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Synthesis and Characterization Studies of Zinc Borotellurite Glass System

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Abstract

Glass samples of the series $50B_2O_3$-(50-x) Zno-xTeO_2(x=0, 5, 10, 15, 20&25 mol%) were prepared by melt quenching and characterized by Density measurement and molar volume. Density of glasses decreased with increase in TeO_2 concentration due to the replacement of heavier lighter B_2O_3 with TeO_2. These glasses are well known for their high density, high refractive index, high dielectric constants,

Introduction

Tellurite glasses are recent interest in techonology, telecommunication. In recent years the study on tellurium oxide based glasses has been the subject of high interest due to their potential applications as IR domes, optical fibers, modulators, memories and laser windows.

The B_2O_3-Zno-TeO_2 system shows good and stable glass forming stability with a broad region. Borotellurite glasses are of the curruent technological interest due to their wide applications.

Pure boron trioxide (B_2O_3) is a very good glass former, covalently bonded, with interesting physicochemical properties [1].Pure B_2O_3 forms a glass by itself and forms binary borates with many oxides. Tellurium dioxide belongs to the intermediate class of glass forming oxides since it does not form glass by itself unless usual preparation conditions were changed or by adding some oxides such as Li2O, BaO, CdO, ZnO, Bi_2O_3, Nb_2O_5 or WO_3 [2].

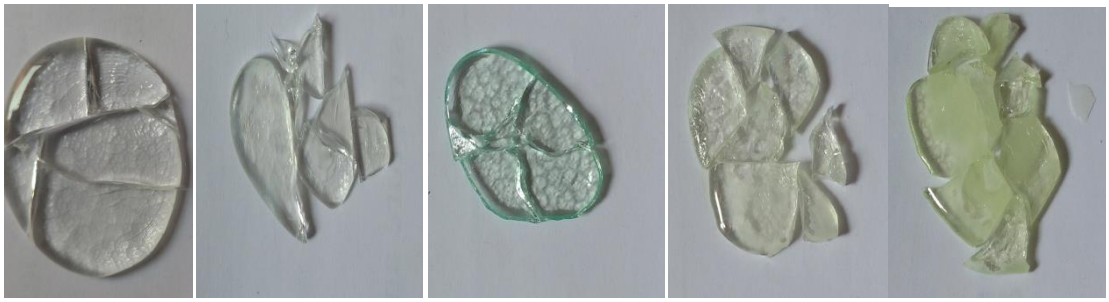
The presence of both B_2O_3 and TeO_2 in borotellurite glasses leads to complex speciation in the glass structure. Also a glass containing two network formers such as TeO_2 and B_2O_3 can lead to the formation of mixed structural units as in borosilicate glasses[3].

It is interesting to study the effect of TeO_2 on the fraction of tetrahedral borons in the glass network. Borotellurite glasses have potential application especially in micro-electronics and opto-acoustics owing to their favorable optical and electrical properties [4].

Experimental

2. Materials and methods

The structure and properties of $50B_2O_3$ –(50 – x)ZnO – $xTeO_2$ glass have been investigated.



BZ-0 **BZT-1** **BZT-2** **BZT-3** **BZT-4**

Photographs of investigated. Zinc Borotellurite Glasses

In the present study, the glass samples of composition **50 B_2O_3-(50-X)ZnO--$XTeO_2$ (X=0,5,10,15,20&25)** have been prepared by the melt quench technique. High purity (99.99%) zinc oxide (ZnO), Tellurium Oxide (TeO_2), Orthoboric acid (H_3BO_3), were used as starting materials. A batch of 20 g of the above high purity chemicals in powder form was weighed, well mixed and melted in a alumina crucible in the temperature range 1150–1250 ^{0}C for 3Hrs.

Result & Discussion

1.XRD Analysis

XRD studies are a very useful technique in determining the structure of the material. The XRD pattern enables one to find out whether the material is crystalline or amorphous in nature. The diffraction pattern for crystalline materials shows up well defined peaks while for amorphous materials, the patterns do not display sharp peaks XRD of all the zinc Borotellurite glass samples showed broad peaks characteristics of glass structure. Representative XRD pattern is shown in following figure.It confirms the amorphous nature of the investigated glass samples.

