

Optical spectroscopy of Sm^{3+} ions in the alkali metal borate glass and cross-relaxation of ${}^4\text{G}_{5/2}$ level of f – f transition

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Abstract: Optical spectroscopy of Sm^{3+} ions doped in the alkali metal borate glasses $(70-x) \text{B}_2\text{O}_3 \cdot 15\text{Li}_2\text{O} \cdot 15\text{Na}_2\text{O} \cdot x\text{Sm}_2\text{O}_3$ (BLN:Sm) fabricated by melting method have been studied. The parameters of spectral intensities of f - f transition determined using the Judd - Ofelt theory allows determination of asymmetric links between RE^{3+} and O, and polarization in this materials. Luminescence decay curves from the ${}^4\text{G}_{5/2}$ state of Sm^{3+} in BLN have been measured at room temperature. Energy transfer from the ${}^4\text{G}_{5/2}$ to the ${}^6\text{F}_J$ states occurs studied for different Sm^{3+} ion concentrations in all samples glasses has been analyzed and the lifetimes are noticed to decrease with increase of concentration. The cross-relaxation mechanism is also discussed for BLN glass

Keywords: alkali metal borate glass, cross-relaxation, Judd – Ofelt, Optical spectroscopy.

I. INTRODUCTION

In recent years, one of the field of research interest is the search for optimal materials suitable fabrication of for optical components used in telecommunications, laser, fiber, optical amplifier, solid laser, 3D display, memory devices, super flat screen devices, UV sensor [4,5]. Alkali metal borate glass with the ingredients focus on the advantages: low energy photons, mechanical stability, chemical, thermal, low melting point, solubility of rare earth ions good and high transparency [9]. The optical properties of rare earth (RE) ions in glassy matrices have been widely investigated because of their interest and potential applications as laser materials. It is observed that though the absorption and emission band positions of these ions are not very sensitive to their environment, the radiative and non-radiative transition probabilities change with the host material. From the optical absorption measurements, the effect of host matrix on the local environment of a given rare earth cation with its first nearest neighbor anions such as oxygen can be elucidated using Judd-Ofelt (JO) theory by studying changes in the experimentally fitted Judd-Ofelt intensity parameters Ω_2 , Ω_4 and Ω_6 . Considerable amount of research work has been done on absorption and emission properties of Sm^{3+} in various glass matrices. Recently Y.C Ratnakaram et al [10] reported the optical properties of Sm^{3+} ions doped borate glasses of the type: $67\text{B}_2\text{O}_3 \cdot x\text{Li}_2\text{O} \cdot (32-x)\text{K}_2\text{O} \cdot 1\text{Sm}_2\text{O}_3$; $67\text{B}_2\text{O}_3 \cdot x\text{Li}_2\text{O} \cdot (32-x) \text{Na}_2\text{O} \cdot 1\text{Sm}_2\text{O}_3$ (where $x = 8, 12, 16, 20$ and 24). Zeng et al [8, 10] reported the luminescence properties of Sm^{3+} activated barium chloroborates and borophosphates. Kumar et al [9] studied the optical properties of Sm^{3+} ions doped

tellurite glasses...Results of this study showed Sm^{3+} ($4f^5$) ion in various glass matrices usually found the narrow radiation line, have long lifetimes in the excited state [3, 10]. This is one of the RE materials used in manufacturing many devices in the visible light (mostly in the red light area) and the material can be used as a probe to measure effectiveness prices of local environment around RE ions, because the flow f - f it provides lots of useful information about the structure around the ion [2, 3, 7].

In this work, we introduce materials fabrication technology alkali metal borate glass doped with Sm^{3+} melting method and the results of research on the optical properties of this material through the analysis of physical quantity theory using JO and energy transfer from the ${}^4\text{G}_{5/2}$ to the ${}^6\text{F}_J$ states occurs studied for different Sm^{3+} ion concentrations in all samples glasses has been analyzed and the lifetimes are noticed to decrease with increase of concentration. The cross-relaxation mechanism is also discussed for BLN:Sm³⁺ glass.

