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RESEARCH ARTICLE

SYNTHESIS AND STUDIES OF PHYSICAL PROPERTIES HEAVY METAL OXIDE DOPED TELLURITE BASE GLASSES

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Abstract

Heavy metal oxide (HMO) doped tellurite glass systems with batch matrix x-HMO -(0.9-x)TeO_2-0.1%Na2O- were prepared by established melt & quench teqnique. Physical properties as density, molar volume, oxygen packing density, poleron radius, interatomic distance were calculated effect of different HMO on density were observed. forbidden energy gap for direct and indirect allowed energies were estimated and further Refractive indices were calculated measured.

Introduction:-

Optical materials in the most general sense can be defined as materials whose function is to alter or control electromagnetic radiation in the ultraviolet (UV), visible or infrared (IR) spectral regions. Such materials are fabricated into optical elements such as lenses, mirrors, windows, prisms, polarizers, detectors and modulators, etc., and they can be used to refract, reflect, transmit, disperse, polarize, detect and transform light. At the microscopic level, atoms and their electronic configurations in the material interact with the electromagnetic radiation (photons) to determine its macroscopic optical properties such as transmission and refraction. These optical properties are functions of the wavelength of the incident light, the temperature of the material, the applied pressure on the material, and in certain instances the external electric and magnetic fields applied to the material. There is a wide range of substances that are useful as optical materials. Most optical elements are fabricated from glass, crystalline materials, polymers or plastic materials. In the choice of a material, the most important properties are often the degree of transparency and the refractive index, along with each property's spectral dependency. In addition to this, the uniformity of the material, strength and hardness, temperature limits, hygroscopic nature and chemical resistivity, may also need to be considered. In the next section the origin of different types of optical material and their applications are discussed.

Heavy metal oxides (HMO) modified Tellurite(TeO_2) base glasses exhibit features that are interesting for a variety of optical technologies. Many studies of the physical characteristics of different compositions of tellurite glasses have been carried out [2–6]. TeO2 glasses have garnered some scientific and technical interest in recent years due to their diversity in terms of applicability [7-9].

Experimental work

[TeO_2](0.8)- [HMO](0.1) -[Na_2O](0.1) (where HMO are Bi_2O_3 and WO_3) samples system was made by combining definite weights of high quality oxides. The 15g of inorganic chemicals were amalgamated by crushing them repeatedly in a mortar for 30 minutes. The mixtures were warmed in an electric furnace for one hour at 940–970 °C in an alumina crucible. Glass samples had a thickness of around 3 mm and a diameter of about 1 cm. The prepared

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samples named as TBN, TWN. The Archimedes principle was used to estimate the density of the glass samples at room temperature.

XRD

X-Ray diffractogram of $[TeO_2](0.8)$- [HMO](0.1) -$[Na_2O](0.1)$ samples shown in figure 1, carried by Rigaku, Japan, Smart Lab 9kW at normal temperature in 10^{O} to 80^{O} 2θ angle range . In X-ray diffraction pattern of the glass system exhibited a dispersed hump near 2θ = 29°. This demonstrates the nature of amorphous glass and the lack of long-range atomic structures.

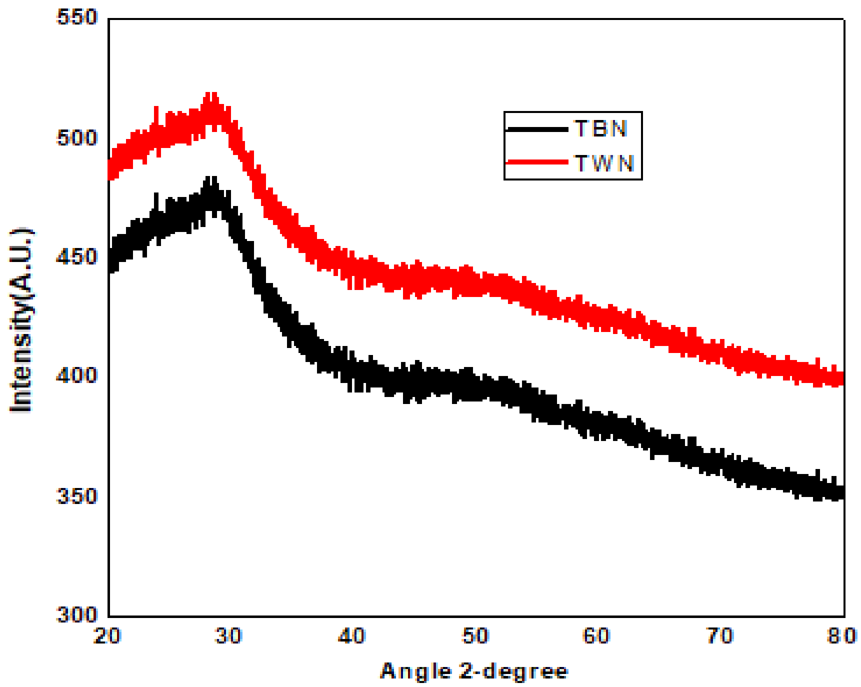

Fig. 1. XRD plot of TBN and TWN glasses

Physical Properties

The Archimedes principle was used to determine the densities (ρ) of produced ternary titanium tellurite glasses at room temperature. As a buoyant liquid, distilled water is employed. The glass samples TBN &TWN were weighed ω_a in the air and ω_l while dipped in a floating liquid (distilled water with a density of ρ_w = 1 g cm^{-3}at ambient temperature). The following relationship was used to determine the densities of prepared glasses:

$\rho = (\frac{\omega a}{\omega a - \omega l})$ .... (1)

The molar volume (Vm) of prepared glasses was estimated using the following relation, with the help of computed densities and molecular weight

$Vm = M/\,\rho$ .... (2)

The oxygen packing density (OPD) of oxide glasses is a measure of the spatial layout of the oxide network. The oxygen packing density (OPD) is determined by the glass sample's molar volume (Vm) and the amount of oxygen atoms (n) accessible. The equation for determination of OPD is given as [10]

$OPD = \frac{1000 \times n}{Vm}$ .... (3)

By using the following relation the content of titanium ions in glass samples' N (ion/cm^3) was estimated. [11]

$N = \frac{\text{mole \% of } \mathbf{Ti} \text{ ions } \times \rho \times NA}{Vm}$ ... (4)

Where NA is Avogadro'snumber. Further the polaron radius (Rp), internuclear distance (Ri) and molar refraction (Rm),are calculated by using the ion concentration [12]

$Rp = 1/2\ (6\pi N)^{1/3}$.......... (5)

$Ri = (1/N)^{1/3}$..................(6)

$Rm = \{(n^2-1)/n^2+1)\} \times Vm$ ……..(7)

Table 1 shows the computed values of physical quantities.

Table 1:- The physical attributes of $[TeO_2](0.8)$- $[HMO](0.1)$ -$[Na_2O](0.1)$ glass system.

Name of the Sample	**TBN**	**TWN**
ρ (g/cm^3)	5.012	5.017
V_m (cm^3/ mol)	29.345	27.860
OPD (mol/l)	68.56	68.42
N($\times 10^{23}$) (ions cm^{-3})	2.162	2.140
R_p (nm)	0.216	0.213
R_i (nm)	0.781	0.773
Rm(cm^3)	14.067	14.004

Conclusion:-

The ternary tellurite glass systems of composition $[TeO_2](0.8)$- $[HMO](0.1)$ -$[Na_2O](0.1)$ (where HMO are Bi_2O_3 and WO_3) were prepared successfully using conventional melt quenching method. It is found that the prepared samples are glass (XRD) and of promising physical properties (table 1).

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