A REVIEW PAPER ON STATE OF SOLIDITY

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ABSTRACT

Because of their capacity to flow, liquids and gases are referred to as fluids. The molecules in each of these states are free to move around, resulting in fluidity. Solids, on the other hand, have fixed component particles that can only fluctuate about their mean locations. This explains why solids are stiff. These characteristics are determined by the composition of the component particles as well as the binding forces that exist between them. The relationship between structure and properties aids in the development of novel solid materials with desirable characteristics. Carbon nanotubes, for example, are a new kind of material that has the potential to be harder than steel, lighter than aluminum, and more conductive than copper. Such materials may play an increasingly important role in the advancement of science and society in the future. High temperature superconductors, magnetic materials, biodegradable polymers for packaging, biocompliant solids for surgical implants, and other materials are anticipated to play a significant role in the future.

KEYWORDS: *Conductivity, Conductors, Liquids, Metals, Solids.*

1. INTRODUCTION

There are three states of matter: solid, liquid, and gas. Which of these would be the most stable state of a particular material under a given combination of temperature and pressure circumstances relies on the net impact of two opposing variables. Intermolecular forces tend to keep molecules (or atoms or ions) closer together, whereas thermal energy tries to keep them away by causing them to move faster. The thermal energy is minimal at sufficiently low temperatures, and intermolecular interactions bring them so close together that they cling to one another and occupy permanent places. These may continue to fluctuate about their mean locations, and the material is still solid[1]–[3]. The solid state's distinguishing characteristics are as follows:

- Their mass, volume, and form are defined.
- The intermolecular distance is small.
- Strong intermolecular forces exist.
- Their component particles (atoms, molecules, or ions) are fixed in their locations and can only fluctuate about their mean positions.

- They are stiff and incompressible.

On the basis of the type of order inherent in the arrangement of their component particles, solids may be categorized as crystalline or amorphous. A crystalline solid is made up of a vast number of tiny crystals, each of which has its own distinct geometrical form. In three dimensions, the arrangement of component units (atoms, molecules, or ions) in a crystal is organized and repeating. If we see a pattern in one area of the crystal, we can correctly anticipate the location of particles in any other portion of the crystal, no matter how far away they are from the observation point. As a result, crystals have long range order, which implies that there is a regular pattern of particle arrangement that repeats itself regularly throughout the crystal. Crystalline solids include things like sodium chloride and quartz. When liquids solidify on cooling, glass, rubber, and many polymers do not form crystals. Amorphous solids are what they're called. The word amorphous is derived from the Greek word amorphos, which means "without shape." In such a solid, the arrangement of component particles (atoms, molecules, or ions) has only a short range order. A consistent and regularly repeating pattern is seen only across short distances in such an arrangement[4]–[6].

The melting point of crystalline solids is quite high. They melt quickly and become liquid at a certain temperature. Amorphous solids, on the other hand, soften, melt, and flow across a wide temperature range and may be moulded and blown into different forms. Amorphous solids have the same structural characteristics as liquids and may be thought of as very viscous liquids. At a certain temperature, they may crystallize. Because of crystallization, certain glass artifacts from ancient civilizations have taken on a milky look. Amorphous solids, like liquids, have a propensity to flow, although slowly. As a result, they are frequently referred to as pseudo solids or super cooled liquids.

In nature, amorphous substances are isotropic. Mechanical strength, refractive index, and electrical conductivity, for example, are all the same in all directions. It's because there's no long-range order in them, and the particle arrangement isn't consistent in all directions. As a result, the overall arrangement equalizes in all directions. As a result, the value of any physical asset would be the same in any direction[7]–[10].

Anisotropic means that certain physical characteristics of crystalline materials, such as electrical resistance or refractive index, have different values when measured in various orientations inside the same crystal. This is due to the fact that particles are arranged in various orientations.

In addition to crystalline and amorphous materials, certain substances look amorphous but contain microcrystalline structures. Polycrystalline solids are what they're termed. Metals are often found in polycrystalline form. Because individual crystals are orientated at random, a metallic sample may seem to be isotropic despite the fact that a single crystal is anisotropic.

Amorphous solids are a kind of material that may be used in a variety of applications. Glass, rubber, and plastics are used in a variety of ways in our everyday lives. One of the finest photovoltaic materials available for converting sunlight into energy is amorphous silicon.

2. DISCUSSION

Various classifications exist for crystalline solids. The technique used is determined on the goal at hand. The type of the intermolecular interactions or bonds that keep the component particles together will be used to categorize crystalline solids. Van der Waals forces, ionic bonds, covalent bonds, and metallic bonds are the four types of bonding.Crystalline solids are divided into four types based on this classification: molecular, ionic, metallic, and covalent solids.Molecules are the individual particles that make up molecular solids.

I. These are subdivided further into the following groups:

i. Non-polar Molecular Solids:

These are made up of either atoms (such as argon and helium) or molecules (such as H_2, Cl_2, and I_2) produced by non-polar covalent bonding. Weak dispersion forces or London forces hold the atoms or molecules together in these substances. These solids are non-conductors of electricity and are squishy.

