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Synthesis and Characterization of Eu^{3+} doped YBO_3 Phosphor

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Abstract

The present paper reports that Thermoluminescence (TL) glow curve and kinetic parameter of Eu^{3+} doped YBO_3 phosphor irradiated by Ultra - Violet (UV) source. Sample was prepared by solid state preparation method. Sample was characterized by X-ray diffraction(XRD) analysis and particle size was calculated by Debye – Scherrer formula. The heating rate used for TL measurements are $6.7^0C\ sec^{-1}$. The samples display good TL peaks at 149^0C and 150^0C. The corresponding kinetic parameters are calculated. The photoluminescence (PL) excitation spectrum at 251nm monitored with 400nm excitation and the corresponding emission peaks at 593, 612 and 627nm are reported.

***Key words**: Kinetic parameters, Thermoluminescence study of YBO_3.*

1.0 Introduction:

Borate compounds are taken to study thermoluminescence because of their low cost and easy handling process and are suited for radiation therapy and clinical application. Most of the pure borates are less efficient but to increase their TL output, dopants are used [1,2]. $(Y,Gd)BO_3:Eu^{3+}$ is one of the best phosphors available for the red primary of the color picture in plasma display panels (PDPs) and a possible new generation of Hg-free fluorescent lamps, due to their high vacuum ultraviolet (VUV) transparency and exceptional optical damage threshold [3,4]. However, the luminescent efficiency of $(Y,Gd)BO_3:Eu^{3+}$ is relatively low according to the phosphors used in cathode radial tube (CRT) and fluorescent lamps [5]. In PDP, the phosphor materials should have good photoluminescence characteristic under the illumination of vacuum ultraviolet (VUV) photons, such as high luminescence efficiency, good chromaticity, chemical and environment stability and long lifetime. However, the characteristic emission of $YBO_3:Eu^{3+}$ is composed of almost equal contributions of $^5D_0–^7F_1$ and $^5D_0–^7F_2$ transitions, which give rise to an orange-red emission instead of red and thus hampers its application. The latter transitions are hypersensitive to the symmetry of the local crystal fields surrounding the Eu^{3+} ions, and they are relatively strong when the symmetry of the crystal field is relatively low.

In the present study YBO_3 doped with $Eu^{3+}$is used and its TL glow curve is plotted and its kinetic parameters like activation energy, frequency factor, trap depth and order of kinetics were calculated. Photoluminescence excitation and emission spectra are recorded.

2.0 Experimental Method:

By solid state reaction process, Y_2O_3, Eu_2O_3 and H_3BO_3 were mixed in stoichiometric ratio by dry grinding in mortar and pestle for nearly 45 minutes. The mixture is taken in quartz boats and is fired in air at 500^0C for 1 hour, 1000^0C for 1 hour and 1250^0C for another 1 hour. The sample was characterized by XRD. The XRD measurements were carried out using Bruker D8 Advance X-ray diffractometer. The X-rays were produced using a sealed tube and the wavelength of X-ray was 0.154 nm (Cu K-alpha).

The x-rays were detected using a fast counting detector based on Silicon strip technology (BrukerLynxEye detector). 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. Thermally stimulated luminescence glow curves were recorded at room temperature by using TLD reader I1009 supplied by NucleonixSys.Pvt.Ltd. Hyderabad [6-8]. The obtained phosphor under the TL examination is given UV radiation using 365nm UV source. Heating rate used for TL measurement is $6.7^{0}Cs^{-1}$.

3.0 Results and Discussion:

The XRD pattern of the sample is shown in figure 1. The width of the peak decreases as the size of the particle increases. The size of the particle has been computed from the full width half maximum (FWHM) of the intense peak using Debye Scherer formula. Particle size of sample in the range 2.1µm is found. Formula used for calculation is

$$d = \frac{0.9\lambda}{\beta \cos\theta}$$

Here d is particle size

βis FWHM (full width half maximum)

λis the wavelength of X ray source

θis angle of diffraction

d = 0.9*1.54/0.345*Cos (27.12) = 2.1µm

For XRD pattern corresponding miller indices values are calculated which match with JCPDS card no. 16-0277 [9] as shown in Figure 1. Sample show hexagonal structure.

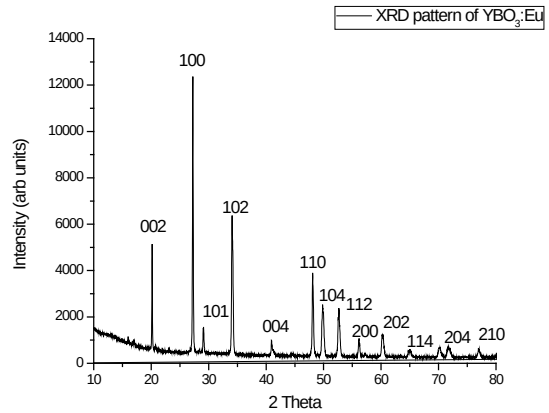

Figure 1 XRD pattern of Eu^{3+} doped YBO_3 phosphor

3.1 Photoluminescence (PL) Study

Fig. 2 and 3 shows the excitation and emission spectrums of Eu^{3+} doped YBO_3 phosphor using inorganic materials taking oxide form. Under different excitation 400 and 251 nm monitored for recording PL spectra. This phosphor shows good emission range from 593 to 627nm which indicates red emission of prepared phosphor.

