International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 2 Issue 8, August - 2013

Photoluminescence and Thermoluminescence of Eu doped LAG phosphor

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Abstract:

In this paper we have reported synthesis and characterization of Eu^{3+} activated LAG (La_2O_3,Al_2O_3, Gd_2O_3) phosphor. This phosphor was prepared by solid state reaction method and characterized by XRD, SEM and photoluminescence techniques. Eu^{3+} ion gives PL emission in different regions of the visible spectrum with different excitations. The crystallite size is calculated through XRD. The shape of the crystal is determined by SEM.

Introduction:

Phosphate based compounds are an important host,which can produce plenty of crystal field environments imposed on emission centres. Rare earth ions doped phosphates have excellent thermal stability. Phosphate based phosphors activated with Eu^{3+} ions for white light emitting diode have been developing. Trivalent Europium is an important activator ion for luminescent materials,which have been extensively studied.The Eu doped solid state materials usually show strong broadband luminescence with a short decay time of the order of some ten nano seconds. The luminescence is very strongly dependent on the host lattice and can occur from the ultraviolet to the red region of the electromagnetic spectrum. The Eu emission is intense enough to find important industrial applications.

Experimental:

The phosphor sample was prepared by solid state reaction method. The phosphor LAG is prepared from the compounds La_2O_3, Al_2O_3 and Gd_2O_3. The prepared LAG phosphor is weighed and grounded into a fine powder using agate mortar and pestle about an hour. The grounded phosphor was placed in an alumina crucible and heated from room temperature to 1200^oC in a muffle furnace with a heating rate of $5^oC/min$. After reaching 1200^oC the phosphor heated for 3hours and the furnace was allowed to cool to room temperature along with the sample. The characterizations are done for the prepared sample.

Characterizations:

The characterizations like Photoluminescence, Thermoluminescence, XRD and SEM and particle size analysis were studied. The photoluminescence spectrum was recorded at room temperature using spectroflurometer (SHIMADZU, RF-5301PC) xenon lamp as excitation source. The thermoluminescence spectra were recorded by TL glow curve reader. Through

XRD crystallite size is calculated. Powder X-ray diffraction patterns were recorded at regular intervals on a Bruker D8 Advance diffractometer using Cu-Kα X-radiation (λ = 1.54056 Å) at 50 kV and 40mA, over 2θrange of 5-50°at scan rate of 1° min^{-1}.The surface morphology of the crystal is observed from SEM study.

Photoluminescence study:

The excitation spectrum shows peak at 276nm.Where the emission spectrum ranging from 400nm to 700nm shows peaks at different wavelengths. For 254nm excitation, the emission spectrum shows small peaks at 468,514,540,586,592,616 and 627nm, with intensities around 99,50,52,56,82,94 and 86a.u. For 275nm excitation, the emission spectrum shows sharp peaks at 469,495,514,540,586,592,616 and 623nm with intensities around 144,70,95,105,121,178,224 and 214a.u. For 314nm excitation, the emission spectrum shows sharp peaks at 593 and 620nm with intensities around 61 and 62a.u.The energy levels with transitions are shown in table 1.

