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Synthesis and Characterization of Trivalent RE Codoped Lanthanum Phosphate Nano Phosphor

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Abstract: The present paper studies the synthesis, Photoluminescence (PL) of the $LaPO_4$ phosphor doped with Ce, Eu and Tb rare-earth ions, keeping Ce, Eu concentration constant and varying Tb concentration as 0.1, 0.5 and 1.5% is described. The phosphors were synthesized using the standard solid state reaction technique and grounded using mortar and pestle, fired at 1200^{o}C for 1 hour in a muffle furnace. The effect of dopants on the Photoluminescent properties of the samples was studied using Spectrofluorophotometer at room temperature. PL emission of undoped $LaPO_4$ phosphor was observed at 470 nm. Under the excitation of 254nm wavelength, PL emission of doped $LaPO_4$ phosphor shows peaks at 381, 415, 437, 457, 473, 488, 545, 589, 596, 614 and 622nm with good intensity. As the Tb Concentration increases the PL intensity also increases.

Keywords: Phosphor, photoluminescence, solid state reaction technique, excitation spectrum, emission spectrum.

1. INTRODUCTION

Making of nano phosphors has taken a most demand by industries due to the potential of its applicability in various fields like PDPs, LEDs, etc. and modify it according to the needs today. Solid state reaction has been used as a very common technique to develop phosphor either at laboratory level or commercial level, but there is a remarkable shift in the paradigm with the advent of nanotechnology which is now driving the industry forward towards an unknown and unprecedented phase, where the small is gaining and the big losing literally. Nanometer-sized phosphor powders exhibit good spectroscopic properties that are different from their micrometer-sized counterparts. Generally, the observed luminescence in nanocrystalline materials has been explained using two arguments: (i) luminescence is dominated by quantum confinement effects and (ii) luminescence is dominated by defect interactions and chemical species. For the last one and half decade the nanotechnology, with size limitation of less than 100nm, has been moving at a pace and gaining momentum, research in this field is becoming more and more active. In this regard the phosphor research has also awakened to the challenge and new and better materials with the size limitations are being pursued rigorously. A number of publications have appeared on the same and the effect on the size with the effect on the optical property has been a topic of great interest today. The goal of this research effort was to develop a comprehensive understanding of the factors that affect the luminescence behavior and study the optical properties of synthesized (using sol-gel method) nano crystal phosphors with crystallite sizes less than 100nm.

2. EXPERIMENTAL DETAILS

The samples were synthesized by standard solid state reaction technique. To prepare $LaPO_4$ host phosphor, the starting chemicals, Lanthanum oxide and Diammonium hydrogen phosphate of assay 99.9% were taken in appropriate stiochiometry of 1:2. They weighed, mixed and grounded using agate mortar and pestle for 1 hour to make fine powder. The samples were heated at 1200^{o}C for 1 hours using muffle furnace. The same method was followed to prepare $LaPO_4$: Ce,Eu,Tb phoshors. The photo-luminescence spectra were recorded at room temperature using Spectrofluoro-photometer (SHIMADZU, RF-5301 PC) using Xenon lamp as excitation source.

3. RESULTS AND DISCUSSION

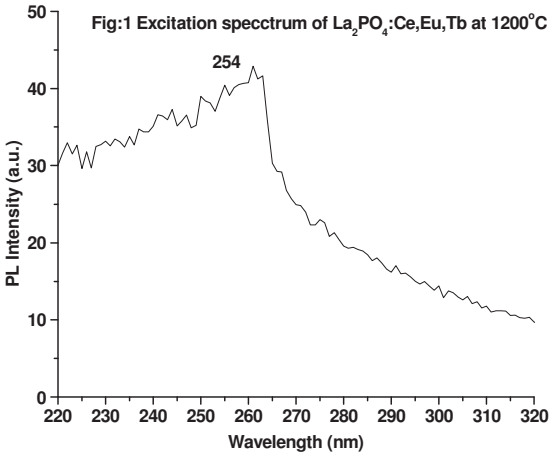

Fig. 1 shows the excitation spectrum of $LaPO_4$: Ce,Eu,Tb phosphor When excited with 254nm wavelength the corresponding PL emission mainly concentrates around 470nm. Under the same excitation, PL emission of doped

$LaPO_4$ phosphor is quite interesting and covers almost entire visible range and shows peaks at 381, 415, 437, 457, 473, 488, 545, 589, 596, 614 and 622nm with good intensity .It should be observed from fig:2, that as the concentration of Tb increases the luminescence also increases at all the emitted wavelengths but there is enormous increase at 488nm and 545nm ie., perfect green region which indicates the effect of primary emissions of Terbium .

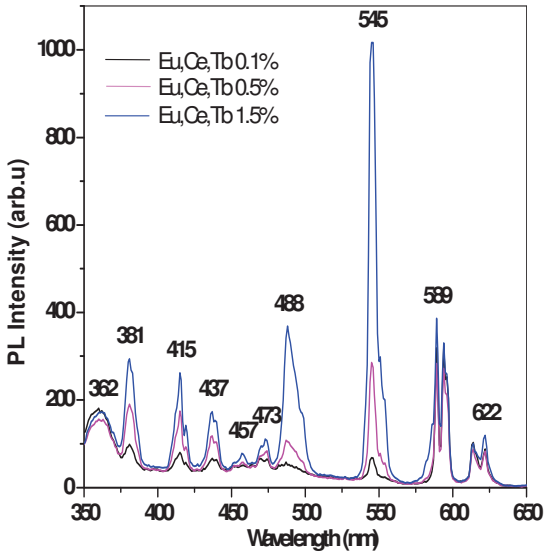

Fig.2:Emission spectrum of La_2PO_4:Eu,Ce,Tb with 254nm excitation

4. CONCLUSION

The crystallite size calculated using shearers formula is 57nm this confirms the formation of nano phosphor. PL emission spectrum of Er (0.5%) doped Sr_2CeO_4 phosphor when excited with 350nm emits good bluish green color. The present studied phosphor can be considered as compact fluorescent lamps (CFLs) phosphor for decorative lamps.

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