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# Spectral and FTIR Analysis of $\text{Ho}^{3+}$ ions doped Zinc Lithium Sodium Potassium Gallium Borotellurite Glasses

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**ABSTRACT:** Glasses samples containing  $\text{Ho}^{3+}$  in zinc lithium sodium potassium gallium borotellurite glasses  $(30-x)\text{TeO}_2:10\text{ZnO}:10\text{Li}_2\text{O}:10\text{Na}_2\text{O}:10\text{K}_2\text{O}:10\text{Ga}_2\text{O}_3:20\text{B}_2\text{O}_3:x\text{Ho}_2\text{O}_3$  (where  $x=1, 1.5, 2$  mol %) have been prepared by melt-quenching method. The amorphous nature of the prepared glass samples was confirmed by X-ray diffraction. Optical absorption, Excitation, fluorescence and FTIR spectra were recorded at room temperature for all glass samples. Judd-Ofelt intensity parameters  $\Omega_\lambda$  ( $\lambda=2, 4$  and  $6$ ) are evaluated from the intensities of various absorption bands of optical absorption spectra. Using these intensity parameters various radiative properties like spontaneous emission probability ( $A$ ), branching ratio ( $\beta$ ), radiative life time ( $\tau_R$ ) and stimulated emission cross-section ( $\sigma_p$ ) of various emission lines have been evaluated.

**KEYWORDS:** ZLSPGBT Glasses, Optical Properties, FTIR Spectroscopy, Judd-Ofelt Theory,

## I. INTRODUCTION

Rare earth glasses have attracted much attention, because they have large practical and potential applications in many fields, such as optical fibers, sensors, glass lasers, optical fiber amplifiers, up-conversion lasers, electro-luminescent devices, memory devices and flat-panel displays [1–5]. Among different glasses, tellurite glasses have unique properties. They have high transparency, high refractive index and low dispersion rates.

Tellurite glasses possess interesting properties high density, high solubility, non-linear optical susceptibilities and low melting temperature [6-8]. Zinc oxide is added in the glass matrix to increase glass forming ability and to ensure low rates of crystallization in the glass system. Tellurite glasses are both scientifically and technologically important materials because they generally offer some unique physical, optical and spectral properties better than other glasses [9-12]. Among active rare-earth ions  $\text{Ho}^{3+}$  exhibits high solubility in ceramic glasses, which also possess excellent Thermal, physical and optical properties [13-15].

The present work reports on the preparation and characterization of rare earth doped heavy metal oxide (HMO) glass systems for lasing materials. I have studied on the Optical absorption, Excitation, fluorescence and FTIR spectra of  $\text{Ho}^{3+}$  doped zinc lithium sodium potassium gallium borotellurite glasses. The intensities of the transitions for the rare earth ions have been estimated successfully using the Judd-Ofelt theory, The laser parameters such as radiative probabilities ( $A$ ), branching ratio ( $\beta$ ), radiative life time ( $\tau_R$ ) and stimulated emission cross section ( $\sigma_p$ ) are evaluated using J.O. intensity parameters ( $\Omega_\lambda$ ,  $\lambda=2, 4$  and  $6$ ).

## II. EXPERIMENTAL TECHNIQUES

### Preparation of glasses

The following  $\text{Ho}^{3+}$  doped borotellurite glass samples  $(30-x)\text{TeO}_2:10\text{ZnO}:10\text{Li}_2\text{O}:10\text{Na}_2\text{O}:10\text{K}_2\text{O}:10\text{Ga}_2\text{O}_3:20\text{B}_2\text{O}_3: x\text{Ho}_2\text{O}_3$  (where  $x=1, 1.5$  and  $2$  mol%) have been prepared by melt-quenching method. Analytical reagent grade chemical used in the present study consist of  $\text{TeO}_2$ ,  $\text{ZnO}$ ,  $\text{Li}_2\text{O}$ ,  $\text{Na}_2\text{O}$ ,  $\text{K}_2\text{O}$ ,  $\text{Ga}_2\text{O}_3$ ,  $\text{B}_2\text{O}_3$  and  $\text{Ho}_2\text{O}_3$ . They were thoroughly mixed by using an agate pestle mortar. then melted at  $1060^\circ\text{C}$  by an electrical muffle furnace for 2h., After complete melting, the melts were quickly poured in to a preheated stainless steel mould and annealed at temperature of  $250^\circ\text{C}$  for 2h to remove thermal strains and stresses. Every time fine powder of cerium oxide was used for polishing the samples. The glass samples so prepared were of good optical quality and were transparent. The chemical compositions of the glasses with the name of samples are summarized in **Table 1**.



