

CHAPTER I

INTRODUCTION

Amorphous and non-crystalline solids are synonymous. Thus we can structurally classify materials either crystalline or non-crystalline (amorphous). A crystal is defined as a substance consisting of atoms arranged in a pattern that repeats periodically in three dimensions⁽¹⁾. Any material which does not meet this criterion of periodically repeated pattern of atoms is non - crystalline. The amorphous material can be classified into:-

a-Complete disordered materials.

B-Oxide glasses.

c-Metallic glasses.

D-Chalcogenide glasses.

Chalcogenide glasses are these materials which contain one or more of the elements Se, Te, or S. The non-crystalline materials can be prepared generally either by condensation from vapour on cold substrate, cathod sputtering, rapid quenching or by slow cooling materials from the melt.

The so called amorphous or glassy state is obtained by rapid quenching from the melt. The short range order which characterizes a particular glass or liquid may be described in terms of an atomic centered coordination system and is frequently represented in terms of radial distribution function.

The non-crystalline semiconductors may be grouped into three major categories as follow :-

1- Covalent Non-crystalline solids

A. Tetrahedral Amorphous films

Si, Ge, InSb, GaAs, Gasb.....

B. Tetrahedral Glasses, $A^{II}B^{IV}C_2^V$

$CdGe_xAs_2$, $CdSi_xP_2$, $ZnSi_xP_2$, $CdSn_xAs_2$

C. Lone pair semiconductors

(i) elements and compounds

Se, S, Te, As_2Se_3 , As_2S_3

(ii) Cross-linked networks

Ge-sb-se

Si-Ge-As-Te

Ge-As-Se

As_2Se_3 As_2Te

As-Se-Te

$Tl_2Se-As_2Te_3$

D. Others

B, As, $(Cu_{1-x}Au_x)Te_2$ -----

2. Semiconducting oxide Glasses

$V_2O_5-P_2O_5$ $MnO-Al_2O_3-SiO_2$

$V_2O_5-P_2O_5-BaO$ $CoO-Al_2O_3-SiO_2$

$V_2O_5-GeO_2-BaO$ $FeO-Al_2O_3-SiO_2$

$V_2O_5-PbO-Fe_2O_3$ $TiO_2-B_2O_3-BaO$

3. Dielectric films

SiO_x , Al_2O_3 , ZrO_2 , Ta_2O_3 , Si_3N_4 , BN,

The first contains the covalent bonded non-crystalline semiconductors which contain :-

a-The tetrahedral semiconductor which only be prepared by thin film deposition.

b-Tetrahedral glasses.

c-Lone pair semiconductor.

The second main group contains the oxide glasses which have strong ionic bonds and hence have been reviewed by Mackenzie⁽²⁾ and Owen⁽³⁾.

The third group are the dielectric films , mentioned above, which sensitive to disorder as their electronic conduction relies on deviation from stoichiometry and the presence of defects center which acts as donors and acceptors. These materials have been reviewed by Scher⁽⁴⁾ and Hill⁽⁵⁾.

Upon cooling a liquid below its melting point it will be either crystalline or glass(Tauc)⁽⁶⁾. During crystallization the viscosity ,entropy and the internal energy change discontinuously and the transformation is first order.

In glass formation, however, these properties change continuously although the change may be rapid in the range near the glass transition temperature(T_g).

Fig(1.1) shows the temperature dependence of the volume of a material which can either form glass or crystallize. Cohen and Turnbull^(7,8) have treated in details the condition whereby