II. EXPERIMENTAL

The chemicals that are used in the present work are Li_2O , Na_2O , B_2O_3 and Sm_2O_3 . The composition of glasses studied in the present work are: $(70-x) \text{B}_2\text{O}_3 \cdot 15\text{Li}_2\text{O} \cdot 15\text{Na}_2\text{O} \cdot x\text{Sm}_2\text{O}_3$ (where $x = 0.25, 0.5, 1.0, 2.0$ and $5.0\text{mol}\%$). The chemicals were weighed accurately in an electronic balance mixed thoroughly and ground to a fine powder. The batches were then placed in quartz cup and melted in an electrical furnace in air at 1323 K for 1,5 hours. The melt was then quenched to room temperature in air by turning of the furnace. The glasses were then annealed at 650 K for 2 hours. The glasses thus obtained were throughout, evenly, no bubble. The samples were cut, grinded, polished blocks rounded product size: thickness $d = 0.98$ mm, radius $r = 6.5$ mm (used for the measurement of refractive index n , density, absorption and fluorescence) fig.1; crushing and sorting grab particles range in size from 76 to 150 micron powder products (used for X-ray diffraction). The glass formation was confirmed by powder X-ray diffraction recorded.

The measurement of the refractive index (n) is made performed on the system Abbe refractometer at a wavelength of Na, 589 nm with $\text{C}_{10}\text{H}_7\text{Br}$ used as the liquid in contact. The density measurements made by Archimede method, using xylene as immersion liquid form.

Optical absorption spectra were recorded in the wavelength

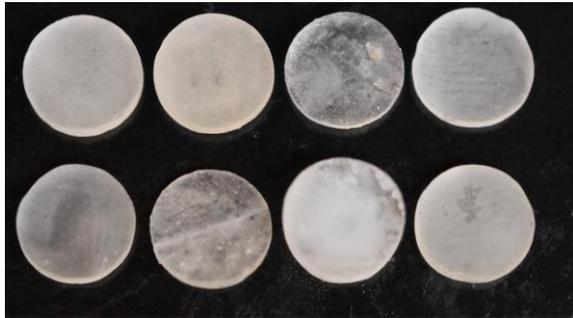


Fig.1. The samples used for the measurement of absorption and fluorescence

regions 300 nm – 2000nm using Varian spectrometer system Cary 5E UV-VIS-NIR, with a resolution of 1nm. Fluorescence spectra were obtained at room temperature using Fluorolog-3 Model FL3-22, Horiba Jobin Yvon, resolution of 0.3 nm, excitation light xenon. For the measurement of fluorescent lifetime, a laser excitation was provided by the third harmonic of 355 nm of a pulsed Nd:YAG laser, model GCR-230, Spectra Physics.

III. THEORETICAL

Theory JO was built for rare earth metals, parameters derived from this theory allows us to evaluate many important physical quantities such as: migration intensity, the lifetime of the flow, as predicted spectra of rare earth ions,...in addition, through the JO parameters also allow us to evaluate many characteristics of the environment surrounding the rare earth ion as the asymmetry, assimilation of treatment, durability. Basis of JO theory is based on the absorption and fluorescence spectroscopy experiments.

A. Oscillator strengths and Judd – Ofelt analysis

The first quantity that we need to consider is the oscillator strengths:

+ The experimental oscillator strengths (f_{exp}) of the absorption bands are determined by using the formula of Smakula:

$$f_{exp} = 4,318.10^{-9} \int \epsilon(v) dv \quad (1)$$

Where: $\epsilon(v)$ is the molar absorptivity at the frequency v (cm^{-1}). This quantity is calculated from the absorbance A by using Lambert-Beer's law: $\epsilon(v) = \frac{A(v)}{c \cdot d}$

where $A(v)$ is absorbance at the frequency v [$\lg(I_0/I)$]; d is the sample thickness [dim: L units: cm]; c is the concentration of rare earth ions [dim: L^{-3} , units: mol^{-1}] (can be determined from the formula: c (ion/ cm^3) = $N_A \cdot d / M$ with: N_A is Avogadro's number, d is the proportion (mol % of RE ion and M molecular weight)