**Table 1.**

Chemical composition of the glasses

| Sample          | Glass composition (mol %)  |
|-----------------|--|
| ZLSPGBT (UD)    | 30TeO <sub>2</sub> :10ZnO:10Li <sub>2</sub> O:10Na <sub>2</sub> O:10K <sub>2</sub> O:10Ga <sub>2</sub> O <sub>3</sub> :20B <sub>2</sub> O <sub>3</sub>                                       |
| ZLSPGBT (HO1)   | 29TeO <sub>2</sub> :10ZnO:10Li <sub>2</sub> O:10Na <sub>2</sub> O:10K <sub>2</sub> O:10Ga <sub>2</sub> O <sub>3</sub> :20B <sub>2</sub> O <sub>3</sub> :1 Ho <sub>2</sub> O <sub>3</sub>     |
| ZLSPGBT (HO1.5) | 28.5TeO <sub>2</sub> :10ZnO:10Li <sub>2</sub> O:10Na <sub>2</sub> O:10K <sub>2</sub> O:10Ga <sub>2</sub> O <sub>3</sub> :20B <sub>2</sub> O <sub>3</sub> :1.5 Ho <sub>2</sub> O <sub>3</sub> |
| ZLSPGBT (HO2)   | 28TeO <sub>2</sub> :10ZnO:10Li <sub>2</sub> O:10Na <sub>2</sub> O:10K <sub>2</sub> O:10Ga <sub>2</sub> O <sub>3</sub> :20B <sub>2</sub> O <sub>3</sub> :2 Ho <sub>2</sub> O <sub>3</sub>     |

ZLSPGBT (UD) -Represents undoped Zinc Lithium Sodium Potassium Gallium Borotellurite glass specimens  
 ZLSPGBT (HO)-Represents Ho<sup>3+</sup> doped Zinc Lithium Sodium Potassium Gallium Borotellurite glass specimens

### III. THEORY

#### 3.1 Oscillator Strength

The intensity of spectral lines are expressed in terms of oscillator strengths using the relation [16].

$$f_{\text{expt.}} = 4.318 \times 10^{-9} \int \epsilon(\nu) d\nu \tag{1}$$

where,  $\epsilon(\nu)$  is molar absorption coefficient at a given energy  $\nu$  (cm<sup>-1</sup>), to be evaluated from Beer–Lambert law.

Under Gaussian Approximation, using Beer–Lambert law, the observed oscillator strengths of the absorption bands have been experimentally calculated [17], using the modified relation:

$$P_m = 4.6 \times 10^{-9} \times \frac{1}{cl} \log \frac{I_0}{I} \times \Delta\nu_{1/2} \tag{2}$$

where c is the molar concentration of the absorbing ion per unit volume, l is the optical path length, log I<sub>0</sub>/I is optical density and  $\Delta\nu_{1/2}$  is half band width.

#### 3.2. Judd-Ofelt Intensity Parameters

According to Judd [18] and Ofelt [19] theory, independently derived expression for the oscillator strength of the induced forced electric dipole transitions between an initial J manifold |4f<sup>N</sup>(S, L) J> level and the terminal J' manifold |4f<sup>N</sup>(S', L') J'> is given by:

$$\frac{8\pi^2 mc \bar{\nu}}{3h(2J+1)n} \frac{1}{n} \left[ \frac{(n^2+2)^2}{9} \right] \times S(J, J') \tag{3}$$

Where, the line strength S (J, J') is given by the equation

$$S(J, J') = e^2 \sum_{\lambda=2, 4, 6} \Omega_{\lambda} \langle 4f^N(S, L) J \| U^{(\lambda)} \| 4f^N(S', L') J' \rangle^2 \tag{4}$$

In the above equation m is the mass of an electron, c is the velocity of light,  $\bar{\nu}$  is the wave number of the transition, h is Planck's constant, n is the refractive index, J and J' are the total angular momentum of the initial and final level respectively,  $\Omega_{\lambda}$  ( $\lambda=2, 4$  and 6) are known as Judd-Ofelt intensity.

#### 3.3 Radiative Properties

The  $\Omega_{\lambda}$  parameters obtained using the absorption spectral results have been used to predict radiative properties such as spontaneous emission probability (A) and radiative life time ( $\tau_R$ ), and laser parameters like fluorescence branching ratio ( $\beta_R$ ) and stimulated emission cross section ( $\sigma_p$ ).

The spontaneous emission probability from initial manifold |4f<sup>N</sup>(S', L') J'> to a final manifold |4f<sup>N</sup>(S, L) J> is given by:

$$A [(S', L') J'; (S, L) J] = \frac{64 \pi^2 \bar{\nu}^3}{3h(2J'+1)} \left[ \frac{n(n^2+2)^2}{9} \right] \times S(J', J) \tag{5}$$

Where,  $S(J', J) = e^2 [\Omega_2 \| U^{(2)} \|^2 + \Omega_4 \| U^{(4)} \|^2 + \Omega_6 \| U^{(6)} \|^2]$

The fluorescence branching ratio for the transitions originating from a specific initial manifold  $|4f^N(S', L') J' \rangle$  to a final many fold  $|4f^N(S, L) J \rangle$  is given by

$$\beta [(S', L') J'; (S, L) J] = \sum_{S L J} \frac{A[(S' L)]}{A[(S' L') J'(\bar{S} \bar{L})]} \quad (6)$$

where, the sum is over all terminal manifolds.