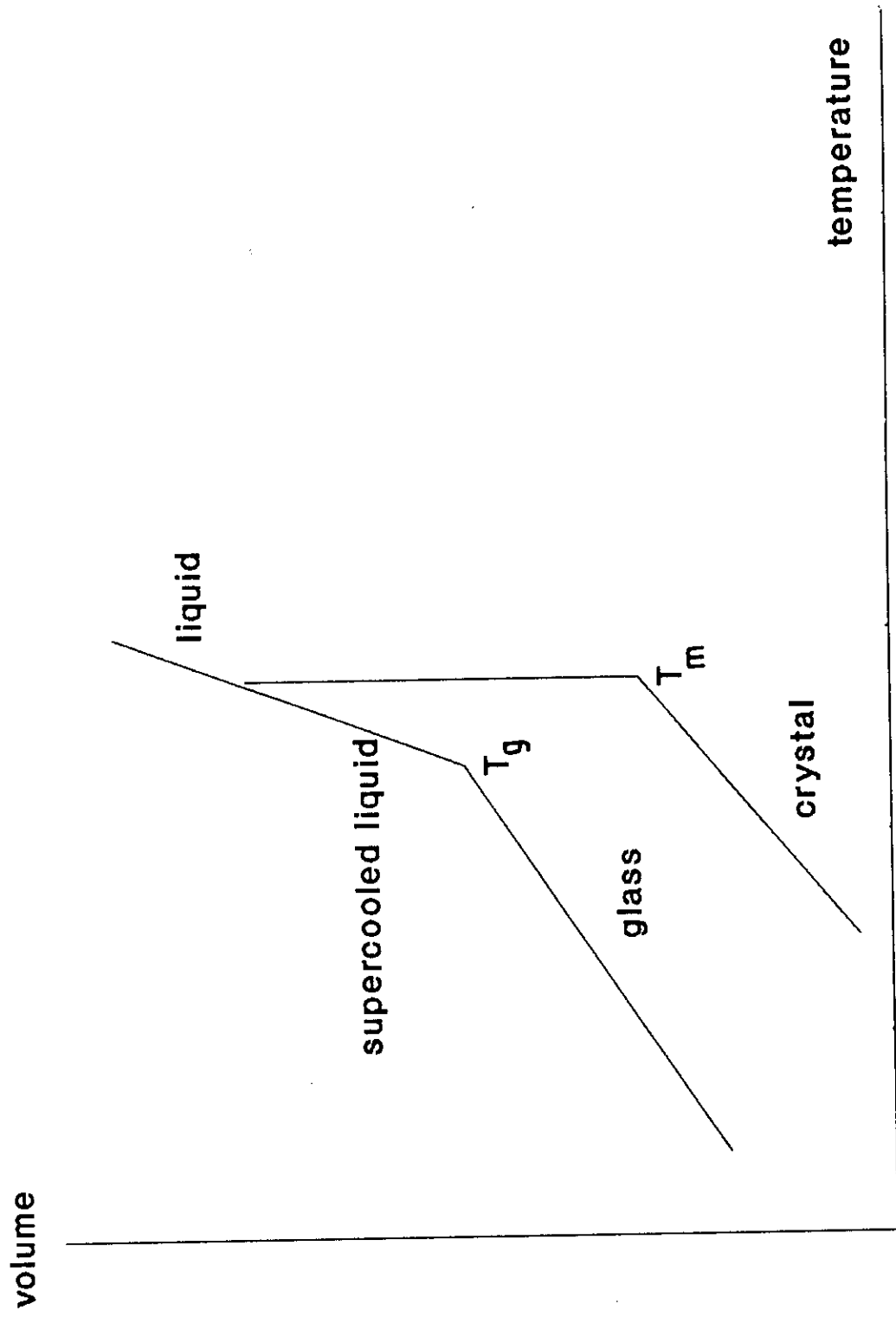


Fig.1.1 .Schematic of a volume-temperature dependence for a material at various states.

crystallization can be bypassed. Glass formation became more probable, the greater the cooling rate the smaller the sample volume and the slower the crystallization rate. The crystallization of an amorphous material proceeds by the processes of nucleation and growth, and the crystallization rate is suppressed by producing either (or both) of these processes.

It has been recognized that good glass formation is associated with high viscosity at the melting point⁽⁹⁾. The transformation from phase to phase is accompanied by a change in most of the physical properties of the material under test. Accordingly, electrical, magnetic, thermal and dielectric properties were used to investigate the crystallization process of amorphous material⁽¹⁰⁾.

The aim of the present work is to study :

1-The phase transformation of the amorphous alloy $\text{Se}_{90}\text{Ge}_{10-x}\text{In}_x$ ($X=2,4$ and 6) by means of the change in:

a-dielectric constant(ϵ).

b-dielectric loss tangent ($\tan \delta$).

2-The composition, temperature, and the frequency dependence of the kinetic parameters electric and dielectric properties of the sample under test.