International Journal of Luminescence and applications
Vol6 (2) May, 2016, pages 128-130

Synthesis and Optical Properties of Lithium Tetra borate doped with Gd^{3+} ion

S. P. Bhagat[2], A. O. Chauhaan[1*], S. K. Omanwar[1]
[1]*Department of Physics, Sant Gadge Baba Amravati University, Amravati (MH), 444602 INDIA*
[2]*Department of Physics, R. A. Arts, M. K. & S. R. Rathi Science College, Washim (MH), 444505 INDIA*
** corresponding author :abhi2718@gmail.com*

Abstract
The phosphor emits narrow UVB emission plays a vital role for production of phototherapy lamps. The light output is in the form of a narrow line around 310-315 nm. The Inorganic borate phosphor Lithium Tetra borate (LTB) doped with Gd^{3+}has been prepared by a solid state diffusion technique. The formation of the sample was confirmed by powder X-ray diffraction (XRD). The spectroscopic property of prepared material was studied at room temperature using HITACHI 7000 spectrophotometer. Under the excitation of 275 nm, the phosphor $Li_2B_4O_7$ (LTB)shows emission at 313 nm (corresponds to $^6P_J \rightarrow {}^8S_{7/2}$ transition). Stokes shift of sample also been calculated (using corresponding excitation and emission wavelengths). The emission band of synthesized phosphor is in the narrowband ultraviolet (UV) region and hence it could be potential candidates for application in UV phototherapy lamps.

Keywords: *Phototherapy Lamp, Borate, Stoke shift, Narrowband UVB.*
PACS Code: *78.55-m*

INTRODUCTION

The use of ultraviolet radiation for ultraviolet therapy is well established [1, 2]. It has been reported that UV therapy is useful for treating more than 40 types of skin diseases and disorders such as such as psoriasis [3], or vitiligo [4], which could be treated by UV-B radiation, and lichen sclerosus [5], morphea [6] scleroderma [7], cutaneous T-cell lymphoma, lupus erythematosus [8], which could be treated by UV-A radiation. In the treatment of hyperbilirubinemia [9] commonly known as infant jaundice was treated by using UV radiation.

Ultraviolet B (UVB) has become the phototherapy treatment of choice for Psoriasis, Vitiligo, Atopic dermatitis (eczema) and other photo-responsive skin disorders. UVB can be divided as narrow-band UVB and broadband UVB. Broadband UVB radiation has been used for the treatment of Psoriasis for decades [10]. Various investigations imply that the most favorable range for the effective UVB treatment of Psoriasis is in the long-wavelength part of the UVB spectrum i.e., between 305 and 315 nm [11, 12]. A narrow UVB source emitting at about 311 nm was made available around 1988. This has revolutionized the UVB phototherapy. LaB_3O_6:Gd^{3+}, Bi^{3+} is a phosphor used in commercial narrow UVB phototherapy lamps. Sonekar *et al.* [13] reported borate host phosphor materials $LaBO_3$, LaB_3O_6, LaB_5O_9 and YBO_3 doped with Gd^{3+} ions for UV lamps.

In the present work, Gd^{3+} doped $Li_2B_4O_7$material was prepared by modified conventional solid state diffusion method. The phase purity of synthesize material was characterized using the powder XRD. After synthesis and characterization of the material, the photoluminescence property of the synthesized material was studied using a spectrofluorometer at room temperature.