The radiative life time is given by

$$\tau_{rad} = \sum_{S L J} A[(S', L') J'; (S, L) J] = A_{Total}^{-1} \quad (7)$$

where, the sum is over all possible terminal manifolds. The stimulated emission cross-section for a transition from an initial manifold  $|4f^N(S', L') J' \rangle$  to a final manifold  $|4f^N(S, L) J \rangle$  is expressed as

$$\sigma_p(\lambda_p) = \left[ \frac{\lambda_p^4}{8\pi c n^2 \Delta\lambda_{eff}} \right] \times A[(S', L') J'; (\bar{S}, \bar{L}) J] \quad (8)$$

where,  $\lambda_p$  the peak fluorescence wavelength of the emission band and  $\Delta\lambda_{eff}$  is the effective fluorescence line width.

### 3.4 Nephelauxetic Ratio ( $\beta'$ ) and Bonding Parameter ( $b^{1/2}$ )

The nature of the R-O bond is known by the Nephelauxetic Ratio ( $\beta'$ ) and Bonding Parameters ( $b^{1/2}$ ), which are computed by using following formulae [20, 21]. The Nephelauxetic Ratio is given by

$$\beta' = \frac{v_g}{v_a} \quad (9)$$

where,  $v_a$  and  $v_g$  refer to the energies of the corresponding transition in the glass and free ion, respectively. The value of bonding parameter ( $b^{1/2}$ ) is given by

$$b^{1/2} = \left[ \frac{1-\beta'}{2} \right]^{1/2} \quad (10)$$

## IV. RESULT AND DISCUSSION

### 4.1 XRD Measurement

Figure 1 presents the XRD pattern of the sample contain – TeO<sub>2</sub> which is show no sharp Bragg's peak, but only a broad diffuse hump around low angle region. This is the clear indication of amorphous nature within the resolution limit of XRD instrument.

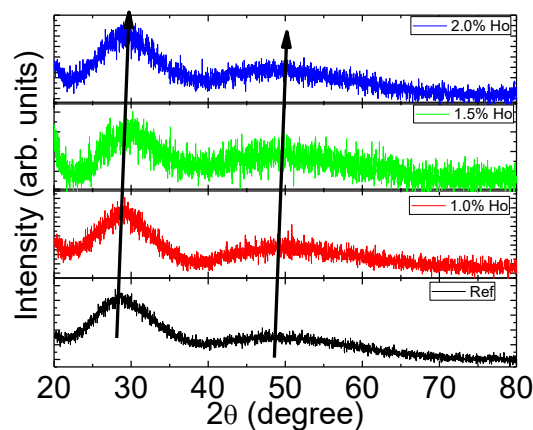


Fig. 1 X-ray diffraction pattern of ZLSPGBT (HO) Glasses.



### 4.2 FTIR Transmission spectra

The FTIR spectrum of ZLSPGBT glass samples are in the wave number range 400-1600 $\text{cm}^{-1}$  is presented in Fig.2 and the possible mechanism bands are tabulated in Table 2

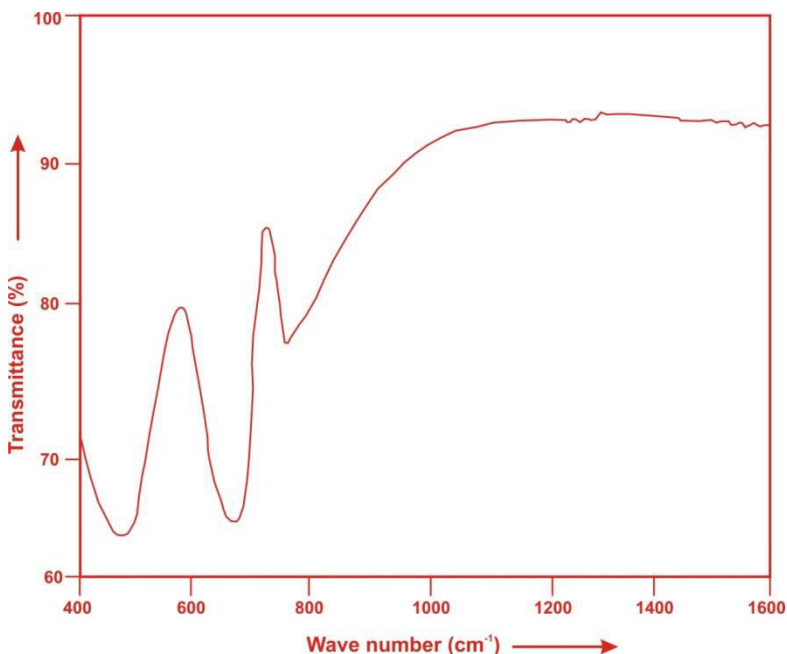


Fig. (2) FTIR spectrum of ZLSPGBT HO (01) glass.

