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FTIR Investigation on the Structure of Rare Earth- Doped Bismuth Zinc Borate Glasses

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Abstract: *Structural analysis of Bismuth Zinc borate glass of the composition of* $49.99H_3BO_3+10SrF_2+10Bi_2O3 + 20ZnO + 10\ SiO_2 + MO\ (M = Sm_2O_3, Dy_2O_3, Eu_2O_3)$ *doped with different rare earth elements was prepared and studied through Fourier Transform Infrared (FTIR) spectroscopy. The results of the present analysis indicated that rare earth elements of* DY^{3+}, Sm^{3+} *and* Eu^{3+} *ions were not influenced to change the structure of the bismuth zinc borate glasses..*

Keywords: *Structural analysis, borate glass, Fourier Transform Infrared (FTIR) Spectroscopy*

1. Introduction

FTIR- spectroscopy has been widely used for the determination of glass structure. Especially, IR- studies were made at large scale for borate compounds such as rare earth metal borates. Gautam et al [1] investigated the IR-spectroscopic studies of borate glasses with the effects of different metal cation additives such as Zn, Pb, Cd, Ce, La and Ba. Different inorganic borate groups are identified by the IR-studies in heavy metal borate glasses which may due to variation of metal ion concentration [2]. Motke et al. [3] studied infrared spectra of zinc doped lead borate glasses and showed conversion of 3f-4f coordinated boron. According to the literature survey, there is no adequate FTIR investigations on cation additives of rare earth borate glasses. Therefore, in this investigation the author is intended to perform the FTIR-analysis for different concentrations of rare earth dopants such as Sm, Dy and Eu in $49.99H_3BO_3+10SrF_2+10Bi_2O3 + 20ZnO + 10\ SiO_2$.

2. Experimental Procedure

The glasses of general formula $49.99\ H_3BO_3\text{-}10SrF_2\text{-}10Bi_2O_3\text{-}20ZnO\text{-}10SiO_2\text{-}M\ (M = Sm_2O_3, Dy_2O_3\ \&\ Eu_2O_3)$ have been prepared by mixing them in appropriate quantity with the help of digital electronic balance. The chemicals of 99.9 % purity (Sigma Aldrich) are taken. All these compositions are mixed together and stirred in a porcelain crucible. The mixture is melted by placing it in a programmable furnace 1100^0C for 30min. The glass samples are taken out from the furnace and pour onto different metal plates. The plate is again annealed for 300^0C and as the result the glasses are obtained having transparent, pure and amorphous in nature. The samples are made into fine powders and characterized by using FTIR- spectrometer (IR affinity-1, Shimadzu) for studying the transmittance spectra.

3. Results and Discussions

The FTIR spectra of rare earth doped bismuth zinc borate glasses are shown in Fig.1 and the corresponding vibrational bands are summarized in table.1. In the present investigation wave number verses % T (transmittance) is plotted over the range of 250-4000 cm^{-1} and the peak positions are observed to be varying between 500-1550 cm^{-1} for all rare earth doped borates. In particularly, these peak positions are noticed at 626.70, 760.05, 1113.26, 1270.60, 1506.99 and 1548.53 cm^{-1}. Among these peak positions at wave number of 760.05 cm^{-1} is due to B-O-B linkage bending in borate net work. Also, asymmetric stretching vibrations of B-O bond from pyro and ortho borate groups in $[BO_3]$ units are found at1270.60 cm^{-1}. Moreover, the peaks at 1396.18 & 1506.99 cm^{-1} are identified because of B-O stretching vibration of BO_3 units in varied borate rings and $B\text{-}O^-$ bond stretching in $[BO_3]$ units due to varied groups respectively. These observations are in well agreement with the reported literature values [4, 5]. The rest peak positions may be due to the presence of metal oxide stretching vibrations of Zn-O, Sr-O, Dy-O, Sm-O & Eu-O.