- They have low melting points and, at room temperature and pressure, are typically liquid or gaseous.
- Polar Molecular Solids: Polar covalent bonds create the molecules of chemicals such as HCl, SO_2, and others. The molecules in such materials are kept together by dipole-dipole interactions that are considerably stronger. These solids are non-conductors of electricity and are squishy. Despite the fact that their melting temperatures are greater than those of non-polar molecular solids, they are mostly gases or liquids at ambient temperature and pressure. Examples of such substances are solid SO_2 and solid NH_3.
- Hydrogen Bonded Molecular Solids: These solids have polar covalent connections between H and F, O, or N atoms in their molecules. The molecules of such substances as H_2O are held together by strong hydrogen bonds (ice). They are electrically non-conductors. Under normal conditions of temperature and pressure, they are volatile liquids or soft solids.

ii. Ionic Solids:

Ionic solids are made up of ions, which are the component particles. The three-dimensional arrangements of cations and anions bonded by strong coulombic (electrostatic) forces create such solids. These substances are brittle and hard by nature. Their melting and boiling points are both quite high. In the solid form, the ions are electrical insulators since they are not free to move about. The ions become free to move about in the molten state or when dissolved in water, and they conduct electricity.

iii. Metallic Solids:

Metals are a well-ordered collection of positive ions surrounded by a sea of free electrons that holds them together. These mobile electrons are equally distributed throughout the crystal. In this sea of mobile electrons, each metal atom contributes one or more electrons. Metals' great electrical and thermal conductivity is due to these free and mobile electrons. These electrons move through the network of positive ions when an electric field is applied. Similarly, when heat is applied to one part of a metal, free electrons distribute the thermal energy evenly across the metal. Metals' sheen and color, in certain instances, are also significant characteristics. This is also owing to the fact that they contain free electrons. Metals are malleable and ductile in nature.

iv. Covalent Solids:

The development of covalent bonds between neighboring atoms throughout the crystal results in a broad range of non-metal crystalline solids. Giant molecules is another name for them. Because covalent bonds are strong and directed in nature, atoms are firmly kept in their places. Solids of this kind are very hard and brittle. Their melting points are very high, and they may even disintegrate before melting. They don't conduct electricity since they're insulators.

3. CONCLUSION

Solid, liquid, and gas are the three states of matter. Because of their capacity to flow, liquids and gases are referred to as fluids. Solids, on the other hand, cannot flow. Because particles in solids are not free to move in available space, this is the case. In solids, there is a significant intermolecular interaction between the particles. The location of the component particles in a solid is fixed, and they can only fluctuate around their mean position. This provides the solid rigidity and, as a result, a set form. The mass, volume, form, and stiffness of a solid state of matter are all fixed. The arrangement of component particles is used to classify solids. It exhibits a broad variety of characteristics as a result of their particular configurations, and therefore has a wide range of applications, such as superconductors, magnetic materials, polymers, and so on.

Two opposing forces control the specific state of matter in nature at a given temperature and pressure. The intermolecular force of attraction and thermal energy are the two factors at work. When the intermolecular force of attraction is greater than the thermal energy, particles stay in close proximity to one another, resulting in very little particle movement. The solid state is the desired state of matter in this situation.

Let's go through the general properties of solids once more:

- Mass, volume, and form are constant.
- A strong intermolecular attraction force.
- Fixed location of component particles.
- Least intermolecular space.
- Stiff and incompressible

Solids are categorized according to how their component particles are arranged. Crystalline solids have the same arrangement of component particles throughout the solid (long range order). Amorphous solids are those in which the arrangement of particles does not follow any regular pattern across the solid (short range order).

- It is made up of a huge number of tiny crystals with a clear geometrical form.
- Throughout the solid, the arrangement of component particles is consistent (long range order). That is, a set pattern of component particles repeats itself across the full spectrum of solids on a regular basis.
- They have very high melting points.
- They are anisotropic in nature, with an uneven distribution of component particles throughout the solid. Only a tiny portion of the component particle pattern is visible. That is, it demonstrates short-term order.

- The melting point is not very high. Amorphous solids melt at different temperatures.
- They have a propensity to flow more slowly.
- They are naturally isotropic.

“The term isotropic refers to the lack of differences in characteristics when seen from any direction.”Van der Waals forces hold the molecules in a solid together. Hydrogen bonding, dipole-dipole attraction, and London dispersion forces are all examples of van der Waals forces. London dispersion forces affect all molecules. Furthermore, dipole-dipole interactions may occur in polar compounds. The London dispersion force and dipole-dipole interactions are the interactions that keep the molecule together in a polar molecular solid.The uniform and repeated arrangement of component particles in space is a distinguishing property of crystalline solids. The crystal lattice is the regular three-dimensional arrangement of component particles in a crystal.

Vacancy defect: This occurs when some of the lattice points during crystal formation are left vacant.

- It may be found in non-ionic compounds.
- It lowers the solid's density.
- It may be made by heating water.

When certain component particles occupy interstitial locations other than the lattice points, an interstitial defect occurs. It may be found in non-ionic compounds. It raises the solid's density.

Impurity defect:

An impurity defect occurs when a tiny quantity of impurity is added to an ionic solid. In an ionic solid, it really produces a cationic vacancy. When SrCl2 is introduced to a molten salt of NaCl, for example, it takes the place of Na+ in the crystal. However, the charge on Sr is 2+. After eliminating two Na+ ions, Sr2+ occupies just one position. As a result, there is a 1 point vacancy.

- It may be found in non-ionic compounds.
- It raises the solid's density.

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