The band at 472  $\text{cm}^{-1}$  is assigned to the symmetric stretching vibration of  $\text{TeO}_4$  or  $\text{TeO}_3$  [22]. The Asymmetric stretching vibration of  $\text{TeO}_4$  is observed around 680  $\text{cm}^{-1}$ [23]. The observed band around 771  $\text{cm}^{-1}$  is due to the Triagonal pyramidal,  $\text{TeO}_3$  structural units [24].

Table2. Assignment of infrared transmission bands of ZLSPGBT HO (01) glass.

| Peak position( $\text{cm}^{-1}$ ) | Band Assignment   |
|-----------------------------------|---|
| ~472                              | symmetric stretching vibration of $\text{TeO}_4$ or $\text{TeO}_3$ [22] |
| ~680                              | Asymmetric stretching vibrations of $\text{TeO}_4(\text{tp})$ [23]      |
| ~771                              | Triagonal pyramidal, $\text{TeO}_3$ structural unit [24]                |

### 4.3 Absorption Spectrum

The absorption spectra of  $\text{Ho}^{3+}$  doped ZLSPGBT glass specimens have been presented in Figure 3 in terms of optical density versus wavelength. Twelve absorption bands have been observed from the ground state  $^5\text{I}_8$  to excited states  $^5\text{I}_5$ ,  $^5\text{I}_4$ ,  $^5\text{F}_5$ ,  $^5\text{F}_4$ ,  $^5\text{F}_3$ ,  $^3\text{K}_8$ ,  $^5\text{G}_6$ , ( $^5\text{G}, ^3\text{G}$ ) $_5$ ,  $^5\text{G}_4$ ,  $^5\text{G}_2$ ,  $^5\text{G}_3$ , and  $^3\text{F}_4$  for  $\text{Ho}^{3+}$  doped ZLSPGBT glasses.

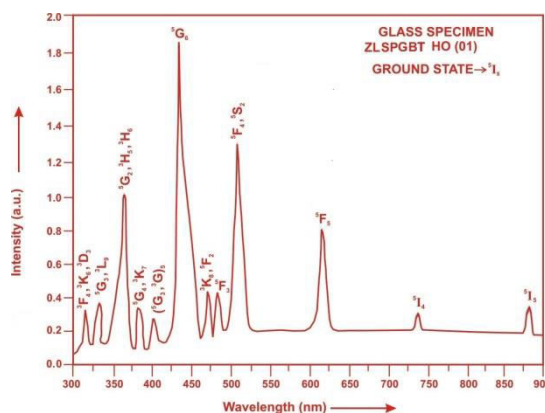


Fig. (3) Absorption spectrum of ZLSPGBT HO (01) glass.

The experimental and calculated oscillator strength for Ho<sup>3+</sup> ions in ZLSPGBT glasses are given in Table 3.

Table 3: Measured and calculated oscillator strength (P<sub>m</sub>×10<sup>6</sup>) of Ho<sup>3+</sup> ions in ZLSPGBT glasses.

| Energy level from <sup>5</sup> I <sub>8</sub>                              | Glass ZLSPGBT (HO01) |                   | Glass ZLSPGBT (HO1.5) |                   | Glass ZLSPGBT (HO02) |                   |
|--|----------------------|-------------------|-----------------------|-------------------|----------------------|-------------------|
|  | P <sub>exp.</sub>    | P <sub>cal.</sub> | P <sub>exp.</sub>     | P <sub>cal.</sub> | P <sub>exp.</sub>    | P <sub>cal.</sub> |
| <sup>5</sup> I <sub>5</sub>  | 0.50                 | 0.28              | 0.47                  | 0.25              | 0.43                 | 0.25              |
| <sup>5</sup> I <sub>4</sub>  | 0.07                 | 0.02              | 0.05                  | 0.02              | 0.03                 | 0.02              |
| <sup>5</sup> F <sub>5</sub>  | 3.75                 | 2.84              | 3.73                  | 2.83              | 3.70                 | 2.80              |
| <sup>5</sup> F <sub>4</sub>  | 4.76                 | 4.42              | 4.72                  | 4.40              | 4.68                 | 4.37              |
| <sup>5</sup> F <sub>3</sub>  | 1.65                 | 2.46              | 1.62                  | 2.45              | 1.58                 | 2.43              |
| <sup>3</sup> K <sub>8</sub>  | 1.45                 | 2.03              | 1.43                  | 2.00              | 1.41                 | 1.98              |
| <sup>5</sup> G <sub>6</sub>  | 26.52                | 26.48             | 25.46                 | 25.44             | 24.25                | 24.26             |
| ( <sup>5</sup> G <sub>4</sub> , <sup>3</sup> G <sub>5</sub> ) <sub>5</sub> | 3.88                 | 1.71              | 3.85                  | 1.70              | 3.82                 | 1.68              |
| <sup>5</sup> G <sub>4</sub>  | 0.09                 | 0.62              | 0.07                  | 0.62              | 0.05                 | 0.61              |
| <sup>5</sup> G <sub>2</sub>  | 5.95                 | 5.62              | 5.92                  | 5.43              | 5.88                 | 5.21              |
| <sup>5</sup> G <sub>3</sub>  | 1.56                 | 1.43              | 1.52                  | 1.331.41          | 1.47                 | 1.39              |
| <sup>3</sup> F <sub>4</sub>  | 1.39                 | 4.22              | 1.36                  | 4.18              | 1.32                 | 4.14              |
| r.m.s. deviation   | ±1.1226              |                   | ±1.1238               |                   | ±1.1289              |                   |

