

Disorders in Non-Crystalline Semi Conductor

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ABSTRACT

The amorphous is non-crystalline state of materials. Strictly speaking amorphous implies the random arrangement of atoms, the absence of any periodic symmetry, or the absence of any crystalline structure. Research tries to find out Disorders in Non-Crystalline Semi-Conductor. Researcher takes primary data for this study. The finding of this was Topological disorder is that type of randomness in which there is no translational periodicity. Certain amorphous materials have considerable short-range order while others have little; however, both have no long range-order.

1. General Introduction

The amorphous materials are not new; the iron rich siliceous glassy materials recovered from the moon by the Apollo mission are some billions of years old; Amorphous solids have been used as glass with various modifications in our life since more than 2000 B.C. The earliest glass objects were beads, which have been found in Egypt and Mesopotamia. However, the scientific study on amorphous glasses started in 20th century, particularly, about sixty years ago, Zachariasen (1932) proposed that the structure of vitreous SiO₂ can be described by a continuous random network (CRN) in which the SiO₄ tetrahedra joined at the corners are connected with each other to form a glassy solid.

The interest in amorphous materials is twofold. Firstly, there is the material science aspect; a wide diversity of materials can be rendered amorphous – indeed almost all materials can. The second interest in amorphous materials is in the fundamental physics of such system. Furthermore, amorphous materials exhibit many properties which are unique to them and are not shared by crystalline solids at all. Some of their properties are different even from one sample to another of the same material.

The amorphous is non-crystalline state of materials. Strictly speaking amorphous implies the random arrangement of atoms, the absence of any periodic symmetry, or the absence of any crystalline structure. The atomic order in amorphous materials is restricted to the nearest neighbors, therefore exhibits only short-range order. In contrast to this, the exact position of the atoms which are farther apart from a given central atom cannot be predicted. This is particularly the case when various kinds of stacking order, i.e., if polymorphic modifications are possible. As a consequence, one observes atomic disorder at long range. The term amorphous solids should therefore be used cum granosalis. We empirically define materials to be amorphous when their diffraction

patterns consist of diffused rings, rather than sharply defined Bragg rings, as are characteristic for polycrystalline solids.

In Crystalline solids, atoms are arranged in definite geometric patterns that are repeated over and again in three-dimensional space and thus forming the crystal structure. However, amorphous materials are basically the amorphous form of their crystalline counterpart and are characterized by the random arrangement of atoms as well as absence of long-range order as shown in Fig. 1.1

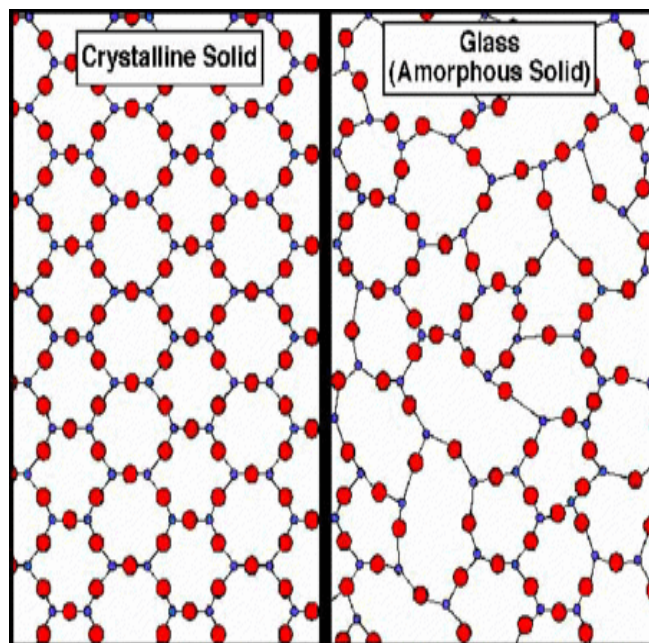


Fig. 1.1 Crystalline and Amorphous solids

In amorphous materials there can be several types of randomness, of which topological, spin, substitution and vibrational disorder are the most important. These types of disorder are illustrated in Fig. 1.2

