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CHEMISTRY

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CLASS 11 & 12th



Learning Inquiry
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Solid State

misostudy



01. The Solid State

The solids are characterized by incompressibility, rigidity and mechanical strength. The molecules, atoms or ions in solids are closely packed i.e they are held together by strong forces and can not move about at random. Thus solids have definite volume, shape, low vapour pressure and possess the unique property of being rigid. Such solids are known as true solids e.g. NaCl, KCl, Sugar, Ag, Cu etc. On the other hand the solid which loses shape on long standing, flows under its own weight and is easily distorted by even mild distortion forces are called pseudo solids e.g. glass, plastic etc.

Some solids such as NaCl, Sugar, Sulphur etc. have properties not only of rigidity and incompressibility but also of having typical geometrical forms. These solids are called as crystalline solids. In such solids there is definite arrangement of particles (atoms, ions or molecules) throughout the entire three dimensional network of a crystal. This is named as long-range order. This three dimensional arrangement is called **crystal lattice or space lattice**. Other solids such as glass, rubber, plastics etc. have rigidity and incompressibility to a certain extent but they do not have definite geometrical forms or do not have long range order are known as amorphous solids.

02. Differences Between Crystalline and Amorphous Solids

(a) Characteristic Geometry

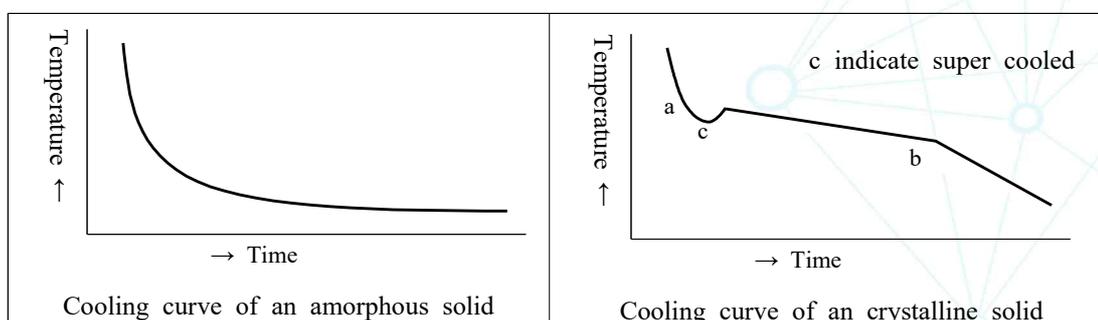
In the crystalline solids the particles (atoms, ions, or molecules) are definitely and orderly arranged thus these have characteristic geometry while amorphous solids do not have characteristic geometry.

Melting Points

A crystalline solid has a sharp melting point i.e. it changes into liquid state at a definite temperature. On the contrary an amorphous solid does not have a sharp melting point.

Cooling curve

Amorphous solids show smooth cooling curve while crystalline solids show two breaks in cooling curve. In the case of crystalline solids two break points 'a' and 'b' appear. These points indicate the beginning and the end of the process of crystallization. In this time interval temperature remains constant. This is due to the fact that during crystallization process energy is liberated which compensates for the loss of heat thus the temperature remains constant.



(b) Isotropy and Anisotropy

Amorphous solids differ from crystalline solids and resemble liquids in many respects. The properties of amorphous solids, such as electrical conductivity, thermal conductivity, mechanical strength, refractive index, coefficient of thermal expansion etc. are same in all directions. Such solids are known as isotropic. **Gases and liquids are also isotropic.**

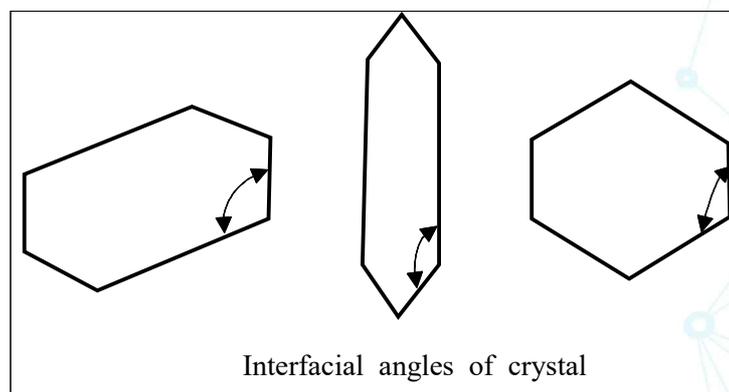
On the other hand crystalline solids show these physical properties different in different directions. Therefore crystalline solids are called anisotropic.

03. Crystalline State

“A crystal is a solid composed of atoms (ions or molecules) arranged in an orderly repetitive array”

“The smallest geometrical position of the crystal which can be used as repetitive unit to build up the whole crystal is called a unit cell.” The unit cell should have same symmetry elements as the crystal and there should be no gaps between unit cells.

The angle between the two perpendiculars to the two intersecting faces is termed as the interfacial angle which may be same as the angle between the unit cell edges. Goniometer is used to measure the interfacial angle. It is important to note that interfacial angle of a substance remains the same although its shape may be different due to conditions of formation.

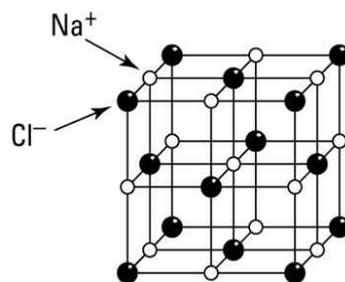
**04. Types of the Crystals**

Crystals are divided into four important types on the basis of chemical bonding of the constituent atoms.

(i) Ionic Crystals

These are formed by a combination of highly electro-positive ions (cations) and highly electronegative ions (anions). Thus strong electrostatic force of attraction acts within the ionic crystals. Therefore, a large amount of energy is required to separate ions from one another.

e.g. NaCl, KF, CsCl etc.



(ii) **Covalent Crystals**

These are formed by sharing of valence electrons between two atoms resulting in the formation of a covalent bond. The covalent bonds extend in two or three dimensions forming a giant interlocking structure called network. Diamond and graphite are the good examples of this type.

(iii) **Molecular Crystals**

In these crystals, molecules occupy the lattice points of the unit cells, except in solidified noble gases in which the units are atoms, where the binding is due to vander Waal's forces and dipole-dipole forces. Since vander Waal's forces are non-directional hence structure of the crystal is determined by geometric consideration only. Solid H_2 , N_2 , O_2 , CO_2 , I_2 , sugar etc. are well known examples of such crystal in which vander Waal's forces are acting.

(iv) **Metallic Crystals**

These are formed by a combination of atoms of electropositive elements. These atoms are bound by metallic bonds. It may be defined as:

The force that binds a metal ion to a number of electrons within its sphere of influences is known as metallic bond.

05. Isomorphism

The occurrence of a given substance in more than one solid crystalline forms have different physical properties is known as polymorphism. This property when occurs in elements is known as allotropy.

Sometimes we come across examples of chemically different solids which crystalline in the crystalline shape. Such substances are said to be Isomorphous (same shape). Their chemical constitutions are very similar and in some cases crystals of one substance may continue to grow when placed in a saturated solution of the other e.g. potash alum and chrome alum crystals have the same shape and can be grown in each other's solutions.