Computed values of F<sub>2</sub>, Lande' parameter (ξ<sub>4f</sub>), Nephelauxetic ratio (β') and bonding parameter (b<sup>1/2</sup>) for Ho<sup>3+</sup> ions in ZLSPGBT glass specimen are given in Table 4.

Table 4: F<sub>2</sub>, ξ<sub>4f</sub>, β' and b<sup>1/2</sup> parameters for Holmium doped glass specimen.

| Glass Specimen   | F <sub>2</sub> | ξ <sub>4f</sub> | β'     | b <sup>1/2</sup> |
|------------------|----------------|-----------------|--------|------------------|
| Ho <sup>3+</sup> | 358.82         | 1258.16         | 0.9337 | 0.1821           |

In the Zinc Lithium Sodium Potassium Gallium Borotellurite glasses (ZLSPGBT) Ω<sub>2</sub>, Ω<sub>4</sub> and Ω<sub>6</sub> parameters decrease with the increase of x from 1 to 2 mol%. The order of magnitude of Judd-Ofelt intensity parameters is Ω<sub>2</sub>>Ω<sub>6</sub>> Ω<sub>4</sub> for all the glass specimens. The spectroscopic quality factor (Ω<sub>4</sub> /Ω<sub>6</sub>) related with the rigidity of the glass system has been found to lie between 0.598 and 0.603 in the present glasses.

The values of Judd-Ofelt intensity parameters are given in Table 4.

Table 5: Judd-Ofelt intensity parameters for Ho<sup>3+</sup> doped ZLSPGBT glass specimens.

| Glass Specimen  | $\Omega_2(\text{pm}^2)$ | $\Omega_4(\text{pm}^2)$ | $\Omega_6(\text{pm}^2)$ | $\Omega_4/\Omega_6$ |
|-----------------|-------------------------|-------------------------|-------------------------|---------------------|
| ZLSPGBT (HO 01) | 6.804                   | 1.417                   | 2.352                   | 0.6025              |
| ZLSPGBT (HO1.5) | 6.486                   | 1.404                   | 2.337                   | 0.6008              |
| ZLSPGBT (HO 02) | 6.125                   | 1.388                   | 2.320                   | 0.5983              |

#### 4.4 Excitation Spectrum

The Excitation spectrum of ZLSPGBT (HO 01) glass has been presented in Figure 4 in terms of Excitation Intensity versus wavelength. The excitation spectrum was recorded in the spectral region 325–525 nm fluorescence at 545nm having different excitation band centered at 349,419, 452, 473and 486 nm are attributed to the <sup>5</sup>G<sub>3</sub>, (<sup>5</sup>G, <sup>3</sup>G)<sub>5</sub>, <sup>5</sup>G<sub>6</sub>, <sup>3</sup>K<sub>8</sub> and <sup>5</sup>F<sub>3</sub> transitions, respectively. The highest absorption level is <sup>5</sup>G<sub>6</sub> and is at 452nm. So this is to be chosen for excitation wavelength.