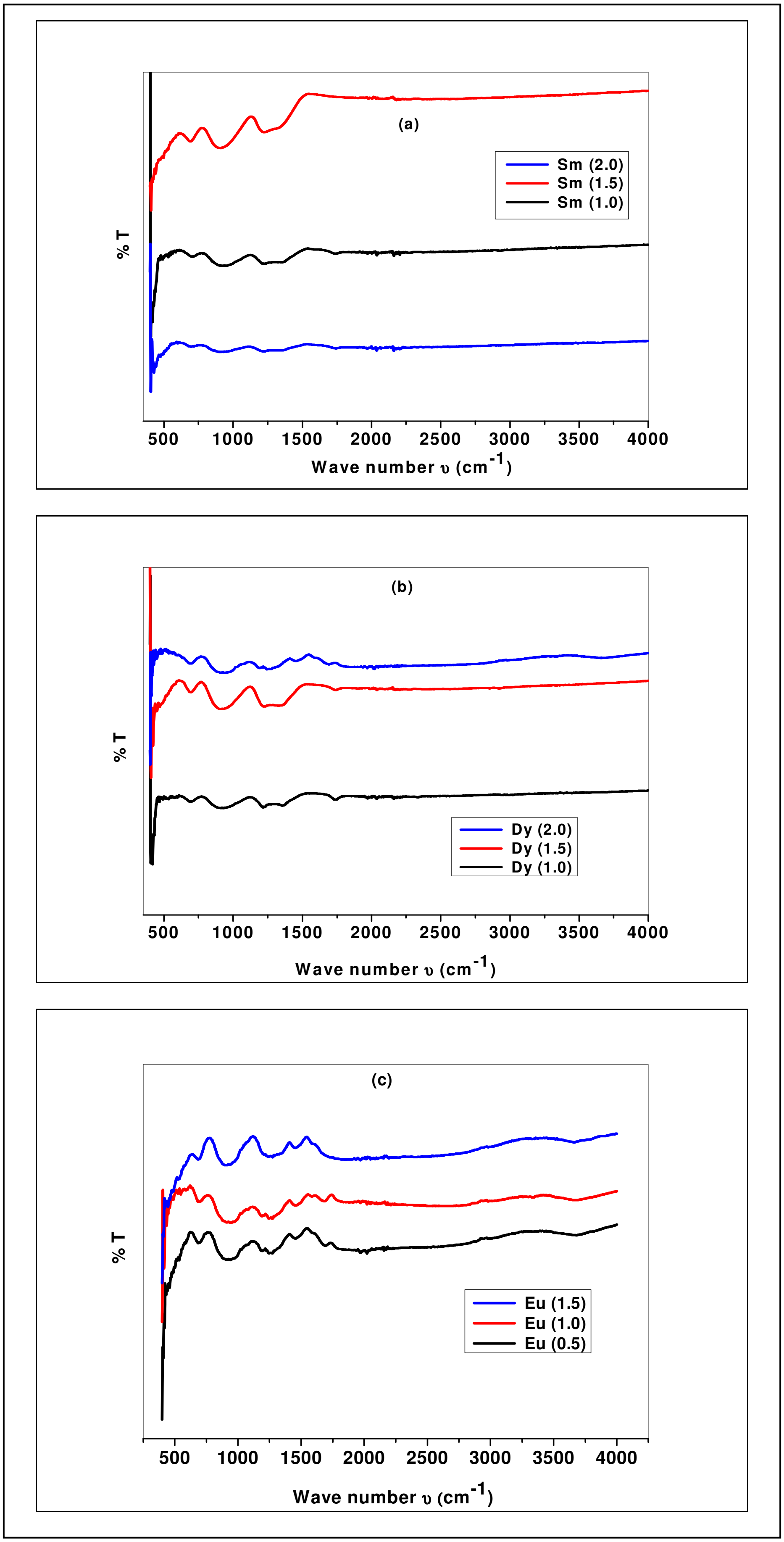

Figure 1: FTIR transmittance spectra of (a) Sm, (b) Dy and (c) Eu doped hydrogen borate glasses.

Reported peaks	Observed peaks	Vibrational modes
~760	~760.05	B-O-B linkages bending in borate net work
~1230-1270	~1270.60	Asymmetric stretching vibrations B-O bond from pyro and ortho borate groups in [BO_3]
~1399	~1396.18	B-O stretching variation of BO_3 units in varied borate rings
~1506	~1506.99	B-O^- bond stretching in [BO_3] units due to varied groups

Table 1: Peak positions of IR-bands and assignments of vibrational modes

4. Conclusions

The transmittance spectra of FTIR confirmed the triangular BO_3 structure and the peaks at 760.05, 1270.60, 1506.99 and 1548.53 cm^{-1} are due to stretching vibrations between B-O. The rest peak positions may be due to the presence of metal oxide stretching vibrations of Zn-O, Sr-O, Dy-O, Sm-O & Eu-O.

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