International Journal of Luminescence and applications
Vol6 (4) January, 2017, **ISSN 2277 – 6362**

Sharp red, green and blue emissions from Gd^{3+} doped $Y_4Al_2O_9$ phosphor for display and sensing applications

[1]Vikas Dubey, [2]Jagjeet Kaur, [2]Neha Dubey, [2]Yogita Parganiha,
[3]Ravi Shrivastava, [4]K. V. R. Murthy

[1]Department of Physics, Bhilai Institute of Technology Raipur, India, 493661
[2]Department of Physics, Govt. V.Y.T.PG., Auto. College, Durg, C.G., India, 491001
[3]Department of Physics, ICFAI University, Kumhari, Raipur, India
[4]Display Materials Laboratory, Applied Physics Department, Faculty of Technology and Engineering, The M. S. University of Baroda, Vadodara – 390001 India
Corresponding author: jsvikasdubey@gmai.com H/P0091 9826937919

Abstract *- The present paper reports synthesis of gadolinium doped yttrium aluminum phosphor having monoclinic structure knows as YAM phosphor. The phosphor was prepared by solid state reaction method and PL emission spectra monitored under UV excitation. It is found that the PL excitation spectra centered at 260nm (broad excitation) having sharp peak centered at 275nm (self transition of Gd^{3+} ion). Under 260nm excitation the emission spectra monitored and found the sharp peaks at 488, 542, 592 and 618nm. The highest intense peak (red emission) is due to intense electric dipole transition. Corresponding spectroscopic parameters are calculated using CIE technique. It is proposed that the prepared phosphor may be useful for display and sensing applications*

.***Keywords:*** *display device applications; gadolinium doped phosphor; YAM phosphor*

1. INTRODUCTION

The Yttria – Alumina system has several phases, including $YAlO_3$ (YAP: Yttrium Aluminium Polymorphs), $Y_4Al_2O_9$ (YAM: Yttrium Aluminium Monoclinic), and $Y_3Al_5O_{12}$ (YAG: Yttrium Aluminium Garnet). Commonly, YAP and YAM form as an intermediate product of YAG phase in solid state reactions. Even if YAG is synthesized with a stochiometric mixture of Y_2O_3 and Al_2O_3, two detrimental phases, YAP and YAM, often co- 3+ exist as by-products [1, 2]. We have deliberately synthesized single phase YAM:Eu by conventional solid state reaction technique and investigated the luminescence properties in 3+ detail to see the effect of changed crystal field in Eu emission characteristics. The 3+ luminescence properties of YAM:Eu under UV excitation was reported earlier by many researchers for different applications [3–4]. However, very few reports [5-10] are 3+ available on the VUV excitation properties of YAM:Eu for PDP application so far. To the best of our knowledge, we report for the first time Gd^{3+} doped YAM that is highly efficient, degradation controlled pure red-emitting phosphor with additional feature of blue and green emission for advanced PDPs.

2. EXPERIMENTAL

The samples were prepared by solid state reaction method. The ingredients used were Y_2O_3, Al_2O_3, CeO_2 and H_3BO_3 as flux. Stoichiometric amounts of all material were taken in agate mortar and pestle and thoroughly ground for nearly 45 minutes to homogenize the mixture and kept in an alumina crucible then fired in air in a muffle furnace at 1000^0C for 1 hour for calcinations then 1200^0C for 3 hour for sintering. Every heating was followed by dry grinding. Finally the samples were cooled slowly to room temperature in the furnace and ground again into powder for subsequent characterization [9-10].
The photoluminescence (PL) emission and excitation spectra were recorded at room temperature by use of a Shimadzu RF-5301 PC spectrofluorophotometer. The excitation source was a Xenon lamp.

3. RESULTS AND DISCUSSION

Figure 1 shows the PL excitation and emission spectra of YAM:Gd^{3+} phosphor monitored at 618 nm.

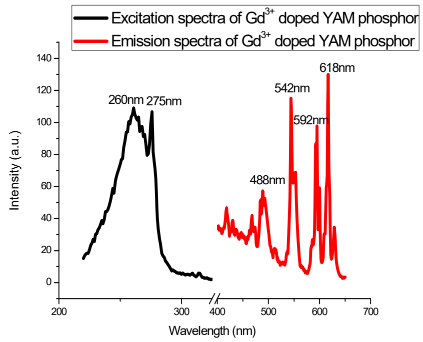

Fig. 1 PL excitation and emission spectra of $YAM:Gd^{3+}$ phosphor

The peak centered at 260 nm corresponds to higher energy $^8S_{7/2}$- ^6D_J transitions of Gd^{3+}. Similarly the peak 275nm is also the transition of Gd^{3+} ion. For excitation of 260nm, the peaks in the visible region in the emission spectra may be due to transition from ^6G_J state. The peak at 542 nm may be due to stark level transition from the ^6G_J state of Gd^{3+}ion. The red emission peaks at 612 nm corresponds to ^6G_J-^6P_J transition.