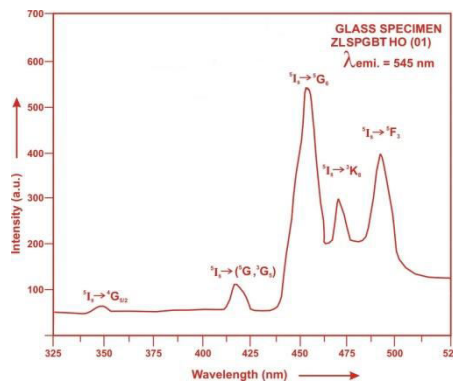
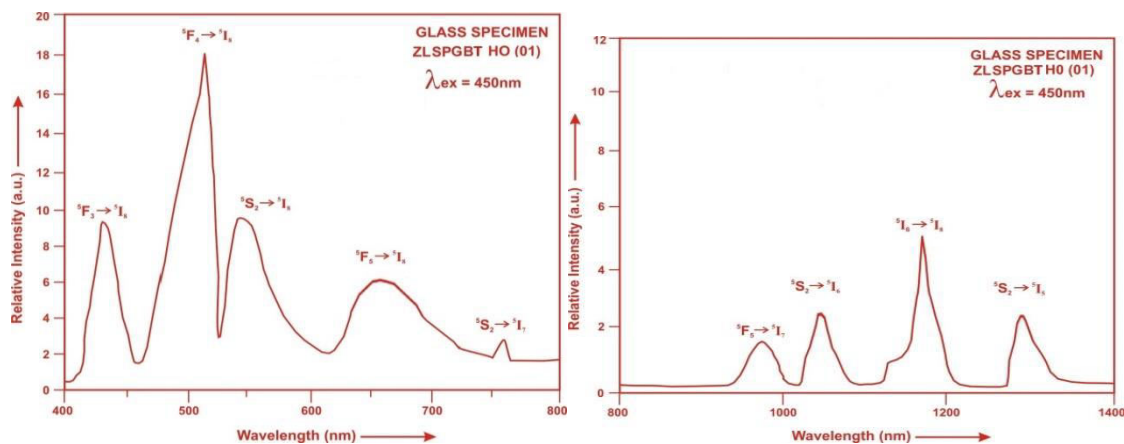


Fig. (4) Excitation spectrum of ZLSPGBT HO (01) glass.

#### 4.5 Fluorescence Spectrum

The fluorescence spectrum of Ho<sup>3+</sup> doped in zinc lithium sodium potassium gallium borotellurite glass is shown in Figure 5. There are eleven broad bands observed in the Fluorescence spectrum of Ho<sup>3+</sup> doped zinc lithium sodium potassium gallium borotellurite glass. The wavelengths of these bands along with their assignments are given in Table 6. The peak with maximum emission intensity appears at 2035 nm and corresponds to the (<sup>3</sup>I<sub>7</sub>→<sup>5</sup>I<sub>8</sub>) transition.



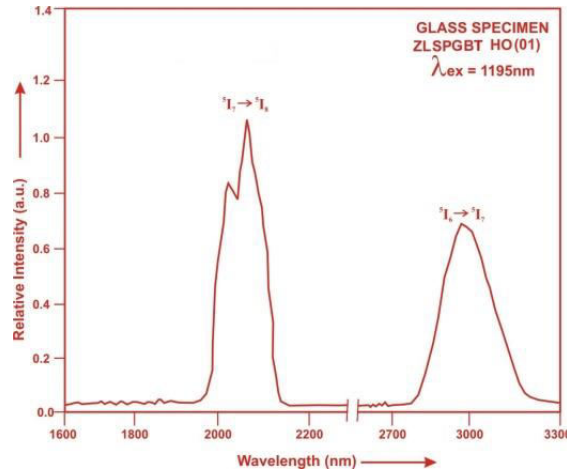


Fig. (5). Fluorescence spectrum of ZLSPGBT HO (01) glass.

**Table6: Emission peak wave lengths ( $\lambda_p$ ),radiative transition probability ( $A_{rad}$ ),branching ratio ( $\beta$ ),stimulated emission cross-section( $\sigma_p$ ) and radiative life time ( $\tau_R$ ) for various transitions in  $Ho^{3+}$  doped ZLSPGBT glasses.**

