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### **PL & TL study of synthesized LaYPO<sub>4</sub>: Gd, Eu Phosphor**

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#### **ABSTRACT**

The present paper reports the synthesis and PL, TL study of the LaYPO<sub>4</sub> phosphor doped with Gd & Eu rare earth ions keeping Gd concentration constant (0.5%) and varying Eu concentration as 0.1, 0.5, 1.5, and 2% is described. The phosphors were synthesized using the standard solid state reaction technique and ground using mortar and pestle, fired at 1200°C for 3 hour in a muffle furnace. The produced materials were analyzed by XRD, PL and TL. We have studied the effect of dopants on the Photoluminescence and thermoluminescence properties of LaYPO<sub>4</sub> phosphor. Under the excitation of 254 nm wavelength, PL properties of the samples were studied using Spectrofluorophotometer at room temperature. PL emission of doped LaYPO<sub>4</sub> phosphor shows peaks at 365, 397, 469, 475, 589, 596, 614 and 622nm with good intensity. As the Eu concentration increases the PL intensity also increases.

**Keywords:** Photoluminescence; XRD; phosphor rare-earth ions; solid state reaction technique; thermoluminescence.

#### **INTRODUCTION**

The useful applications of rare earth element compounds, especially lanthanide phosphate doped inorganic materials, have been touched upon broadly. Over the past a few years, they have been applied. Various solution-phase routes, including solid state reaction, sol-gel, precipitation

have been tried to lower the reaction temperature and obtain high-quality LaYPO<sub>4</sub> based nanoparticles. Phosphors are widely used in displays and lighting devices. The phosphor particles must have good characteristics such as their high brightness, fine size and narrow size distribution for application in PDP. We adopted the standard solid state reaction technique to prepare LaYPO<sub>4</sub> with good morphologies and fine crystal structures. However, the simple and mass fabrication of LaYPO<sub>4</sub> nano crystals with narrow grain size distribution and uniform morphology still remains a challenge. TLD is one of the good techniques to measure absorbed dose. Many investigators are invented different TL dosimeter. But very few lamp phosphors are studied for TL dosimeter.(1-3). The thermo luminescence examination of phosphors brings out lot of information and throws light on the use of materials as TL dosimeter (3-5). In present paper, the TL spectra of synthesized phosphors have been recorded at room temperature.

## MATERIALS AND METHOD

The base sample LaYPO<sub>4</sub> and LaYPO<sub>4</sub> phosphor doped with rare-earth ions were prepared using solid state synthesis method. Stoichiometric proportions of raw materials namely, Lanthanum Oxide (La<sub>2</sub>O<sub>3</sub>), Yttrium Oxide (Y<sub>2</sub>O<sub>3</sub>), Di ammonium Hydrogen Phosphate [(NH<sub>4</sub>)<sub>2</sub> H PO<sub>4</sub>], Europium Oxide (Eu<sub>2</sub>O<sub>3</sub>), Gadolinium Oxide (Gd<sub>2</sub>O<sub>3</sub>) were grinded in an agate motor and mixed and compressed into a crucible and heated at 1200<sup>0</sup>C for 3 hour in a muffle furnace. The prepared samples were again powdered for taking the measurements.

The excitation & emission spectra were recorded at room temperature using (SHIMADZU, make Spectrofluorophotometer RF – 5301 PC) using Xenon lamp as excitation source at display research Lab., Department of Applied Physics, M.S.U. Baroda.. The emission and excitation slit were kept at 1.5 nm. Samples were irradiated by β-rays using Sr-90 as a natural soures for β-rays.TL glow curve are recorded at room temperature by using TLD reader 11009 supplied by Nucleonix systems Pvt.Ltd, Hyderabad.