+ According to JO theory, the calculated oscillator strengths for induced electric dipole transition from the ground state $|A\rangle$ to an excited state $|B\rangle$ is:

$$f_{cal} = \frac{8\pi^2 mc}{3h} \frac{v}{2J+1} \frac{(n^2+2)^2}{9n} \sum_{\lambda=2,4,6} \Omega_{\lambda} \left| \langle \Psi J | U^{(\lambda)} | \Psi' J' \rangle \right|^2 \quad (2)$$

where n is refractive index of the medium, J is the total angular momentum of the ground state, v is the frequency of the transition, Ω_{λ} ($\lambda=2,4,6$) called JO intensity parameters, it does not depend on shifted absorption or fluorescence that depends only on the crystal structure, this quantity can be calculated from the experimental. Quantity $\langle \Psi J | U^{(\lambda)} | \Psi' J' \rangle^2$ is the reduced matrix element dual, $\|U^{(\lambda)}\|^2$ are the doubly reduced matrix element evaluated in the intermediate coupling approximation for a transition $\Psi J \rightarrow \Psi' J'$ (it just depends on the rare earth ion and migrates the state – last).

The oscillator strength of various observed transitions are evaluated using Eq.(1) and are used in Eq.(2). A least-squares fitting approach is then used for Eq.(2) to determine Ω_{λ} parameters which gives the best fit between experimental and calculated oscillator strength [3]. The theoretical oscillator strength (f_{cal}) are then calculated using Eq.(2) and Ω_{λ} .

B. Radiative properties

+ The JO parameters along with refractive index (n) are used to predict the radiative properties of excited states of RE^{3+} ion. The radiative transition probability for a transition $|\Psi J\rangle \rightarrow |\Psi' J'\rangle$ as $A(\Psi J, \Psi' J') = A_{ed} + A_{md}$

Where: A_{ed} is electric dipole radiative transition probability:

$$A_{ed} = [16\pi^4 v^3 / 3h(2J+1)] [n(n^2+2)^2 / 9] S_{ed} \quad (3)$$

and A_{md} is magnetic dipole radiative transition probability:

$$A_{md} = [16\pi^4 v^3 / 3h(2J+1)] n^3 S_{md} \quad (4)$$

where the electric S_{ed} and magnetic S_{md} dipole lines strength are calculated using the formulate:

$$S_{ed} = e^2 \sum_{\lambda=2,4,6} \Omega_{\lambda} \langle \Psi J | U^{(\lambda)} | \Psi' J' \rangle^2 \quad (5)$$

$$\text{and } S_{md} = \frac{e^2 h^2}{16\pi^2 m^2 c^2} \left\| \langle \Psi J | L + 2S | \Psi' J' \rangle \right\|^2 \quad (6)$$

The sum of A_{ed} and A_{md} gives the radiative transition probability $A_{(R)}$ is:

$$A_{(R)}(\Psi J, \Psi' J') = \frac{16\pi^2 v^3}{3h(2j+1)} \left[\frac{n(n^2+2)^2}{9n} S_{ed} + n^3 S_{md} \right] \quad (7)$$

The total radiative transition probability $A_{(T)}$ for an excited state is given as the sum of the $A_{(R)}(\Psi J, \Psi' J')$ terms calculated over all the terminal states:

$$A_{(T)} = \sum_{\Psi' J'} (A_{(R)}(\Psi J, \Psi' J'))$$

+ The radiative branching ratio $\beta_R(\Psi J, \Psi' J')$ is defined as:

$$\beta_R(\Psi J, \Psi' J') = \frac{A(\Psi J, \Psi' J')}{A_T(\Psi J)} \quad (8)$$

(the excited state ΨJ is relaxed to several lower-lying states $\Psi' J'$)

The branching ratios can be used to predict the relative intensities of all emission lines originating from a given excited state. The experimental branching ratios can be found from the relative areas of the emission lines.