| Transition                | ZLSPGBT (HO 01)      |                   |         |                            |                 | ZLSPGBT (HO 1.5)  |         |                            |                  | ZLSPGBT (HO 02)   |         |                            |                          |
|---------------------------|----------------------|-------------------|---------|----------------------------|-----------------|-------------------|---------|----------------------------|------------------|-------------------|---------|----------------------------|--------------------------|
|                           | $\lambda_{max}$ (nm) | $A_{rad}(s^{-1})$ | $\beta$ | $\sigma_p (10^{-20} cm^2)$ | $\tau_R(\mu s)$ | $A_{rad}(s^{-1})$ | $\beta$ | $\sigma_p (10^{-20} cm^2)$ | $\tau_R (\mu s)$ | $A_{rad}(s^{-1})$ | $\beta$ | $\sigma_p (10^{-20} cm^2)$ | $\tau_R (10^{-20} cm^2)$ |
| $^5F_3 \rightarrow ^5I_8$ | 435                  | 3984.47           | 0.2488  | 0.618                      | 6243.39         | 3967.04           | 0.2489  | 0.609                      | 6274.37          | 3946.13           | 0.2490  | 0.595                      | 6311.05                  |
| $^5F_4 \rightarrow ^5I_8$ | 501                  | 6312.85           | 0.3941  | 1.273                      |                 | 6279.12           | 0.3940  | 1.249                      |                  | 6242.56           | 0.3940  | 1.225                      |                          |
| $^5S_2 \rightarrow ^5I_8$ | 555                  | 1662.27           | 0.1038  | 0.445                      |                 | 1655.90           | 0.1039  | 0.438                      |                  | 1647.17           | 0.1040  | 0.428                      |                          |
| $^5F_5 \rightarrow ^5I_8$ | 652                  | 1792.85           | 0.1119  | 0.747                      |                 | 1783.45           | 0.1119  | 0.735                      |                  | 1771.77           | 0.1118  | 0.723                      |                          |
| $^5S_2 \rightarrow ^5I_7$ | 761                  | 1261.73           | 0.0788  | 1.149                      |                 | 1256.21           | 0.0788  | 1.125                      |                  | 1249.59           | 0.0789  | 1.105                      |                          |
| $^5F_5 \rightarrow ^5I_7$ | 995                  | 419.14            | 0.0262  | 1.229                      |                 | 415.58            | 0.0261  | 1.195                      |                  | 411.30            | 0.0260  | 1.168                      |                          |
| $^5I_6 \rightarrow ^5I_8$ | 1032                 | 193.22            | 0.0121  | 0.711                      |                 | 192.38            | 0.0121  | 0.697                      |                  | 191.29            | 0.0121  | 0.684                      |                          |
| $^5S_2 \rightarrow ^5I_5$ | 1195                 | 221.20            | 0.0138  | 1.246                      |                 | 219.97            | 0.0138  | 1.230                      |                  | 218.38            | 0.0138  | 1.200                      |                          |
| $^5S_2 \rightarrow ^5I_6$ | 1310                 | 58.92             | 0.0037  | 0.641                      |                 | 58.65             | 0.0037  | 0.628                      |                  | 58.34             | 0.0037  | 0.615                      |                          |
| $^5I_7 \rightarrow ^5I_8$ | 2035                 | 87.88             | 0.0055  | 4.792                      |                 | 87.33             | 0.0055  | 4.670                      |                  | 86.68             | 0.0055  | 4.599                      |                          |
| $^5I_6 \rightarrow ^5I_7$ | 2925                 | 22.41             | 0.0014  | 4.021                      |                 | 22.23             | 0.0014  | 3.945                      |                  | 22.02             | 0.0014  | 3.866                      |                          |



## V. CONCLUSION

In the present study, the glass samples of composition  $(30-x)\text{TeO}_2:10\text{ZnO}:10\text{Li}_2\text{O}:10\text{Na}_2\text{O}:10\text{K}_2\text{O}:10\text{Ga}_2\text{O}_3:20\text{B}_2\text{O}_3:x\text{Ho}_2\text{O}_3$ . (where  $x = 1, 1.5$  and  $2$  mol %) have been prepared by melt-quenching method. The value of stimulated emission cross-section ( $\sigma_p$ ) is found to be maximum for the transition ( $5I_7 \rightarrow 5I_8$ ) for glass ZLSPGBT (HO 01), suggesting that glass ZLSPGBT (HO 01) is better compared to the other two glass systems ZLSPGBT (HO1.5) and ZLSPGBT (HO 02). The large stimulated emission cross section in tellurite glasses suggests the possibility of utilizing these systems as laser materials. The FTIR of glasses revealed the presence of characteristic bonding vibrations of different functional groups.