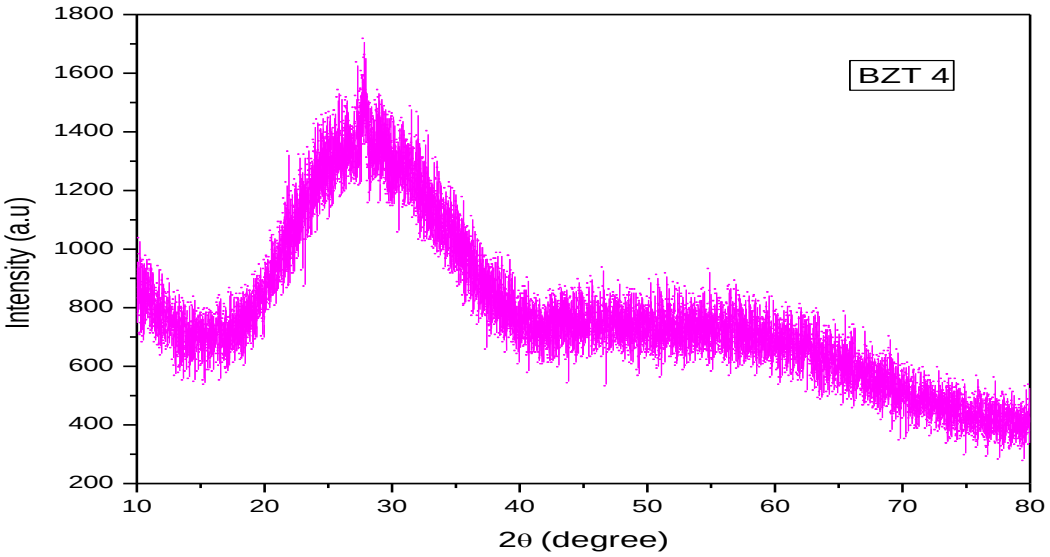


Fig1..XRD pattern of a zinc Borotellurite glass

2.Density and Molar Volume

Sr.No.	Glass Code	Glass Composition (mol %)			Molar Mass (gm)	Density (g/cm^3)	Molar Volume (cc/mol)
		B_2O_3	ZnO	TeO_2			
1	BZ-0	50	50	-	75.35	1.963	38.38
2	BZT-1	50	45	05-	79.26	1.678	46.67
3	BZT-2	50	40	10	83.17	1.433	58.03
4	BZT-3	50	35	15	87.08	1.366	63.74
5	BZT-4	50	30	20	90.99	1.332	68.31

Table1.Chemical composition (mol%), density values and molar volume of* zinc *Borotellurite glasses

In the present work, density of the samples was measured by following Archimedes principle. Xylene was used as buoyant liquid (□=0.865 gm/cc). The weight of the glass samples were taken on Citizen make single pan balance of precession 0.0001 gm. All the measurements were carried out at room temperature. A small piece of sample was weighed in single pan balance and noted as W and same piece of sample is weighed when sample is immersed in liquid and marked as WL and then measured the density using the formula. The estimated error on measured density was ±0.001gm/cc. The molar volume (V) was determined using the measured density and molecular weight (M) of all the glasses using the relation V=M/□. The molecular weight of the glass depends on the composition. There details can be seen in the following section.

The value of density decreases from 1.963to 1.332 g/cm^3; while the values of the molar volume increase from 38.38 to 68.31cc/mol with the gradual increase of the TeO_2 in the zinc Borotellurite glasses as shown in table 3.5.1. The variation of density and molar volume with different % of $TeO_2$for $50B_2O_3$ –(50 – x)ZnO – xTeO_2 with x=0,5,10,15&20. mol % glass system is shown in fig.