3.1 CIE co-ordinates

The luminous colour was depicted by studying colour co-ordinates and colour ratios of $YAM:Gd^{3+}$phosphor. The values of chromaticity coordinates of the YAM powder has been estimated from 1931 CIE system and is shown in **Figure 2**. It was observed that the Commission Internationale de l'Eclairage (CIE) co-ordinates of YAM phosphor were measured as (x, y) and the value is found in blue, green and red region covered white line boundary [11, 14]. Their corresponding location has been marked in **Figure 2** with cross in white line boundary region.

$$ColourPurity = \frac{\sqrt{(x_s - x_i)^2 + (y_s - y_i)^2}}{\sqrt{(x_d - x_i)^2 + (y_d - y_i)^2}} \times 100\% \quad ....(1)$$

where (x_s, y_s) are the coordinates of a sample point, (x_d, y_d) are the coordinates of the dominant wavelength and (x_i,y_i) are the coordinates of the illuminant point. The calculation was carried out. The color purity is found nearly 91% of Gd^{3+} doped phosphor

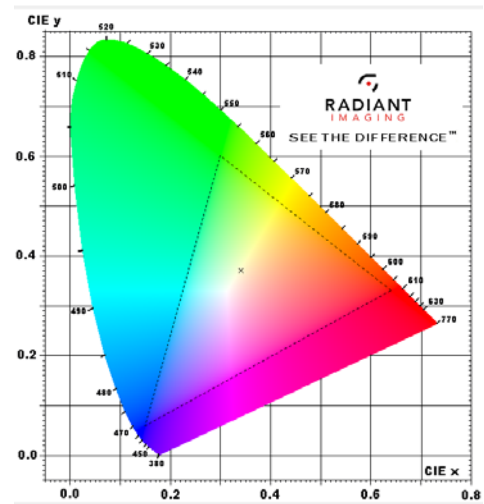

Figure 2 CIE coordinate for $YAM:Gd^{3+}$ phosphor

CONCLUSIONS

It is concluded that from above study the YAM phosphor having monoclinic structure shows good spectroscopic properties such as color rendering index is high nearly 91% which is suitable for LED, WLED etc. and some peaks at orange – red region (592 and 618nm) shows the prepared phosphor may be useful for PDP applications.

REFERENCES

[1] V. Dubey, J.Kaur, S. Agrawal, N.S.Suryanarayana, KVR Murthy, Optik – Int. J. Light Electron Opt. (2013), doi 10.1016/j.ijleo.2013.03.153.
[2] V. Dubey, N.S.Suryanarayana., J. Kaur, Kinetics of TL Glow Peak of Limestone from Patharia of CG Basin (India), Jour. Miner. Mater.Charac.Engin., 9(12) (2010) 1101-1111.
[3] V. Dubey, J. Kaur, N.S. Suryanarayana, K.V.R.Murthy, Res. Chem. Intermed. (2012). doi: 10.1007/s11164-012-0872-7.
[4] V. Dubey, J.Kaur, S. Agrawal, Res. Chem. Intermed.(2013).DOI 10.1007/s11164-013 1201-5.
[5]V. Dubey, J. Kaur, S. Agrawal; N.S. Suryanarayana, K.V.R.Murthy, Superlattices and Microstructures 67 (2014) 156–171.
[6] J. Kaur, Y. Parganiha, and V. Dubey, "Luminescence Studies of Eu^{3+} Doped Calcium Bromofluoride Phosphor," Physics Research International, vol. 2013, Article ID 494807, 5 pages, 2013. doi:10.1155/2013/494807.
[7] Y. Parganiha, J. Kaur, V. Dubey, D. Chandrakar, Superlattices and Microstructures 77, 152–161 (2015)
[8] Y. Parganiha, J. Kaur, V. Dubey, KVR Murthy, Materials Science in Semiconductor Processing 31 (2015) 715–719

[9] V Dubey, R Tiwari, RK Tamrakar, J Kaur, S Dutta, S Das, HG Visser, S. Som, Journal of Luminescence 180 (2016) , 169-176.
[10] V Dubey, J Kaur, Y Parganiha, NS Suryanarayana, KVR Murthy, Applied Radiation and Isotopes 110 (2016), 16-27.
[11] W. G. Lee., D. H. Lee Y. K. Kim, J. K. Kim and J. W. Park J. Nucl. Sci. and Tech., Supplement 4, (2008) 572-574.
[12] M. D Dramicanin., V. Jokanovic, E.Antic-Fidancev, M. Mitric, Z.Andric, Jour. Alloys Comp. 424 (2006) 213-217.
[13] S. Som, A. K. Kunti, V. Kumar, V. Kumar, S. Dutta, M. Chowdhary, S. K. Sharma, Terblans J. J., and Swart H. C., Journal of Applied Physics 115, 193101 (2014).
[14] Y. C. Fang, S. Y. Chu, P.C. Kao, Y. M. Chuang, Z. L. Zeng, J. Electrochem. Soc. 158, (2014)