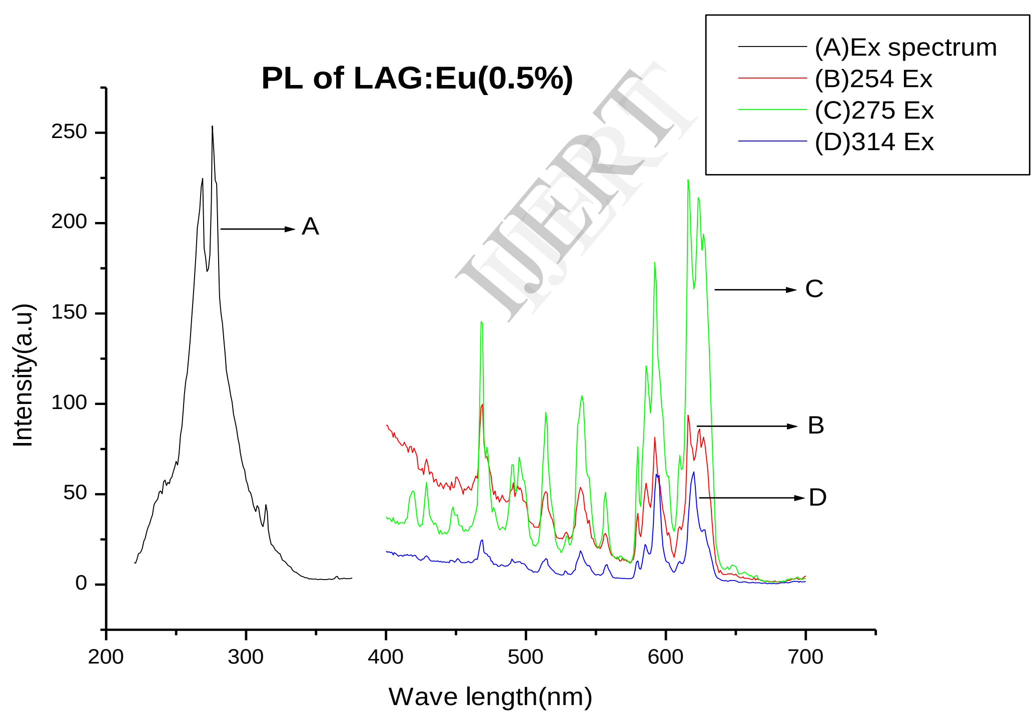

Fig.1: Photoluminescence of LAG: Eu

Wavelength (nm)	**Transitions**	Energy(cm^{-1})
468	$^5D_2 \rightarrow ^7F_0$	26492
514	$^5D_2 \rightarrow ^7F_3$	24121
592	$^5D_0 \rightarrow ^7F_1$	20943
616	$^5D_0 \rightarrow ^7F_2$	20192
627	$^5D_0 \rightarrow ^7F_3$	19774
470	$^5D_2 \rightarrow ^7F_0$	26379
540	$^5D_1 \rightarrow ^7F_1$	22960
586	$^5D_0 \rightarrow ^7F_1$	21157
623	$^5D_0 \rightarrow ^7F_3$	19869

Table 1: Observed energy levels of Eu co-doped LAG phosphor

From table-1 it is found all allowed transitions of Eu^{3+}. From blue to red emissions are observed which are useful for white light generation.

XRD study:

Fig.2 is the XRD of Eu doped LAG phosphor. The calculated crystallite size using Scherer's formula $d = K.\lambda/ \beta Cos\theta$, where 'K' is the Scherer's constant (0.94), 'λ' the wavelength of the X-ray (1.5418 Å), 'β' the full-width at half maxima (FWHM) (0.0024), 'θ' the Bragg angle of the highest peak is 14.56^0,Cosθ, = 0.9678 ,the crystallite size is around 62.95nm.From XRD study the phosphor may be in single phase.

