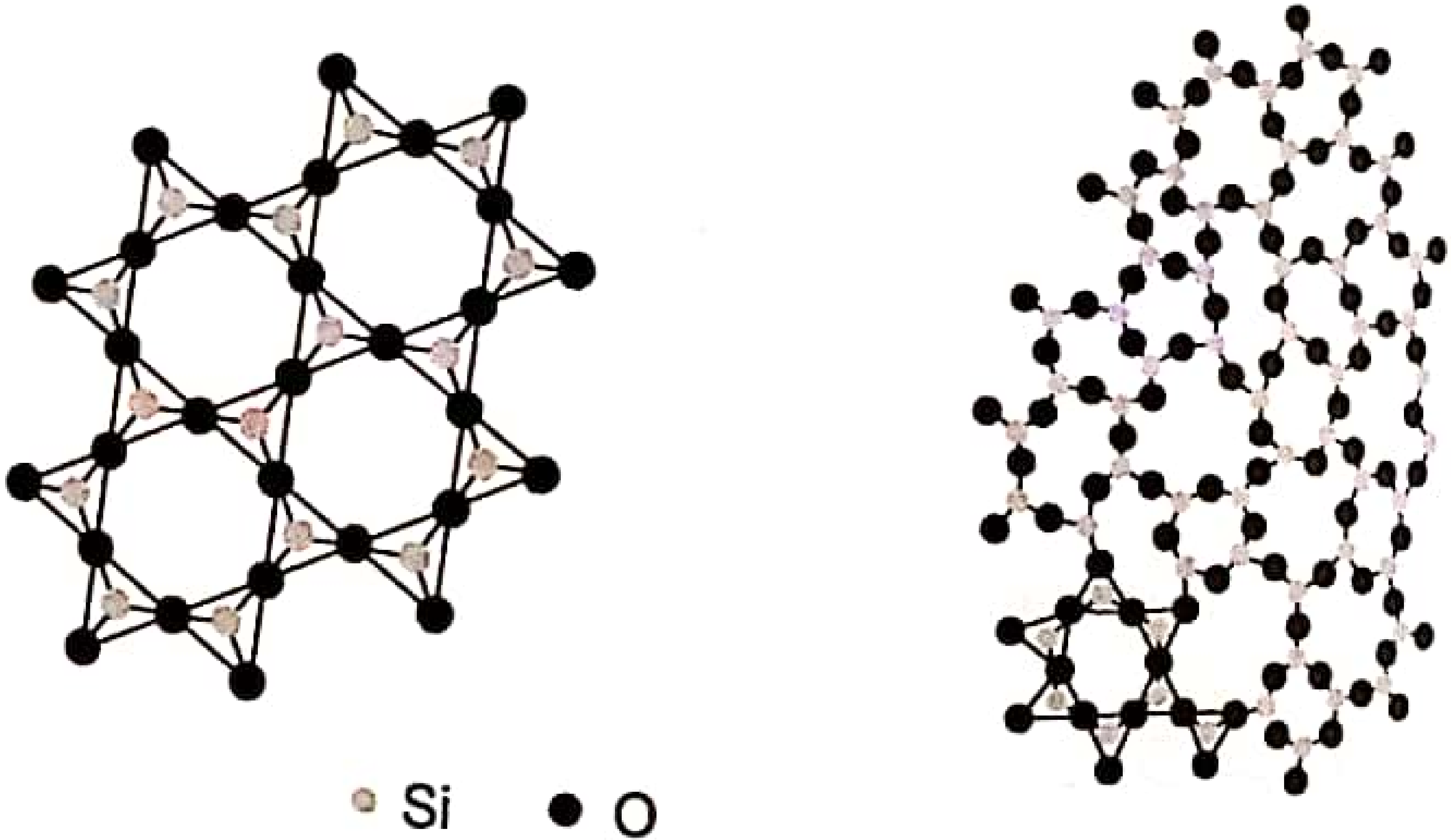
- Crystalline solids have *definite* geometries.
- The crystalline solids can be further divided into two categories: the single-crystalline and the polycrystalline solids. In a single-crystalline solid, the regular order extends over the entire crystal. In a polycrystalline solid, however, the regular order exists only over a small region of the crystal, with grain size ranging from a few hundred angstroms to a few centimeters.
- A polycrystalline solid contains many of these small single-crystalline regions surrounded by the grain boundaries.

## Amorphous

Amorphous solids have no regular arrangement of their atoms or molecules, in other words, in amorphous solids, the atoms are set in an irregular manner, without any short or long-range order in their atomic arrangement. This class of solids is commonly known as non crystalline or amorphous materials. Examples of amorphous solids are glass and plastic

Amorphous substances have the following properties:

- Amorphous solids do not show a sharp phase change from solid to liquid at a definite melting point, but rather soften gradually when they are heated.
- The physical properties of amorphous solids are identical in all directions along any axis so they are said to have **isotropic** properties,
- These do not have definite geometrical shapes.




(*a*) *Crystalline* $SiO_2$
(*Quartz*)

(*b*) *Amorphous* $SiO_2$
(*Glass*)

**Fig. 3.1**

## 3.2 SPACE LATTICE OR CRYSTAL LATTICE

The constituent particles of a crystalline solid are arranged in a definite fashion in the three dimensional space. A lattice is a regular array of (imaginary) points showing how molecules, atoms and ions are arranged in space.

One such arrangement by representing the particles with points is shown below (Fig. 3.2).

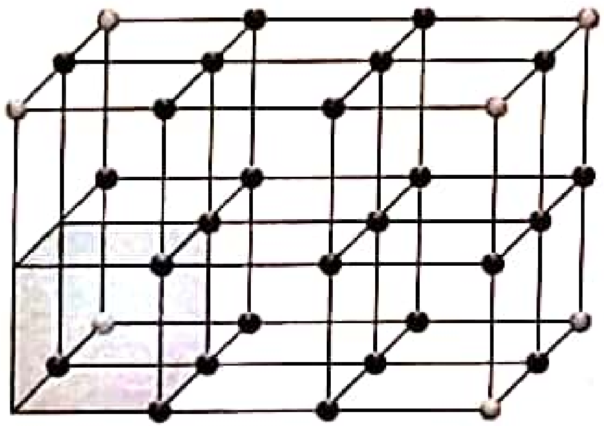


**Fig. 3.2(a)** Representation of space lattice and unit cell

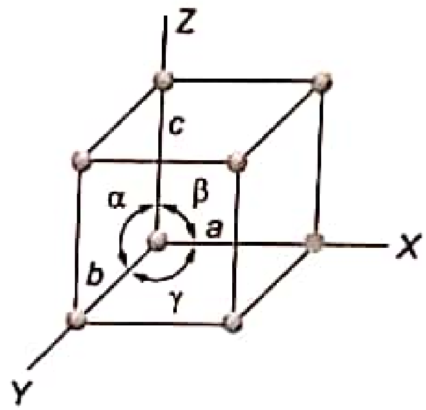



**Fig. 3.2(b)** Representation of dimensions of a unit cell

Such a regular arrangement of the constituent particles of a crystal in a three dimensional space is called crystal lattice or space lattice.

From the complete space lattice, it is possible to select a smallest three dimensional portion which repeats itself in different directions to generate the complete space lattice. This is called a Unit Cell.

### Unit Cell

Unit cell is the smallest three-dimensional portion of a complete space lattice, which when repeated over and again in different directions produces the complete space lattice Fig. 3.2 (b).