+ The lifetime of the excited state:

$$\tau(\Psi J): \tau = [A_{(R)}(\Psi J)]^{-1} \quad (9)$$

+ The bonding parameter: $\delta = \frac{1-\bar{\beta}}{\beta} \times 100$ (10)

The bonding parameter is characterizes the interaction of rare earth ions with other ions of the background, in other words, the description of the links in the material: If $\delta > 0$ then covalent link; if $\delta < 0$ then ionic bonds.

IV. RESULTS AND DISCUSSION

A. Absorption spectroscopy and analysis the theoretical by JO

1. Absorption spectra

The absorption spectra of Sm³⁺ doped alkali metal borate glasses for UV-VIS (for the regions 300nm–550nm) and NIR (for the regions 900 nm–1700 nm) are shown in Figure 2 and 3 respectively.

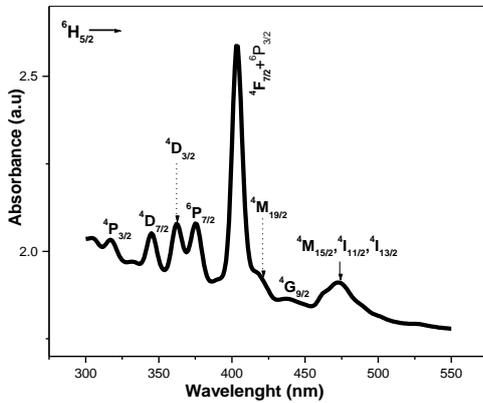


Fig.2. Absorption spectra of Sm³⁺ doped alkali metal borate glass for UV-VIS

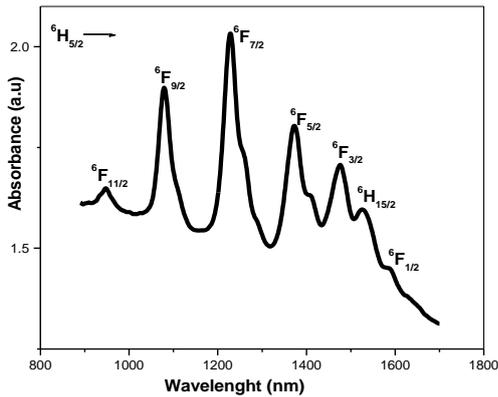


Fig.3. Absorption spectra of Sm³⁺ doped alkali metal borate glass for NIR

The absorption spectra: in regions 300nm-600nm are shown the peaks at 342nm; 360nm; 373nm; 401nm; 415nm; 437nm; 460nm and 470nm; in the regions 900 nm–1700 nm, included in the top 6 positions 940nm, 1070nm, 1220nm, 1365nm, 1480nm and 1582nm. all the absorption bands originate from the ground state ⁶H_{5/2}. The observed band positions of the excited levels of Sm³⁺ ion are presented in table 1.

2. Electronic energies and spectral intensities

From the measurement results of sample extracts (n = 1.526) and the absorption spectrum in Figure 2 and 3, the experimental f_{exp} and calculated f_{cal} spectral intensities of the observed absorption bands of Sm³⁺ ion are obtained using the theory explained in Ref. [8, 10]. Using Judd-Ofelt theory [3], spectral intensities are calculated and these values are also presented in the table 1.

Table 1: Position of the absorption peak Sm³⁺; The experimental (f_{exp}) and calculated (f_{cal}) oscillator strengths for alkali metal borate glass.