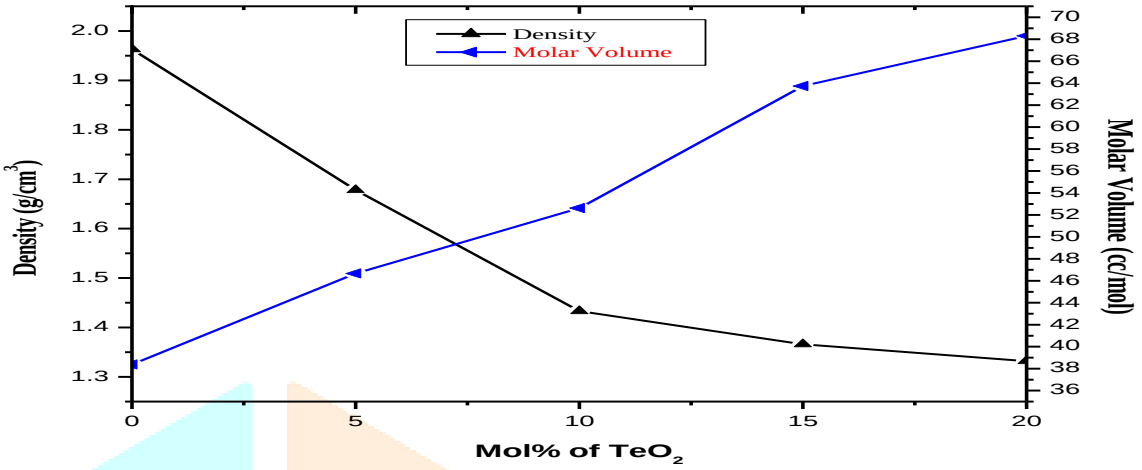
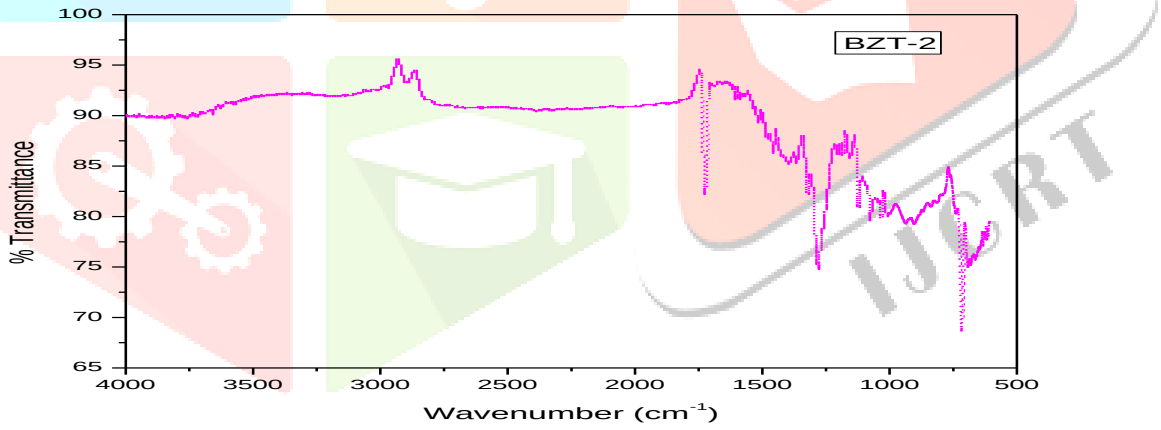


Fig.2. Variation of density and molar volume with mol% TeO_2

3. Infrared Transmission Spectroscopy



The transmittance spectra of zinc borotellurite glass samples in the IR region500 to 4000 cm[1]The FTIR absorption spectra of the glasses in the range **500 – 2000 cm^{-1}** contains several peaks specifying its local structure and the same is shown in figure 6.2.The measurements were done using the KBr pellet technique. The samples were crushed in an agate mortar to obtain particles of micrometer size to avoid structural modifications due to ambient moisture. The transmission band of the local structure of pure TeO_2 glass was centered at 625.38cm^{-1}. The peak positions and their assignments are presented in table . The first group of bands observed around 1200–1600 cm^{-1} is due to the asymmetric stretching relaxation of the B–O bond of trigonal BO_3 units. The second group bands formed around 800–1200 cm^{-1} is due to the B–O stretching of BO_4 units.[(5)]

Tellurite glasses consists of two group of bands. The first group of band formed around 600–640 cm^{-1} corresponds to TeO_4 trigonal bypyramids and the second group of band observed around 685.52–710.44 cm^{-1} is due to the TeO_3 trigonal pyramids.

4.Refractive index

Refractive index is important physical property of a glass. It is used to calculate purity , to identify the substance and to measure the concentration. Different glasses have different refractive indexes. Optical system which uses refraction possesses RI. We have calculated the RI of prepared glass samples and formulated it in table.