2. EXPERIMENTAL

2.1 Synthesis of material

The phosphors $Li_2B_4O_7$ doped with Gd^{3+} was prepared by modified conventional solid state diffusion method [14]. The stoichiometric amounts of high purity (Analytical Reagent) starting materials Lithium nitrate ($LiNO_3$), Boric acid (H_3BO_3) and stock solution of Gadolinium nitrate ($Gd(NO_3)_3$)(99.99% purity) were used for preparation of phosphors. The stoichiometric amount of starting materials with little amount of double distilled water were mixed thoroughly in a china basin to obtain homogeneous solution. The solution was slowly heated at lower temperature at 90º C in order to remove the excess of water contents. The thick paste obtained after heating is then transferred into a microwave furnace maintained at 200°C for 1 hr. After that the temperature of microwave furnace was increased up to the 400°C and kept material for 1 hr. Then sample was grinded by using mortar pestle and faced to the microwave furnace maintaining at temperature 650°C for

International Journal of Luminescence and applications
Vol6 (2) May, 2016, pages 128-130

3hr then quenched to room temperature. The resultant powder sample was then characterized using powder XRD and Spectrofluorometer.

2.2. Characterization of samples

The phase purities of $Li_2B_4O_7:Gd^{3+}$ sample was studied using Rigaku miniflex II X-ray Diffractometer with scan speed of 6.000_/min and Cu Ka (k = 1.5406 Å) radiation in the range 10-70º. PL and PL excitation (PLE) spectra were measured on (Hitachi F-7000) fluorescence spectrophotometer at room temperature. The parameters such as spectral resolution, width of the monochromatic slits (1.0 nm), photomultiplier tube (PMT) detector voltage and scan speed were kept constant throughout the analysis of samples.

3. RESULT AND DISCUSSIONS

3.1. Structural properties

The XRD pattern of the $Li_2B_4O_7$ doped with Gd^{3+}phosphor as shown in Fig. 1. The XRD pattern agreed well with the International Center for Diffraction Data (ICDD) having card no.**01-079-0963**. Also the XRD show that synthesized phosphor was in single phase and completely in crystalline. The structure of Lithium tetra borate was tetragonal system, having space group 141 cd (101) wherelattice parameters a= b= 9.4790 Å, c= 10.2900 Å, α= β= γ= 90.

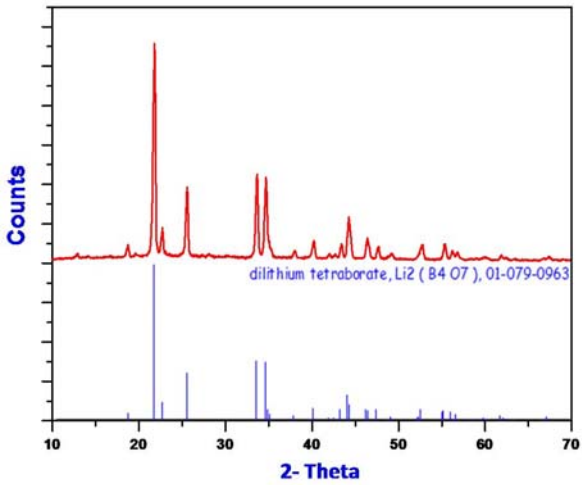

Fig 1. XRD pattern of $Li_2B_4O_7$ doped with Gd^{3+} ion.

3.3. Photoluminescence Analysis

Fig 2. represents the room temperature Photoluminescence spectra for sample of composition $Li_{1.99}Gd_{0.01}B_4O_7$. The phosphor gives sharp narrow emission in the UVB region around 313 nm corresponding to $^6P_{7/2} \rightarrow {}^8S_{7/2}$ transition under the excitation of 276 nm. This narrow UVB emission was very useful in the field of phototherapy treatment for treating the skin diseases like psoriasis, Vitiligo, Atomic dermatitis etc. In the emission spectra we alsoobserved weak line at 304 nm. These lines correspond to the $^6P_{5/2} \rightarrow {}^8S$ transitions of the Gd^{3+} ion. Finally the stoke shift was calculated to be 4283cm^{-1}