⁶ H _{5/2} →	$\lambda_{(nm)}$	$f_{exp} (x10^{-6})$	$f_{cal} (x10^{-6})$	E_{exp}	E_{aau}
⁶ H _{13/2}	1890	0.44	0.28	5128	5042
⁶ F _{1/2}	1582	1.58	1.21	6578	6397
⁶ F _{3/2}	1480	3.80	3.79	6849	6641
⁶ F _{5/2}	1365	5.45	4.45	7299	7131
⁶ F _{7/2}	1220	5.80	3.74	8196	7977
⁶ F _{9/2}	1070	4.10	2.79	9345	9136
⁴ I _{1/2}	474	2.10	0.55	21739	20627
⁶ P _{3/2}	401	4.00	2.85	25000	24950
⁴ D _{7/2}	373	2.96	1.76	26570	25465
⁴ D _{5/2}	360	2.73	1.68	27453	26967
⁴ D _{3/2}	342	2.21	1.43	29121	28875

rms = 1.31 × 10⁻⁶

3. Nephelauxetic effect – Bonding parameter

Using the formula (3.8) and (3.9) to determine value of β for each displacement, from which we determine the value $\bar{\beta} = 1.013$. The bonding parameter (δ) is defined as $\delta = [(1-\bar{\beta})/\bar{\beta}] \times 100$, where $\bar{\beta} = \sum \beta/n$ and β (Nephelauxetic ratio) = v_c/v_a , v_c and v_a are energies of the corresponding transitions in the complex and aqua-ion, respectively, and n refers to the number of levels that are used to compute $\bar{\beta}$ values, resulted in $\delta = -1.27$. The bonding parameter depends on the environment field: δ can be received the positive or negative value indicating covalent or ionic bonding. In our sample, the values of β and δ bonding parameter are 1.013 and -1.27, respectively. Thus in this case the bonding of Sm³⁺ ions with the local host is ionic bonding [6, 8, 9, 10].

4. Spectral intensity and JO parameter

From the absorption spectral, the JO parameters have been calculated by using the Eq.(2) and the results are the Ω values of our sample in comparison with different host as displayed in the table 2. The characteristic feature of the Ω_2 is that it is sensitive to local environment of the Sm³⁺ ions and is often related with the asymmetry of the coordination structure, polarizability of ligand ions or molecules, and bonding nature [1,8,9,10]. We see that: The value of Ω_2 is small compared to other platforms may be related to the small and asymmetric links between the RE and O⁻ linked ion polarization should be small [5, 9, 10].

Table 2: The JO parameters of Sm³⁺ ions doped various hosts

Host matrix	Ω_2 ($\times 10^{20} \text{c}$ m^2)	Ω_4 ($\times 10^{20} \text{c}$ m^2)	Ω_6 ($\times 10^{20} \text{c}$ m^2)	Ref.
69B ₂ O ₃ .15Li ₂ O. 15Na ₂ O.1Sm ₂ O ₃ (gl ass)	1.02	4.20	5.17	Prese nt
67B ₂ O ₃ .12Li ₂ O. 20K ₂ O.1Sm ₂ O ₃ (glas s)	0.76	6.39	7.09	[4]
67B ₂ O ₃ .12Li ₂ O. 20Na ₂ O.1Sm ₂ O ₃ (gl ass)	0.88	3.93	4.65	[5]
K ₂ YF ₃ (crystal)	0.38	3.55	2.18	[9]
50.5Li ₂ CO ₃ - 39.5H ₂ BO ₃ (glass)	6.99	12.00	8.47	[4]
49.5Li ₂ CO ₃ - 49.5H ₂ BO ₃ (glass)	6.21	9.68	7.16	[5]
39.5Li ₂ CO ₃ - 59.5H ₂ BO ₃ (glass)	4.71	10.33	6.50	[5]
LiF-H ₂ BO ₃ (crystal)	2.34	7.54	5.40	[9]
PbO-PbF ₂ (crystal)	1.16	2.60	1.40	[9]

B. Fluorescence spectra and radiation characteristic displacement

1. Fluorescence spectrum

Fluorescence spectra measured in the wavelength ranges from 500nm to 750nm of Sm³⁺ in the alkali metal borate glass 69B₂O₃.15Li₂O.15Na₂O.1Sm₂O₃ at temperature room, sample is excited by light with a wavelength of 400nm of Xenon lamp source, results shown in figure 4. It exhibits four emission bands observed at the position 562nm, 600nm 646nm and 707nm which are assigned from high-level stimulus ⁴G_{5/2} to levels ⁶H_{5/2}, ⁶H_{7/2}, ⁶H_{9/2} and ⁶H_{11/2} transitions, respectively. The analysis fluorescence spectral shows: three bands intense but narrow line width 562nm, 600nm and 646nm, band at and 707nm have little strength is the wide range. On the other hand from the fluorescence spectra have also seen all 4 bands are overlapping each other a maximum of two (types are the same), as explained by the authors in [3,4,9], it is the splitting of the flow allows the electric dipole.