## REFERENCES

- [1].Elkhoshkhany, N., Khatib, M.A. and Kabary Marwa, A.(2018). Thermal, FTIR and UV spectral studies on tellurite glasses doped with cerium oxide. *Ceram Int* 459, 2789-2796.
- [2].Meena, S.L.(2022).Spectral and Upconversion properties of Dy<sup>3+</sup> ions doped zinc lithium potassium niobate borosilicate glasses.*Int.J.Eng.Sci.Inv.*11,44-49.
- [3]. Kashif ,I., Ratep,A. and Ahmed,S.(2020).Spectroscopic properties of lithium borate glass containing Sm<sup>3+</sup> and Nd<sup>3+</sup> ions, *Int. J. of Adv. in App. Sci.* 9( 3), 211-219.
- [4]. Yasukevich, A. S., Rachkovskaya, G.E., Zakharen, G.B., Trusova,E.E., Kornienko,A. A., Dunina,E.B., Kisel,V. E.and Kuleshov, N. V. (2020).spectral luminescence properties of oxyfluoride lead silicate germanate glass doped with Tm<sup>(3+)</sup> ions, *J. lumin.* 117667.
- [5]. Monisha, M., Nancy,A. , Souza, D., Nimitha ,V. L., Prabhu, S and Sayyed, M.I.(2020). Dy<sup>3+</sup> doped SiO<sub>2</sub>- B<sub>2</sub>O<sub>3</sub>- Al<sub>2</sub>O<sub>3</sub>-NaF-ZnF<sub>2</sub> glasses: An exploration of optical and gamma radiation shielding features, *Current Applied Physics* 20, 1207-1210.
- [6]. Meena, S.L.(2022).Spectral and Raman analysis of Eu<sup>3+</sup> doped in zinc lithium cadmium magnesium borophosphate glasses. *Int.J.Appl.Phys.*14,39-44.
- [7]. A. M. Noorazlan, H. M. Kamari, S. S. Zulkefly, and D.W.Mohamad, (2013).Effect of erbium nanoparticles on optical properties of zinc borotellurite glass system, *J.Nanomater*,168, 1–8.
- [8]. T.V.R. Rao, R.R. Reddy, Y. Nazeer Ahammed and M. Parandamaiah (2000). Luminescence properties of Nd<sup>3+</sup>, TeO<sub>2</sub>-B<sub>2</sub>O<sub>3</sub>-P<sub>2</sub>O<sub>5</sub>-Li<sub>2</sub>O glass. *Infrared Physics and Technology*, 41(4), 247-258.
- [9].Yang,Y.,Liu,Y.,Cai,P.,Maalej,R. and Seo,H.J.(2015).Thermal stability and spectroscopic properties of Ho<sup>3+</sup> doped tellurite-borate glasses.*J.Rare earths*,33,939-945.
- [10].J.V. Gunha, A. Goncalves, A.Somer, A.V.C. Andrade, D.T. Dias, A. Novatski, Thermal, structural and optical properties of TeO<sub>2</sub>-Na<sub>2</sub>O-TiO<sub>2</sub> glassy system, *J. Mater. Sci.: Mater. Electron.* 30 (2019) 16695-16701.
- [11].V.N. Jambhale, A.L. Patil, U.B. Chanshetti, FT-IR and density studies on neodymium doped zinc borotellurite glass system, *Int. J. Sci. Res.*7 (2017) 562-565.
- [12].J.N. Mirdda, S. Mukhopadhyay, K.R. Sahu, M.N. Goswami, Enhancement of optical emission and dielectric properties of Eu<sup>3+</sup>-doped Na<sub>2</sub>O-ZnO-TeO<sub>2</sub> glass material, *Glass Phys. Chem.* 46 (2020) 218-227.
- [13].X. Li, Z. Guan, Y. Duan, R. Shen, Y. Tian, X. Wang, S. Xu, H. Yu, X. Zhang and B. Chen, Bright green up-conversion luminescence of LaNbO<sub>4</sub>: Nd<sup>3+</sup>/Yb<sup>3+</sup>/Ho<sup>3+</sup> phosphors under 808 nm and 980 nm excitations and the effects of dopant concentration, *J. Lumin.*, 2022, 241, 118524.
- [14].Cai,J.E.,Qiang,L.,Ming,N.M.,Hui,L.,Xi,H.Y.,Guo,G.Z. and Li,G.M.(2015).Spectroscopic properties of heavily Ho<sup>3+</sup> doped barium yttrium fluoride crystals.*Chin.Phys.B* 24,09216,1-5.
- [15].Liu,L.,Xing,J.,Shang,F. and Chen,G.(2021).Structure and up-conversion luminescence of Yb<sup>3+</sup>/Ho<sup>3+</sup> co-doped fluoroborate glasses.490,126944,1-6.
- [16]. Gorller-Walrand, C. and Binnemans, K. (1988). Spectral Intensities of f-f Transition. In: Gshneidner Jr., K.A. and Eyring,L., Eds., *Handbook on the Physics and Chemistry of Rare Earths*, Vol. 25, Chap. 167, North-Holland, Amsterdam, 101-264.
- [17]. Sharma, Y.K., Surana, S.S.L. and Singh, R.K. (2009) Spectroscopic Investigations and Luminescence Spectra of Sm<sup>3+</sup> Doped Soda Lime Silicate Glasses. *Journal of Rare Earths*, 27, 773-780.
- [18]. Judd, B.R. (1962). Optical Absorption Intensities of Rare Earth Ions. *Physical Review*, 127, 750-761.
- [19]. Ofelt, G.S. (1962). Intensities of Crystal Spectra of Rare Earth Ions. *The Journal of Chemical Physics*, 37, 511.
- [20].Sinha, S.P. (1983).Systematics and properties of lanthanides, Reidel, Dordrecht.1-8.
- [21].Krupke, W.F. (1974).IEEE J.Quantum Electron QE, 10,450.
- [22]. Mansour,E.(2012). FTIR spectra of pseudo-binary sodium borate glasses containing TeO<sub>2</sub>, *J. Mol. Struct.* 1014, 1–6.



- [23]. Elkhoshkhany, N. and Mohamed, H.M.(2019). UV–Vis-NIR spectroscopy, structural and thermal properties of novel oxyhalide tellurite glasses with composition  $\text{TeO}_2$  - $\text{B}_2\text{O}_3$  - $\text{SrCl}_2$  - $\text{LiF}$ - $\text{Bi}_2\text{O}_3$  for optical application. Res. Phys., 13, 102222.
- [24]. Mansour, E.(2012). FTIR spectra of pseudo-binary sodium borate glasses containing  $\text{TeO}_2$ , J. Mol. Struct. 1014, 1–6.



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