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SYNTHESIS AND STUDY OF OPTICAL AND PHOTOLUMINESCENCE PROPERTIES OF ER ION CODOPED BISMUTH TELLURITE GLASS AT 800NM

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ABSTRACT:
Bismuth tellurite glasses of composition (80–x) TeO_2–$20Bi_2O_3$–$10Na_2O$–xEr_2O_3 (x is 0.5 and 1% mol percentage) were synthesized by melting-quenching-pressing method. Various characterization of sample has been done, as differential scanning calorimetry (DSC), X-Ray diffraction, UV-VISIBLE-IR absorption spectroscopy and fluorescence spectroscopy. DSC is done for thermal characterization, X-Ray diffractogram is supportive evidence for justify samples to be glass. Study of absorption spectra is provide information of optical forbidden energy gap E_{opt}, refractive index (n), Urbatch energy (E_u), cutoff and wavelength λ_0, for the study of photoluminescence (PL), fluorescence spectrometry is done.

Keywords: Bismuth tellurite photoluminescence, Urbatch energy

NTRODUCTION:

Glasses in which bismuth is one of the important factor can produce photoluminescence (PL) in large span of wavelengths from visible to infra red for various exited radiations [1]. Various host materials as silicate, borate, germinate, phosphate, chalcogonite are used as glass former with bismuth as codoped[[2-3],nd germanates [4–6], but also phosphates [7], borates [8], chalcogenides [9, 10] .The new promising glasses are tellurite base glasses due to its attribution in wide rang transmission ,high sustainability ,good resistance against corrosion ,comparatively moderate phonon energy ,high ref. index (n) and good linear and non linear optical properties [11–13]

In group of oxides of heavy metals (OHM), Bi2O3 is one of most important and extraordinary metal because of its non-toxic features [14,15]. Bi2O3 doped oxide glasses having optical properties due to both of its function as modifier and former. Bismuth exhibit important electronic applications due to its polarizability [16]. The tellurite glasses possessing nonlinear and linear ref. indices (n), wide transmission, moderate melting temperature, and solubility for other oxides and lanthanides, these properties of tellurite glasses attract researchers. The potential applications of tellurite base glasses are increases in the field of optical fibers, lasers, display devices, optical amplifiers and solar cells [16, 17].

EXPERIMENT:

Bismuth tellurite glasses are synthesize with the composition of (80–x) TeO_2–$10Bi_2O_3$–$10Na_2O$–xEr_2O_3 (x is 0.5 and 1% mol percentage) by melt quench method. Chemicals compounds in powder form are taken with high purity 99% to 99.7% weigh with very sensitive digital weighing machine. Mix homogeneously then with pestle-mortar. The mixtures is the

put in the muffle furnace in alumina crucible to get temperature 850°C and the taken out for manual stirring. Put melt again in the furnace for 30 minutes at 900°C and the pour in steel mould to get pellets. For the annealing samples were kept in oven at 350 in oven for 1 hour. The prepared glasses are yellowish to pinkish in colour are named TB1 and TB2. The densities of the sample were calculated by Archimedes principle at atmospheric temperature. For the study of glass transition temperature DSC is done. X-Ray diffraction is done for study of nature of solid sample. Absorption spectroscopy is done in the range of 350nm to 950nm for the optical study of sample, photoluminescence is observed by fluorescence spectrometry.

RESULT AND DISCUSSION:

3.1 DSC

Differential scanning calorimery of TB1 glass is carried in temperature range 50.00°C to 410.00°C by using PerkinElmer (Pyris 6 DSC)(figure 1).The glass transition temperature T_g was measured. For TB1 glass transition temperature to be T_g =330°C.

3.2. X-Ray diffraction Analysis:

The justification of amorphous nature of sample TB1 is given by X-Ray diffractograme taken in scans were recorded for 2θ values from 20^o to 70^o. The diffraction plot of TB1 samples exhibit wide hump near 30^o and no sharp spike were observed (figure 2). It confirms the glassy nature of the TB1glass.