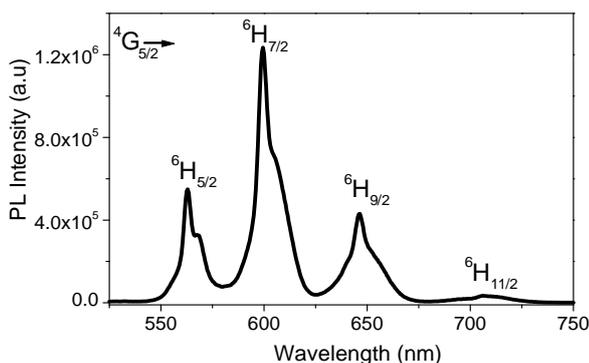


Fig.4. PL spectrum of Sm³⁺ in the alkali metal borate glass ($\lambda_{\text{ex}} = 400\text{nm}$)

To evaluate Sm³⁺ doped alkali metal borate glass performance on color luminescent emission, Commission International Eclairage 1931 (CIE) chromaticity coordinates for BLN: Sm³⁺ glass were calculated and represented as Fig. 5. The x and y values of CIE chromaticity coordinates were obtained as 0,5850 and 0,4234, respectively and this result is corresponding to hue of orange r in Fig. 5, the color purity is a measure of a color defined as the ratio of the space separation between white point (0,333; 0,333) and a given coordinate (x, y) and the distance from white point shaped locus intersection.

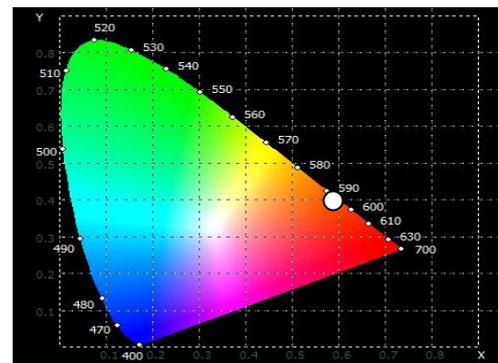


Fig 5. CIE chromaticity diagram for Alkali metal borate glass doped with Sm³⁺

2. The radiation characteristic displacement

On the basis of fluorescence spectra in Figure 4, using the formula from (3.5) to (3.10) we can determine the flow characteristics of radiation (fluorescence parameters) with the corresponding displacement intense (with large oscillator force from ⁴G_{5/2} to ⁶H_{5/2}, ⁶H_{7/2}, ⁶H_{9/2}, ⁶H_{11/2}): The stimulated emission cross section ($\sigma_{\lambda p}$), branching ratios (β_{mes}) were determined for the ⁴G_{5/2} as displayed in the table 3:

Table 3: The radiation characteristic displacement: nephelauxetic ratio (relative fluorescence intensity) calculated: β_{cal} and experimental β_{exp} and cross - section radiation calculations.

⁴ G _{5/2} →	λ_p (nm)	S_{edX} $10^{-20}/$ e^2	E ($\times 10^{-3}$)	A_{ed} (s^{-1})	β_{cal} (%)	β_{exp} (%)	$\sigma(\lambda_p)$ (cm^2)
⁶ H _{11/2}	-	-	1.40	34.9	12.60	-	-
⁶ H _{9/2}	650	6.57	1.55	70.6	25.50	31.10	0.465
⁶ H _{7/2}	600	9.79	1.67	145.0	52.40	49.30	0.600
⁶ H _{5/2}	560	5.72	1.78	6.04	2.18	19.6	0.26

Analysis the table 3 shows: nephelauxetic ratio β_R and emission cross section σ greatest value to the displacement ⁴G_{5/2} → ⁶H_{7/2}, followed by ⁴G_{5/2} → ⁶H_{9/2}; ⁴G_{5/2} → ⁶H_{5/2}. Such displacement of concern here is ⁴G_{5/2} → ⁶H_{7/2} is β_R and σ large, it makes sense to use the material for manufacturing lasers [9].