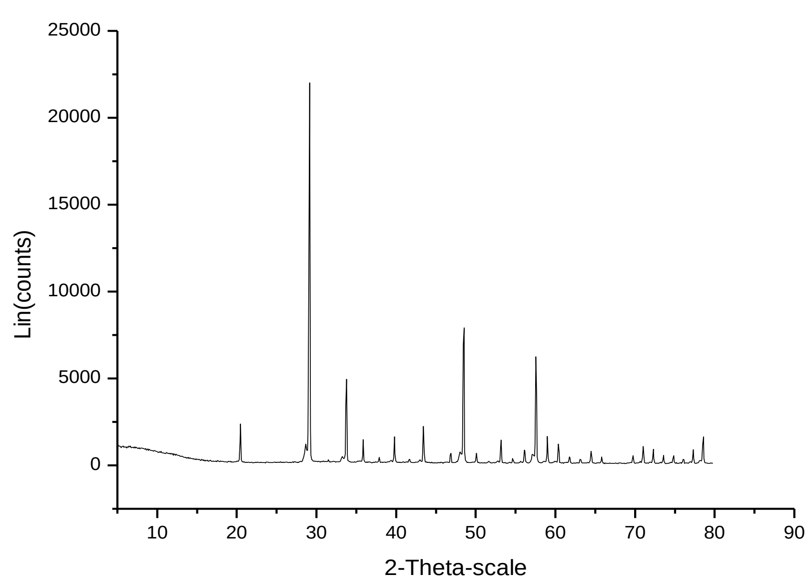

Fig.2 : XRD of Eu doped LAG phosphor

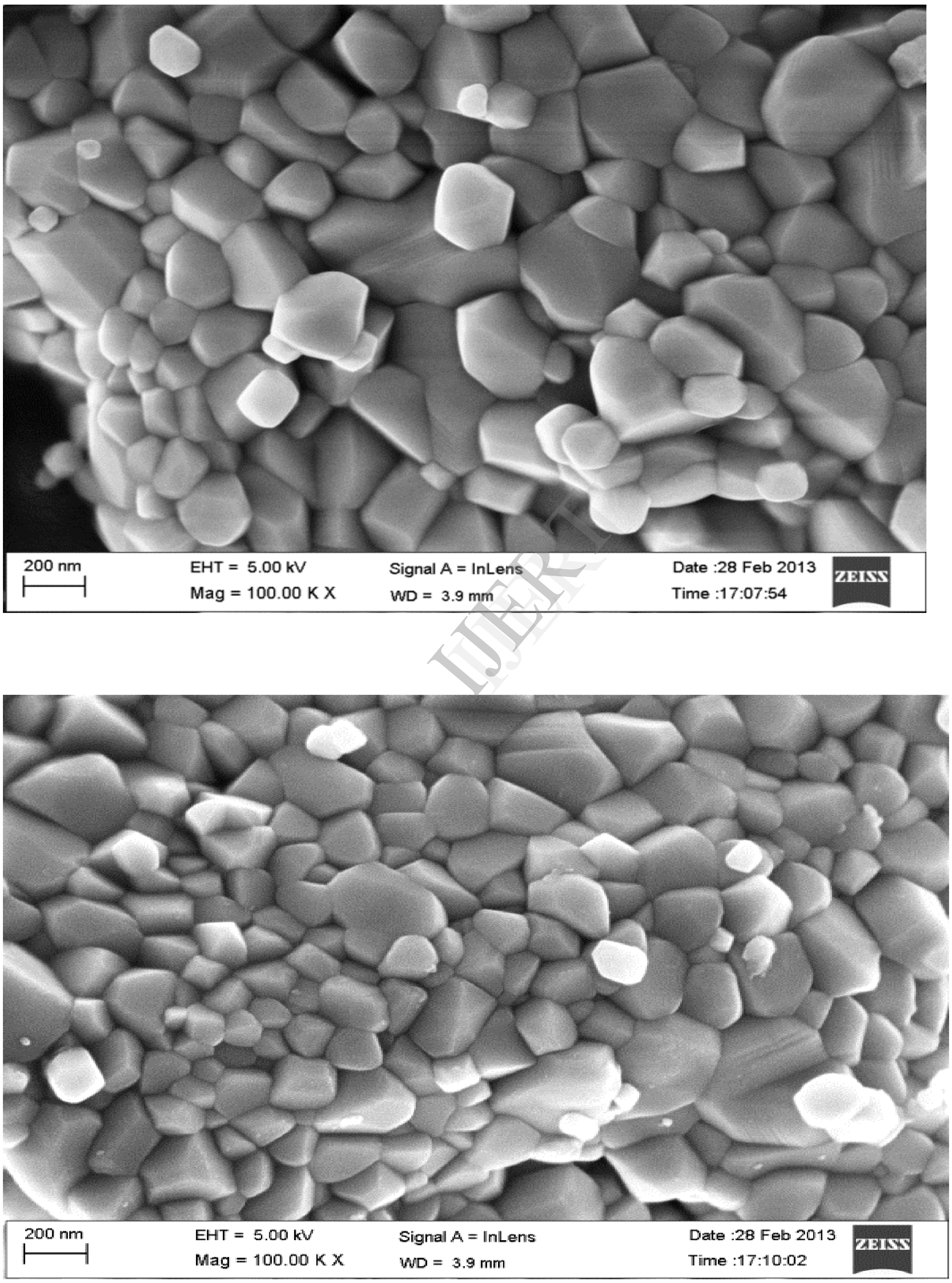

Fig.3: SEM of LAG

Fig.3 is the scanning electron microscope of LAG. It is clearly seen that the particles formed have an irregular shapes with a size of about 100nm and average crystallite size is in nanometre and formation of bright crystals are seen in SEM images which is due the emission from the phosphor particles due to electron beam irritation.

Conclusions:

The Eu^{3+} doped LAG phosphor was prepared by solid state reaction method .The characterizations was confirmed by XRD, SEM and Photoluminescence. Under different excitations, the emission spectrum shows peaks at different wavelengths of around 450nm to 620nm.From XRD it is observed that the crystallite size is around 62nm and the phosphor may be in single phase. This phosphor may be a good candidate in display devices.

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