## RESULT AND DISCUSSION

### Phase purity and structure:

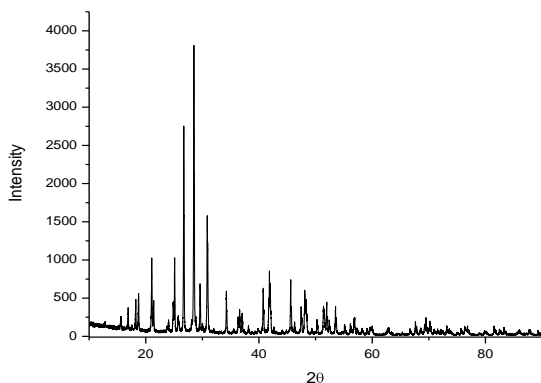


Fig.1. XRD pattern of LaYPO<sub>4</sub>

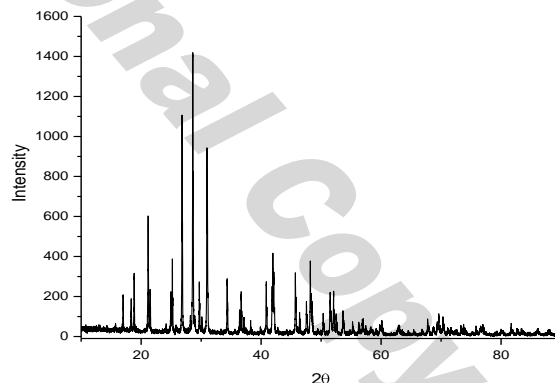


Fig.2. XRD pattern of LaYPO<sub>4</sub>:Gd:Eu

The crystallinity and phase purity of the product were firstly examined by XRD analysis. Fig 1 and 2 shows the typical X-ray diffraction (XRD) patterns of synthesized samples of pure LaYPO<sub>4</sub> and LaYPO<sub>4</sub> doped with Gd, Eu. The XRD pattern of LaYPO<sub>4</sub>: Gd, Eu is similar to that of bulk powder except for the much broader peaks [14]. The peaks in the diffraction pattern seems to match with those of LaYPO<sub>4</sub> (JCPD no.- 32-0493) indicating monoclinic phase of monazite structure. The main peak was found around 28.7° corresponding to a d- value of about 3.12Å, followed by other less intense peaks corresponds to the monoclinic system of crystal structure of Lanthanum Yttrium Phosphate[5-7]. All diffraction patterns were obtained using CuKα radiation (λ = 1.540598 Å) at 40 kv and 30 mA, and divergence slit fixed at 1.52 mm. Measurements were made from 2θ = 10° to 80° with steps of 0.008356°.

The crystallite size of particles of powder sample were calculated by using Scherer equation  $D = 0.9 \lambda / \beta \cos \theta$

Where β represents full width at half maximum (FWHM) of XRD lines

λ = Wavelength of the X-rays.(0.154 nm in the present case)

θ = Bragg's angle of the XRD peak.

### Photoluminescence Study:

Fig.3. and fig. 4. Represents the emission spectra of LaYPO<sub>4</sub>.The PL emission of undoped LaYPO<sub>4</sub> phosphor was observed at 470 nm under the excitation of 254 nm wavelength perfect blue region with very good intensity. The emission spectra of LaYPO<sub>4</sub>: Gd (0.5%) and Eu with varying concentration are shown in fig.4 reveals the modification of the emission wavelength of pure phosphor. The peaks at 365,397,469,475,589, 596, 614 and 622 nm corresponding to orange red colour are derived from the allowed magnetic dipole moment transition [<sup>5</sup>D<sub>0</sub>→<sup>7</sup>F<sub>1</sub>], whose intensity is affected by the crystal environment surrounding Eu.(8,9)The peak at 614 nm corresponding to red colour are generated from the forced electric transition [<sup>5</sup>D<sub>0</sub>→<sup>7</sup>F<sub>2</sub>].The Eu ions allow to occupy a site without inversion center. The intensities <sup>5</sup>D<sub>0</sub>→<sup>7</sup>F<sub>3</sub> and <sup>5</sup>D<sub>0</sub>→<sup>7</sup>F<sub>4</sub> are highly suppressed as compared to the intensified <sup>5</sup>D<sub>0</sub>→<sup>7</sup>F<sub>1</sub>→<sup>5</sup>D<sub>0</sub>→<sup>7</sup>F<sub>2</sub>.(12,13)

Sr. No.	Chemical Formula of the Sample	PL Emission Peak Wavelength (nm)	PL Emission Peak Intensity (arb.u.)
1	2LaYPO <sub>4</sub> : Gd(0.5%), Eu(0.5%)	365, 398, 469, 589, 595, 613	165, 112, 76, 41, 39, 39
2	2LaYPO <sub>4</sub> : Gd (0.5%), Eu(1.0 %)	365, 396, 451, 469, 535, 589, 594, 613	174, 118, 69, 78, 36, 111, 121, 136
3	2LaYPO <sub>4</sub> : Gd (0.5%), Eu(1.5%)	365, 398, 468, 536, 589, 593, 613	150, 121, 76, 39, 188, 183, 192
4	2LaYPO <sub>4</sub> : Gd (0.5%), Eu(2.0 %)	365, 398, 468, 535, 589, 595, 613	155, 118, 72, 37, 174, 184, 206