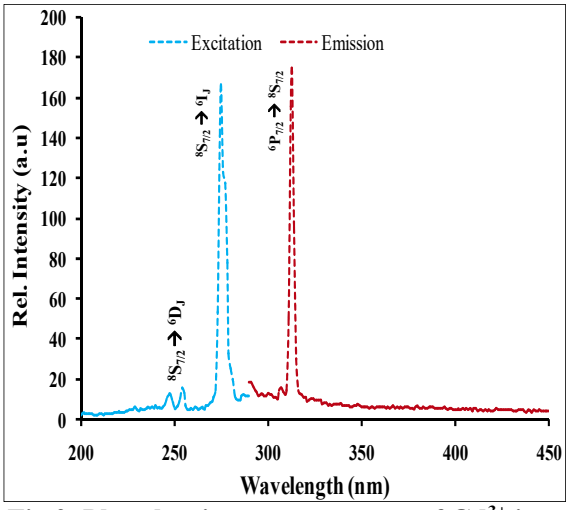

Fig 2. Photoluminescence spectra of Gd^{3+} ion activated $Li_2B_4O_7$ phosphor.

4. CONCLUSIONS

The inorganic narrow UVB emitting Lithium tetra borate phosphor doped with $Gd^{3+}$was successfully prepared by modified conventional solid state diffusion method. The XRD pattern of prepared sample found in agreements with the appropriate ICDD file and found to be in complete crystalline nature. Moreover the photoluminescence properties was studied, from that it is conclude that phosphor show sharp emission in the UV region, which is applicable for treatment of skin diseases.

The photoluminescence spectra represent that the $Li_2B_4O_7:Gd^{3+}$ gives pointed narrow UVB emission i.e. 313 nm attributed to $^6P_{7/2} \rightarrow {}^8S_{7/2}$ optical transition of Gd^{3+} ion under the excitation of 275 nm.The sharp narrow UVB emission and easy preparation make this phosphor a potential candidate as phototherapy lamp phosphor for treating many skin diseases.

ACKNOWLEDGEMENTS

One of the authors Abhijit O. Chauhan is thankful to the Chairman FIST-DST Project, SGBA University, Amravati (MH), PIN-444602 INDIA for providing XRD facility for this work.

REFERENCES

[1] K. Kaneko, Y. Takei, T. Aoki, S. Ikeda, H. Matsunami, S. Lynch, Int. Med., 39, (2000), 961.

[2] H. Dittmar, D. Pflieger, E. Schopf, J. Simon, Hautarzt., 52, (2001),423.

[3] H. Honigsmann, W. Brenuer, W. Rauschmeier, Am. Acad. Dermatol., 10,(1984),238.

[4] L. Scherschun, J. Kim, W. Lim, J. Am. Acad. Dermatol., 44, (2001), 999.

[5] A. Kreuler, T. Jansen, M. Stucker, M. Herde, K. Hoffmann, P. Altmeyer, G. Vonkobyletzki, Clin. Exp. Dermatol., 26, (2001), 30.

[6] J. Hawk, Radiat. Prot. Dosim., 91, (2000), 143.

[7] A. Morita, K. Kobayashi, I. Isomura, T. Tsuji, J. Krutmann, J. Am. Acad. Dermatol., 43, (2000), 670.

[8] T. Millard, J. Hawk, Lupus., 10, (2001), 185.

[9] C. Dani, E. Martelli, M. Reali, G. Bertini, G. Panin, F. Rubaltelli, J. Pediatrics., 138, (2001), 438.

[10] M. Weichenthal, T. Schwarz, Photodermatol. Photoimmunol. Photomed., 21, (2005), 260.

[11] H. van Weelden, H. Baart de la Faille, E. Young, J.C. van der Leun, Brit, J. Dermatol., 11, (1988), 119.

[12] B. Johnson, C. Green, T. Lakshmipathi, J. Ferguson, Light in biology and medicine, Plenum Press, NY, London, 1988, pp. 173.

[13] R. Sonekar, S. Omanwar, S. Moharil, S. Dhopte, P. Muthal, V. Kondawar, Opt. Mater., 30, (2007), 622.

[14] C. Palan, N. Bajaj, S. Omanwar, Mat. Rese. Bull., 76,(2016), 216.