The refractive index was measured with simple technique by using travelling microscope. The refractive index is 1.15 for 5% $TeO_2$and 1.4 for 15% $TeO_2$the glasses.

Sr. No.	Glass Code	X	Y	Z	R.I.
1	BZ-0	3.40	3.543	3.735	1.74
2	BZT-1	5.775	5.830	6.195	1.15
3	BZT-2	5.775	5.901	6.205	1.4
4	BZT-3	5.775	5.883	5.998	1.9
5	BZT-4	5.775	5.952	6.012	3.95

Table : Shows the R.I. of the glass composition $50B_2O_3 – (50 – x)$ ZnO – xTeO2 with x=0,5,10,15&20 mol%

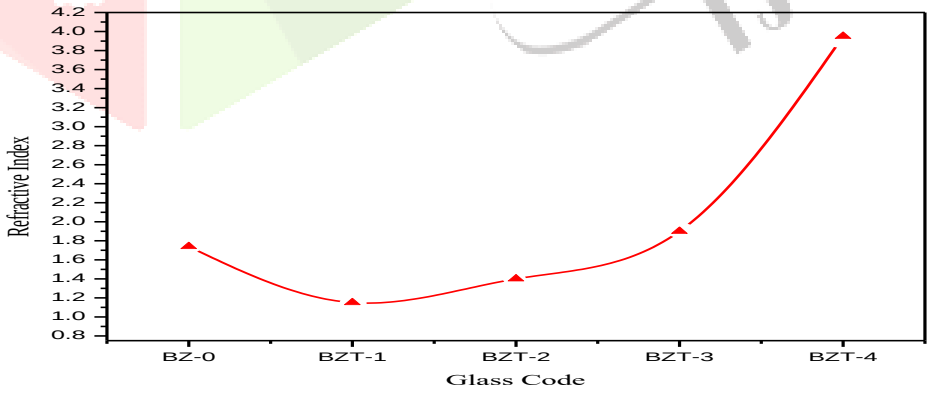


Fig. Graph shows thr Refractive index of the glass composition $50B_2O_3 – (50 – x)$ ZnO – xTeO2 with x=0,5,10,15&20 mol%

Conclusion:

The present glasses were prepared by melt-quenched technique $50B_2O_3 – (50 – x)$ ZnO – $xTeO_2$ with x=0,5,10,15&20 mol%. It is observed that the changes in density and molar volume with TeO_2 content have been discussed in terms of ionic packing density and rigidity of the glass. The refractive index is 1.15 for 5% $TeO_2$and 1.4 for 15% $TeO_2$the glasses.

References

(1).Zhang H., Koritala S., Farooqui K.,Boekenhauer R., Bain D., Kambeyanda S., Feller S.A.,**(1991)**, *Phys. Chem. Glasses*,**32(5)**, 185.

(2) P. Sarjeant, R. Roy, J. Am. Cer. Soc. 50 (1967) 500.

(3). D.Manara, A. Grandjean, D.R. Neuville, Structure of borosilicate glasses and melts: a revision of the Yun, Bray and Dellmodel, J. Non-Cryst. Solids 355 (2009) 2528–2531.

(4). D. Yardımcı,M. Çelikbilek, A.E. Ersundu, S. Aydin, Thermal and microstructural characterization and crystallization kinetic studies in the TeO2–B2O3 system, Mater.
Chem. Phys. 137 (2013) 999–1006.

(5). K.Marimuthu, S.Surendra Babu, G.Muralidharan, S.Arumugam, C. K. Jayasankar, Phys. Status Solidi A, 206 (2009) 131.

[7] M. Pal, Y. Tsujigami, A. Yoshikado, H. Sakata, 2000 *Phys. Stat. Sol*. A **182** 727

[8] G. El-Damrawi, 2000 *Phys. Stat. Sol*. A **177** 385

[9] G. El-Damrawi, S. Abd-El-Maksoud, 2000 *Phys.Chem. Glasses.* **41** 64

G. El-Damrawi, S. Abd-El-Maksoud, 2000 *Phys.Chem. Glasses.* **2** 56

[10] R. A. Montani, S.E Giusia, 2001 *Phys. Chem. Glasses.* **42** 12