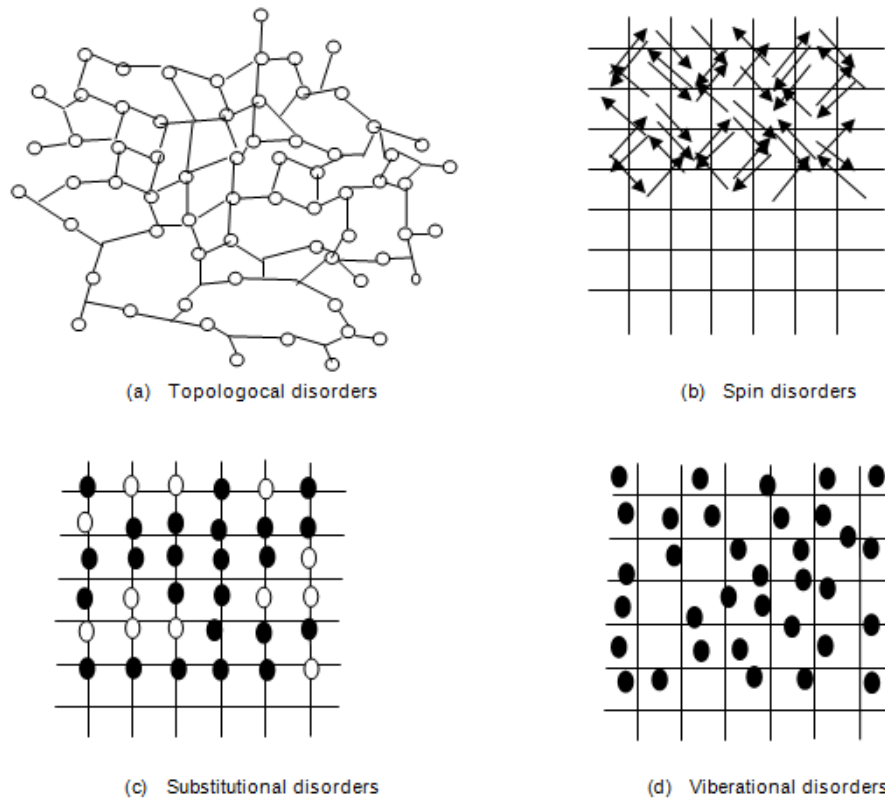


Fig. 1.2 Types of disorders

Topological disorder is that type of randomness in which there is no translational periodicity. Certain amorphous materials have considerable short-range order while others have little; however, both have no long range-order.

Another variety of randomness is spin or magnetic disorder, in which crystalline lattice is preserved, but spins or magnetic moment of each atomic site is oriented randomly. Those materials which are topological disordered and possess a randomly oriented spin are called as spin glasses. A further kind of randomness is substitution disorder in which, crystalline structure is preserved but one type of atom is randomly substituted for the other in the lattice. The material is in fact an alloy. The final category of randomness is vibrational disorder of a crystalline lattice in which the atoms vibrate about their equilibrium positions.

In the present era of science and technology, amorphous and non-crystalline are synonymous. These materials can be prepared by different techniques; however, the most widely used is melt quenching. Materials prepared in this way are often referred to as "Glasses". The terms glassy and vitreous are normally restricted to those amorphous solids which are obtained by super cooling a liquid. An amorphous solid which shows a glass transition phenomenon is termed as glass. The glass transition denotes a transition from a liquid to glassy state. When a liquid is cooled, one of the two events may occur. Either crystallization may take place at the melting point T_m or else the liquid will become "Super cooled" for temperature below T_m becoming more viscous with decreasing temperature, and may ultimately form a glass. These changes can be observed by monitoring the volume as a function of temperature (Fig.1.3). The crystallization process is manifested by an abrupt change in volume at T_m whereas glass formation is characterized by a gradual break in slope. The region over which the change of slope occurs is termed as glass transition temperature ' T_g '.

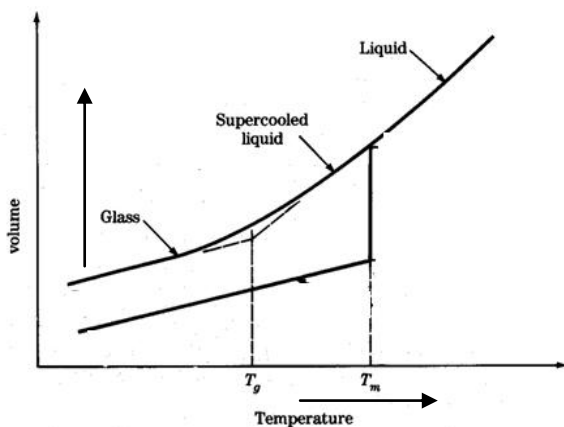


Fig. 1.3 Volume-temperature relationship for glass forming system

Amorphous materials can be regarded as amorphous semiconductors, if the band gap energy lies in the range 0.1 – 4.0 eV[1]. Mott and Cohen et al [2-4] generalized the band Model of amorphous solids (Fig.1.4), and the following postulates have been proposed :

1. The overlapping of valence and conduction bands give rise to band tails of localized states, which depend upon the extent of disorder present in the material.
2. The overlapping of tails of valence and conduction band implies that in some region of the material, an

electron in a valence band may have a higher energy, than the electron in non-bonding state in the conduction band in some other part of the material. In these materials the Fermi level lies near the center of the gap where the local density of the states is minimum.