3.3 Density

The Density of the samples measured by fluid displacement method based on the Archimedes principle. The Relation for density of sample is $\rho = W_g \rho_w / (W_s - W_0)$. Where W_s is the weight of the sample in air, W_0 is the weight of the sample in buoyant liquid, $(W_g - W_0)$ is the buoyancy, ρ_w is the density of buoyant. As the immersion liquid distilled water was used. All the weighing measurements were done using a digital balance. Calculated densities of glasses of different batch composition are given in table 1.

3.4 Optical properties

Optical properties of glass samples TB1 and TB2 are studied by UV-VIS-IR absorption spectra which is recorded in the range of 300 nm to 950nm by using model no. RI2SA spectrometer of Research India taken at atmospheric temperature (shown in Figure 3). The coefficient of absorption α can be calculated as $\alpha(\upsilon) = A / t$ where A is absorbance and t is thickness of sample. [18].

The forbidden energy band gaps are calculated by using relation $(\alpha h\upsilon)^2 = A(h\upsilon - E_g)$ [19] and Tauc's plot [20],Hence evaluated values of forbidden energy band gap E_g are shown in table 2. The value of $E_{g(optical)}$ for TB1 glass is 3.18 eV slightly less with compare to TB2(3.2 eV) glass.

The Urbach's energy *Eu* were estimated by i.e. plot between hν and lnα. [21], The Urbach's plot for TB1and TB2 glasses shown in figure 4, and calculated *Eu* are given in table2.

3.5. Photoluminescence at 800 nm

Normalized PL spectra of synthesized glasses TB1 (Inset) and TB2 are taken at 800nm excitation wavelength, shown in figure 5. Both sample exhibit luminescence spectra in the same wavelength that is 500nm to 650nm. The intensity of PL very much affected by the mole percentage doping of Er^{3+} ion in the glass, hence the presence of luminescence emission is because of Er ions and with increase of mole percentage intensity increases. It is also observed that nature of emission is of diffused type .In this emission various adjacent transition levels of Er^{3+} ions are involve.

CONCLUSION:

Bismuth Erbium doped tellurite glasses are synthesize successfully with composition of (80–x) TeO2–10Bi_2O_3–10Na_2O–xEr_2O_3 (x is 0.5 and 1% mol percentage) by melt quench method. Physical and optical properties as density, molar volume (table1), optical energy band gap, and Urbach's energy (table2) and photoluminescence of synthesized samples were studied. Results manifest that synthesized glasses are having good transparency in visible and infrared region ; density of samples are quite high 5.26 gm/cc and 5031. Their optical band gap and Urbatch's energies are respectively are 3 eV & 3.18eV and 188 meV & 300 meV, justify its candidature for photonic devices. Photoluminescence in the synthesized TB1 and TB2 glasses are the attribution of Er^{+3} ions and bismuth.

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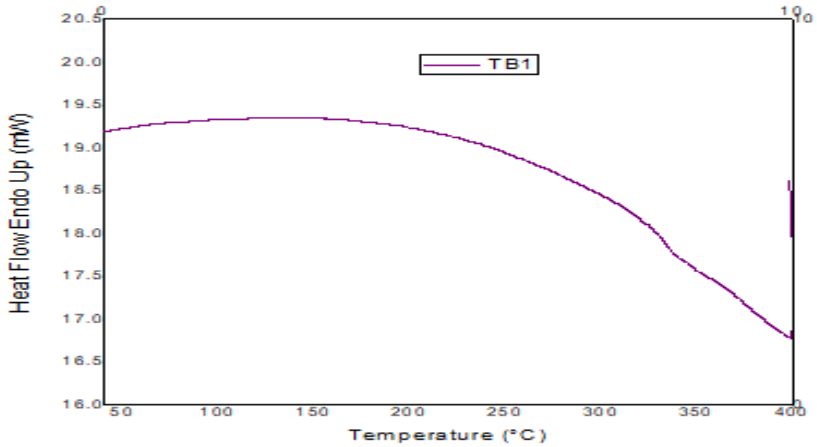