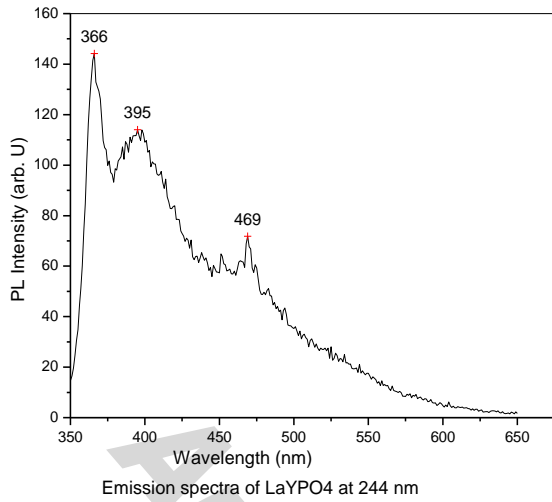


Fig. 3. Emission spectrum of LaYPO<sub>4</sub>

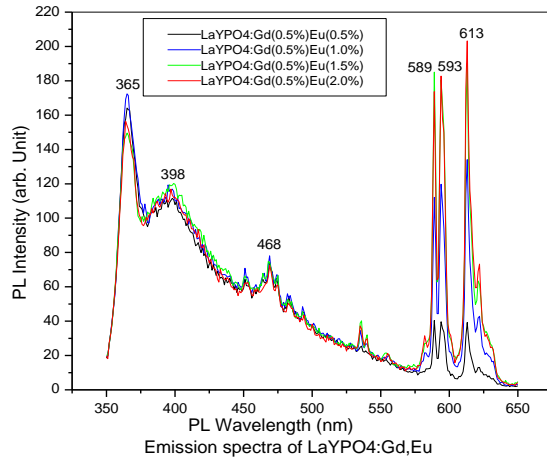


Fig. 4. Emission spectrum of LaYPO<sub>4</sub>:Gd, Eu

### Thermo luminescence Study:

The all TL glow curves are recorded at room temperature. Figure 5 represents TL glow curve of LaYPO<sub>4</sub> sample with 20 Gy beta irradiation. The glow curve exhibit one peak at 257.98°C temperature. But same phosphor doped with Gd (0.5%) constant and Eu with varying concentrations synthesized exhibit one emission peaks at 114°C & other emission peck at 229°C & other emission peck at 229°C & other emission peck at 229°C with increasing intensity as shown in figure 6.

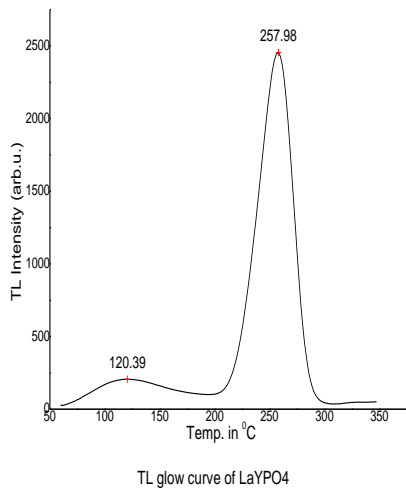


Fig.5. TL curve of LaYPO<sub>4</sub>

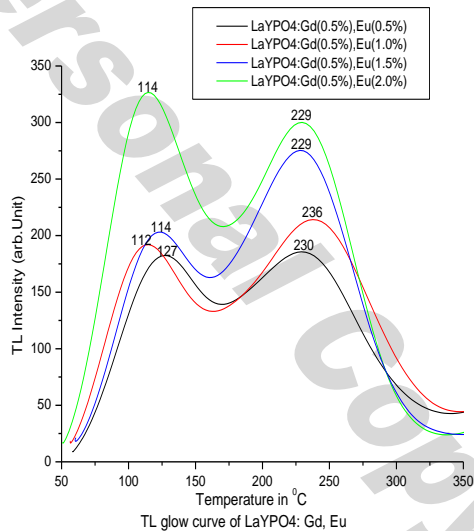


Fig.6. TL glow curve of LaYPO<sub>4</sub>:Gd, Eu

## CONCLUSION

LaYPO<sub>4</sub> phosphor doped with Gd, Eu rare earth ions keeping Gd concentration constant (0.5%) and varying Eu concentration as 0.1, 0.5, 1.5, and 2% were prepared using solid state synthesis method are successfully synthesized. The main peak in XRD pattern was found around 28.7° corresponding to a d-value of about 3.12 Å, followed by other less intense peaks corresponds to the monoclinic system of crystal structure of Lanthanum Yttrium Phosphate. The photoluminescence and thermoluminescence properties of the material are studied. As Eu concentration increases PL & TL intensity also increases.

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