IOP Conf. Series: Journal of Physics: Conf. Series **1455** (2020) 012018 doi:10.1088/1742-6596/1455/1/012018

DENSITY AND MOLAR VOLUME OF BISMUTH OXIDE DOPED LITHIUM LEAD BORATE GLASS SYSTEM

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***Abstract*—**This work mainly focuses on the study of the density and molar volume of bismuth oxide doped lithium lead borate coded as LPBB glass system. These glasses were prepared by conventional melt quench method, in order to study their structure. Variation in the value of both density and molar volume as the mole concentration of bismuth content in lead-borate glasses was studied. Variation of density of present glasses is exactly opposite to that of molar volume with increasing mole concentration of bismuth oxide. The F.T.I.R Analysis of LPBB glasses discovered that the network structure mainly depends on the BO3 and BO4 units. Because of the role played by PbO as a glass modifier the transformation of [BO3] units to [BO4] units takes place.
***Keywords*—** Glass, density, molar volume, mole concentration.

1. INTRODUCTION

Glasses containing heavy metal oxides such as lead, bismuth etc. are of potential interest because of their unique optical properties such as high refractive index, large non-linear properties etc. Further, alkali borate glasses have been studied for various technical and industrial applications. Lead oxide glasses in borate host have tremendous applications in radiation shields, opto-electronics including thermal properties [1-4]. Similarly bismuth doped oxide glasses are good laser host materials, glass ceramics, memory and switching devices and long IR cut off and they also exhibit interesting structural properties [5-6]. The presence of both BiO6 and BiO3 groups make Bi2O3 glasses to exhibit interesting physical properties [7]. Therefore these glasses form interesting subject for the investigation. One of the simplest and important physical property that can be measured and used for structural determination of different types of glasses is molar density of the materials. Kalinowski proposed a model for relating the bridging to non-bridging oxygen ratio as a function of glass composition [8]. To analyze the structure and dynamics of amorphous or glassy materials Infrared Spectroscopy (I.R) is used as a very important tool. In the present investigations we have under taken alkali lead borate glass doped with Bi_2O_3 to study the structural role of Bi_2O_3.

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2. EXPERIMENTAL

2.1 Glass Preparation

The glasses of following compositions 15Li2CO3-(50-x)PbO-35B2O3-xBi2O3 (x = 0, 5, 10, 15, 20) were prepared using conventional melt quench method and coded as LPBB glass series. Starting materials like bismuth oxide (Bi2O3), lead monoxide (PbO), boric acid (H_3BO_3), and lithium carbonate Li_2CO_3 of A.R grade, were used. These chemicals were thoroughly mixed and powdered for 30-40 min in a agate mortar to get homogeneous melt. After thorough grinding, the batch (10g) was transferred into a porcelain crucible and melted in an electric muffle furnace at 900°C for about 30-40 min depending on composition. The details of the samples alreadyexplained elsewhere [9]. Melt was poured on the brass

molds after attaining desirable viscosity. The prepared samples (yellowish in color) were stored in a desiccator.

3. RESULTS AND DISCUSSIONS

3.1 Density and Molar Volume

Density measurements were done using Archimedes principle at room temperature using immersion liquid as toluene. Generally measured by,

$$\rho = \frac{W_A}{W_A - W_L}\rho_b \qquad (1)$$

Here, W_A is the wight of the glass in air, W_L is the weight of the glass in liquid and ρb is the density of toluene.

Molar volume of the glass samples is calculated using the relation,

$$V_m = \frac{M}{\rho} \qquad (2)$$

Here, V_m→ molar volume, ρ→ density of the sample and M→ molecular weight of the sample.

3.2 I.R. Spectra

IR Spectra of glasses were recorded at room temperature using KBr pellet technic, in the wave number range 400–2000 cm^{-1} and are shown in Fig.2. All the glasses investigated show prominent peak corresponding to borate network. The region 700-800 cm^{-1} due to the B-O-B bending vibrations, 1100-1200 corresponds to vibrations due to [BO3] triangles, and the region 1000-1100 arises due to vibration in [BO4] units [7]. The careful observation shows that the peak intensities gradually increase with increase in Bi_2O_3 content indication population NBO's. Further with increase in Bi_2O_3 concentration the width of the peaks also increase indication greater randomness in the network. In addition to these peaks, the spectra also show soverlapping peaks which are likely due to vibrations due to mixed bonding such as Bi-O-B, Pb-O-B etc. Cage vibration of Pb^{2+} and Bi^{3+} represent peaks in the lower wavelength side (~500 cm^{-1}).

3.3Figures and Tables

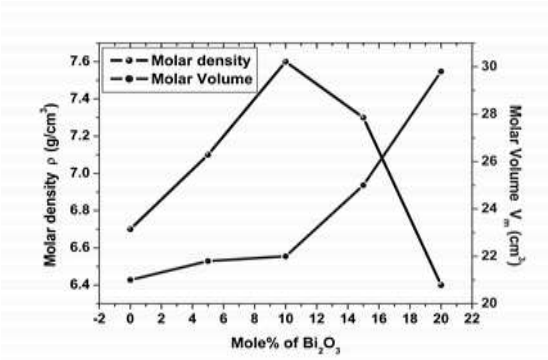

Fig. 1 Variation of density and Molar Volume with Bi_2O_3 content.

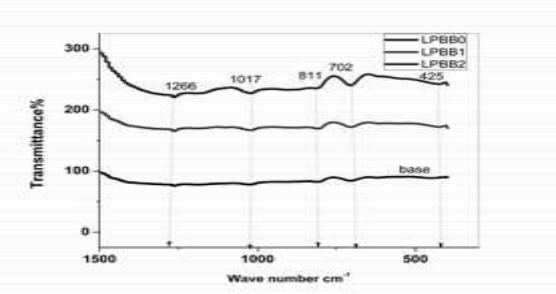

Fig. 2 I. R spectra of LPBB0, LPBB1 and LPBB2 glasses as a function of Bi_2O_3 content.

4. CONCLUSION

Glasses (transparent) with yellowish color are formed. The density of the glasses increases first up to 10% mole-concentration of bismuth content in lead borate glasses. But Molar volume values increase with Bi_2O_3 concentration. The F.T.I.R Analysis of LPBB0, LPBB1 and LPBB2 glasses revealed that the network structure of the prepared samples is mainly based on the BO_3, BO_4 and PbO_4 units. In the LPBB glass samples, bands around 1250 cm^{-1} confirmed the existence of Bi-O-Bi vibrations of [BiO6] octahedral units. The vibrational band between 460 and 520 cm^{-1} in LPBB glasses indicates the coexistence of [BiO3] and [BiO6] groups. Peaks in the lower wavelength side (~500 cm^{-1}) are due to cage vibration of Pb^{2+} and Bi^{3+}. Because of the role played by PbO as a glass modifier the transformation of [BO3] units to [BO4] units takes place.

ACKNOWLEDGMENT

Sangeeta B. Kolavekar is grateful to late Dr.Rajan V. Anavekar, former Professor, department of Physics, Bangalore University, Bengaluru for valuable suggestions and useful discussions. Expresses her thanks to K.L.E. Society and Physics department B.V.B.C.E.T., Hubballi for providing financial support through Capacity Building Project and TEQIP grants.

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