3. Cross – Relaxation channels

Fig. 6 presents the experimental decay curves obtained for different Sm³⁺ ion concentrations. The lifetimes of the ⁴G_{5/2} level have been determined and were showed in table 4. Lifetimes decrease with increase of Sm³⁺ ion concentrations in BLN glasses from 2.95 ms for 0.25 mol% to 1.62 ms for 5.0 mol%, which is due to concentration quenching [8, 11]. The discrepancy between the measured and calculated lifetime may be due to the additional non – radiative (include the multiphonon relaxation and the energy transfer process through cross-relaxation)

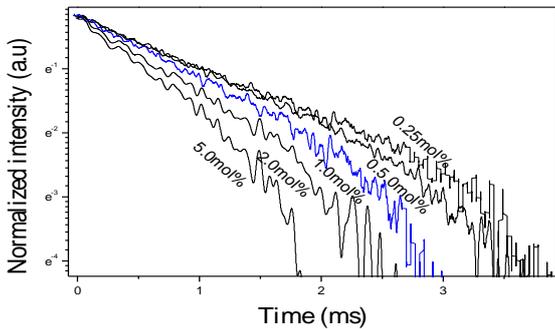


Fig. 6. Decay curves in sodium borate glasses for different Sm³⁺ ion concentrations

By using the Inokuti–Hirayama model, the fluorescence decay of BLN:Sm³⁺ with 0.25; 0.5; 1.0; 2.0 and 5.0 mol% of Sm³⁺ ions to have a best fitting with S = 6, where we used τ₀ value (~2.95 ms) obtained for the BLN doped with 0.25 mol% of Sm³⁺ ions. The parameter (S) is good as agreement with other reports [2, 9]. Energy transfer parameters Q, C_{DA} and critical distance (R₀) are calculated following (4) and (5): The results were shown in table 4. The value of S = 6 to noted that the dominant interaction for energy transfer through cross – relaxation is of dipole – dipole type.

Table 4. Variation of lifetime (τ, ms), quantum efficiency (η, %), cross-relaxation rate (W_{CR} s⁻¹), energy transfer parameter (Q), critical distance (R₀, Å) and donor-acceptor interaction parameter (C_{DA}, ×10⁻⁴² cm⁶/s) with respect to concentration (mol%) of Sm³⁺ ions in BLN glasses.

Concentrations	τ _{cal}	τ _{mes}	η	W _{CR}	Q	R ₀	C _{DA}
0.25	3.7	2.9	91.	82.8	-	-	-
	6	5	3				
0.5	3.6	2.8	89.	117.	0.4	4.2	5.17
	8	3	2	1	32	3	8.09
1.0	3.6	2.6	83.	175.	0.2	4.4	
	1	2	3	4	82	4	
2.0	3.1	1.9	69.	389.	0.7	4.7	15.4
	2	1	6	2	05	9	0
5.0	2.8	1.6	51.	1635	1.9	4.9	24.4
	8	2	3	.6	15	2	9

From the absorption and emission spectra of BLN:Sm³⁺ glasses, the energy level diagram of Sm³⁺ metal borate and was shown in Fig. 7.