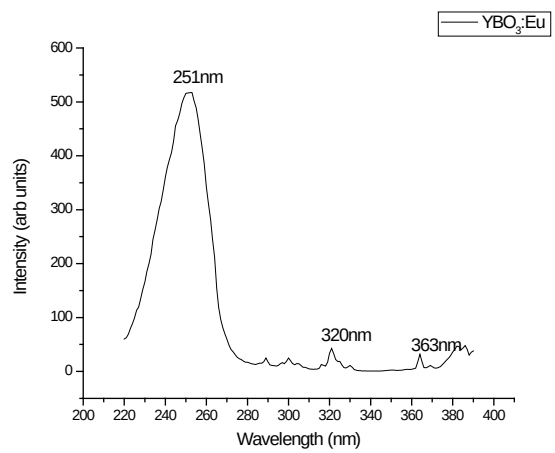

Figure 2 YBO_3: Eu^{3+} doped phosphor monitored with 400nm excitation

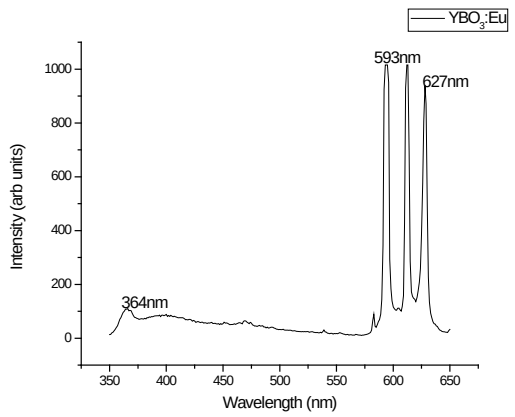

Figure 3 Emission spectra of YBO_3:Eu doped monitored with 254nm excitation

3.2 TL glow curve of Eu^{3+} doped YBO_3 phosphor:

This paper reports the trapping parameters such as trap-depth (E), escape frequency factor (s) and "order of kinetics" for the glow peaks obtained under UV excitation. The TL glow curve YBO_3:Eu^{3+} phosphor shows second order kinetics. The sample was irradiated with UV source giving a dose of 5 and 10 min UV exposure and the heating rate used for TL measurements are 6.7^0Cs^{-1}. The samples display good TL peaks at 149^0C and 150^0C. The corresponding kinetic parameters such as activation energy (E), order of kinetics (b) and frequency factor (s) are calculated are shown in Table 1.

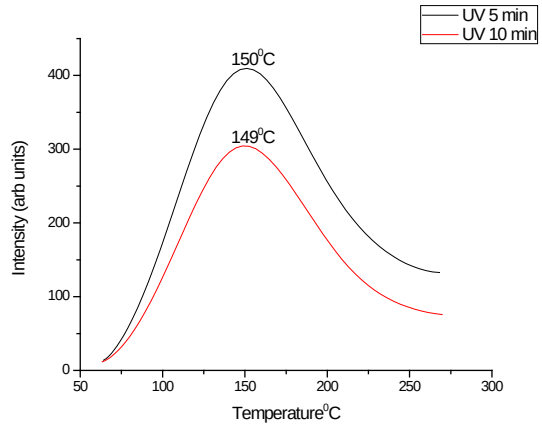

Figure 4 TL glow curve of YBO_3:Eu^{3+} doped phosphor

4.0 Conclusion

It has been concluded that from above study Eu^{3+} doped YBO_3 phosphor gives the intense peak at red emission from PL study. The structure of that sample is hexagonal. It can be concluded from the XRD that the sample is in a mixed phase. Sharp peak indicates microcrystalline behavior of the rare earth (RE) doped phosphor. The calculated crystalline size is 2.1µm. The photoluminescence excitation spectrum at ~251nm and the corresponding emission spectrum peak at visible region are reported.

References;

[1] C. Furetta, M. Prokic, R.Salamon, V. Prokic, G.Kitis, Nucl.Instr. and Meth. A456, 411 (**2001**).

[2] J. Li, J.Q. Hao, C.Y.Li, C.X. Zhang, Q. Tang, Y.L. Zhang,Q.Su, S.B Wang, Radiat. Meas. 39, 229 (**2005**).

[3] C.H. Kim, I.E. Kwon, C.H. Park, Y.J. Hwang, H.S. Bae, B.Y. Yu, C.H. Pyun, G.Y. Hong, J. Alloys Compounds 311 (**2000**) 33.

[4] C.R. Ronda, T. Justel, H. Nikol, J. Alloys Compounds 669(**1998**) 275.

[5] C.R. Ronda, J. Lumin. 72-74 (**1997**) 49.

[6]KaurJagjeet, Suryanarayana N.S., DubeyVikas and Neha Rajput, Research journal of chemical sciences, Vol 1(6), **2011**

[7] VikasDubey, Suryanarayana N.S., JagjeetKaur, Kinetics of TL Glow Peak of Limestone from Patharia of CG Basin (India), Jour. Miner.Mater.Charac.Engin., 9(12) 1101-1111, (2010).

[8] VikasDubey, JagjeetKaur, N.S. Suryanarayana, K.V.R.Murthy, Res. Chem. Intermed. (2012). doi: 10.1007/s11164-012-0872-7.

[9] Newnham, santero, jour. Am. Ceremic Soci.46, 253, (1963)

TABLE 1 : shape factors (μ), Activation Energy E and Order of Kinetics b of UV irradiated $YBO_3:Eu^{3+}$ doped phosphor

UV min	T_1	T_m	T_2	τ	δ	ω	μ = δ / ω	Order of kinetic (b)	Activation energy (E) (eV)	Frequency factor (s) s^{-1}
5 min UV	104	149	198	45	49	94	0.52	2	0.51	1×10^7
10 min UV	104	150	210	46	60	106	0.56	2	0.51	1×10^7