Figure 1.DSC curve of TB1 glass heat from 45.00°C to 410.00°C at 5.00°C/min

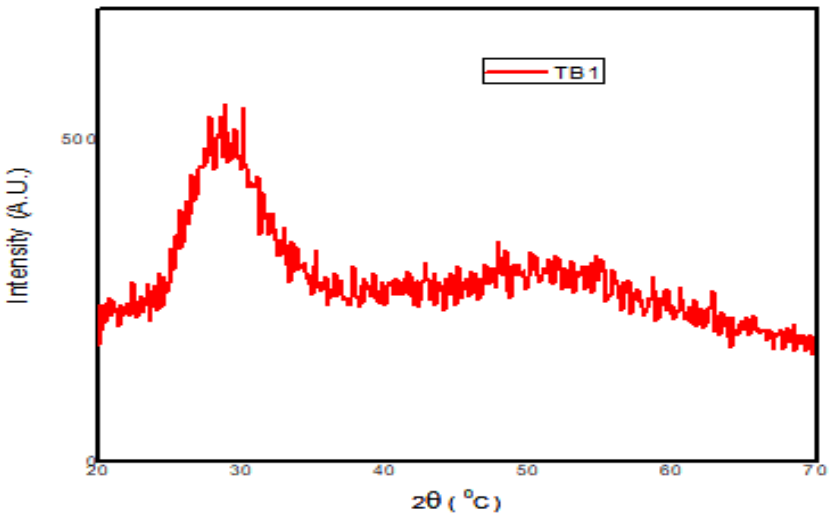

Figure2. X-Ray diffractograms of TB1 glass

Table1. Chemical composition with mole percentage and gram weight of synthesized glass samples

Glass	Composition	Density gm/cc
TB1	(79.5)%TeO_2–10Bi_2O_3–10Na_2O–0.5%Er_2O_3	5.28
TB2	(79)%TeO_2–10Bi_2O_3-10Na_2O–1%Er_2O_3	5.31

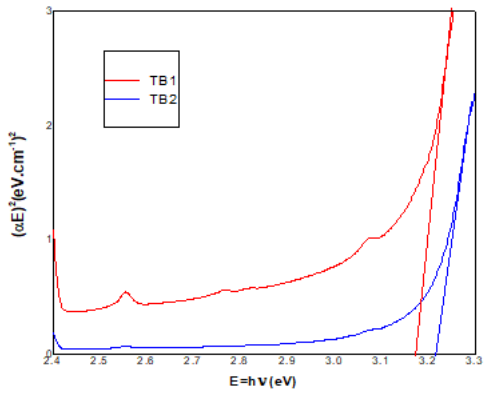

Figure 3.Tauc's plot for direct forbidden energy gap for the TB1 and TB2.

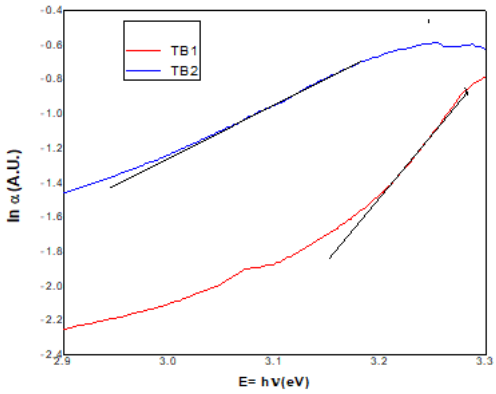

Figure 4.Urbach's plot for TBNE and TBNEY glass samples

Table 2. Optical parameters of TB1 and TB2 glasses.

Sample	Direct energy bangap	Urbach's energy
TB1	3.18eV	188meV
TB2	3.0 eV	330meV

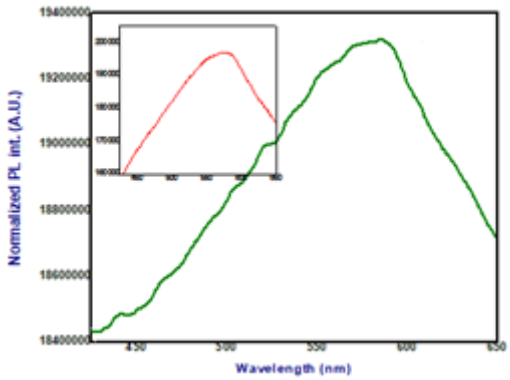

Figure 5. Normalized PL spectra of synthesized glasses TB1 (Inset) and TB2are taken at 800nm excitation wavelength.