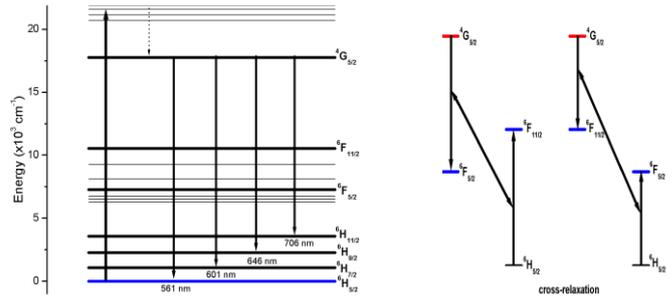


Fig 7. Energy level diagram and cross-relaxation channels for Sm³⁺ ions in BLiNa glasses

When Sm³⁺ ions are excited to the levels above the ⁴G_{5/2}, there is a fast non-radiative relaxation to this fluorescent level and and emission takes place from ⁴G_{5/2} level to its lower levels. The energy transfer process through cross – relaxation (CR) between the pair Sm³⁺ ions (as shown in Fig 7) leads luminescence quenching. The cross – relaxation channels in BLN glasses may be estimated to be (⁴G_{5/2} → ⁶F_{5/2}) → (⁶H_{5/2} → ⁶F_{11/2}) and (⁴G_{5/2} → ⁶F_{11/2}) → (⁶H_{5/2} → ⁶F_{5/2}) as the energy difference between these transitions are negligible. The cross – relaxation is due to the energy transfer from the Sm³⁺ ion in an excited ⁴G_{5/2} state to a near Sm³⁺ ion in the ground state ⁶H_{5/2} state. This transfer leads the first ion in the intermediate level of ⁶F_{5/2} (or ⁶F_{11/2}) at around 1373 nm (or 946 nm) and the second one in ⁶F_{11/2} (or ⁶F_{5/2}) at around 946 nm (or 1373 nm), which occur in resonance with the ⁴G_{5/2} → ⁶F_{5/2} (or ⁴G_{5/2} → ⁶F_{11/2}) transition. Then, from these states, the Sm³⁺ ions will relax to ground state by nonradiative relaxation. Thus, emission will be quenched.

V. CONCLUSION

Materials alkali metal borate glass with the ingredients: (70-x)B₂O₃.15Li₂O.15Na₂O.xSm₂O₃ as optical materials have high transparency, low melting point. Elements play a role luminescent center Sm³⁺ development of narrow line radiation mainly in the visible region (562nm, 600nm 646nm and 707nm), so this is one of the materials RE-doped glass can be used in the manufacture of lighting equipment visible region.

Analysis of absorption spectra by JO theory , we obtain values of the intensity parameters Ω₂ = 1.02×10⁻²⁰ cm²; Ω₄ = 4.20×10⁻²⁰ cm²; Ω₆ = 5.17×10⁻²⁰ cm². The Ω₂ parameter characterizing the asymmetry of the coordination structure , the polarization of the ligand and the nature of the link between the Sm³⁺ ions with other ions (O⁻, Li ..). Because the value of Ω₂ is smaller than the Sm³⁺ case when in the other glass [9]. This may be related to the small and asymmetric links between the RE and O⁻ linked ion (polarization is small).

Fluorescence spectra have four bands at 560nm, 600nm 650nm and 710nm corresponding to the shift from an excited state ⁴G_{5/2} to ⁶H_{5/2}, ⁶H_{7/2}, ⁶H_{9/2}, ⁶H_{11/2}. Analysis by JO theory tells nephelauxetic ratio β_R; emission cross section σ and lifetime is calculated to be quite long (τ = 3.61 ms) and the

displacement of the reduced lifetime of the stimulus ${}^4G_{5/2}$. the greatest value to the displacement ${}^4G_{5/2} \rightarrow {}^6H_{7/2}$ it makes sense to use the material for manufacturing lasers. Luminescence decay curves from the ${}^4G_{5/2}$ state of Sm^{3+} in BLN have been measured at room temperature. Energy transfer from the ${}^4G_{5/2}$ to the 6F_J states occurs studied for different Sm^{3+} ion concentrations in all samples glasses has been analyzed and the lifetimes are noticed to decrease with increase of concentration. The cross-relaxation mechanism is also discussed for BLN glass.

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