3. The extended and localized states are separated by sharp mobility edges giving rise to well defined activation energies, despite the fact that these materials lack sharp band edges.
4. The conduction states are locally neutral when unoccupied and valence band states are locally neutral when occupied by an electron. This gives rise to charged states, above and below the Fermi level, which act as efficient trapping centers for electrons and holes. These charged states make the conductivity of amorphous semiconductors less sensitive to doping than their crystalline counterparts.

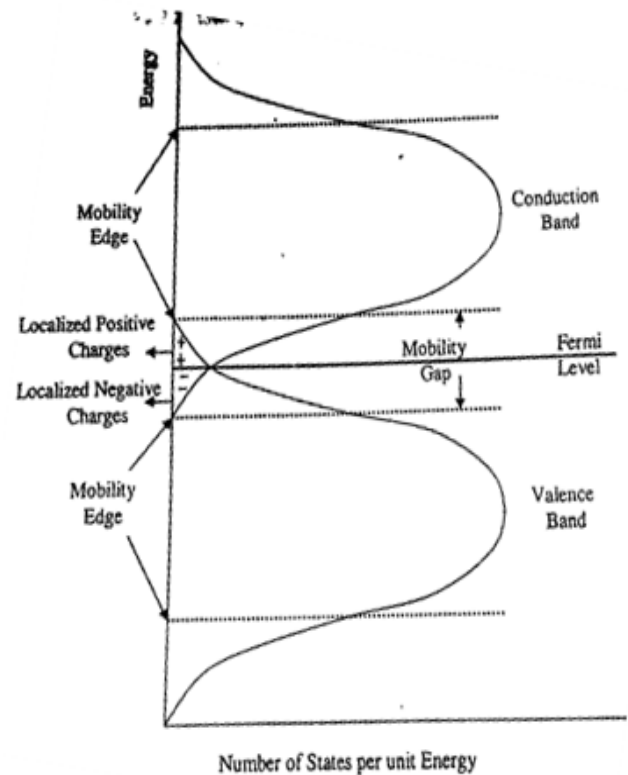


Fig. 1.4 Energy band diagram

References

1. C. Stchle, C. Vira, D. Vira, D. Hogan. S. Feller. M. Affatigato, Phys. Chem. Glasses 392 (1998) 83.
2. C. Dayanand, C. Bhikahamaiah, M. Salagram, Mater. Lett. 23 (1995) 309
3. C.H. Cheng. J.D. Mackenzie, J Non-Cryst. Solids 42 (1980) 151.
4. D.Mmaniu, T. Iliescu, I. Ardelean, L. Bratu, C. Dem, Studia Universitatis Babes- Bolyai, Physica, Special issue, 2001.
5. D.W. Hall, M. A. Newhouse, N. F. Borell, W.H. Dumbaugh, D.L. Weidman, Appl. Phys, Lett. 54 (1989) 1293.
6. Davis E.A. and Mott. N.F. (1970) Phil. Mag., 22 903.
7. Doweiden Physica B 293 (2001) 268.
8. Doyale B.S. and Jonscher A.K. (1986) J. Mater. Science, 21, 284.
9. Drvechenskil A.V. Karanovich A.A., Rybin A.V. and Grotzschel R. (2012) Nucl. Instrum Method B, 80-81, 620.
10. Duwez, R.I. Willens, Trans. Met. Soc. AIME 227 (1963) 362.
11. E. Culea, A. Nicula, Solid State Commun. 58 (1986) 545.
12. E. Mansour. G.M. El – Damrawi, Y.M. Moustafa, S. Abel El Maksoud, H.
13. E.A. Davis, N. F. Mott, Phil, Magn. 22 (1970) 903.
14. E.A. Davis, N.F. Mott, Phil. Magan. 22 (1970) 903.
15. E.A. Davis, N.F. Mott, Phil. Magn. 22(1970) 903.
16. E.A. Davis, N.F. Mott, Phil. Magn, 22(1970) 903.
17. E.E. Horopainitis, G. Perentzis, A. Beck, L. Gucci, G. Peto, L. Padadimitriou, J. Non-Cryst. Solids 354 (2008) 374.
18. E.I. Kamitsos, A.P. Patsiss, G.D. Chryssikos, J Non-Cryst. Solids 152 (1993) 246.
19. E.I. Kamitsos, A.P. Patsis, G.D. Chryssikos, J. Non-Cryst. Solids 152 (1993) 246
20. E.I. Kamitsos, M.A. Karakassides, G.D. Chryssikos, J Phys. Chem. Glasses 91 (1978) 1073.