



Photoluminescence Studies of Eu doped CaO Phosphor without and with Citric Acid Flux

¹Karunakar Shakampally, ²P. Madhusudana Rao and ³K.V.R.Murthy

¹Department of Physics, Nalla Malla Reddy Engineering College

Divyanagar, Ghatkesar Mandal, Ranga Reddy District- 500088. Telangana

²Department of Physics, BVRITH College of Engineering for Women, Hyderabad- 500090. Telangana

³Display Materials Laboratory, Applied Physics Department, Faculty of Technology & Engineering, M.S University of Baroda, Vadodara-390008, India

skarunakar83@gmail.com

Abstract - Paper reports the effect of concentration of the rare-earth Eu^{3+} doped on the host material CaO with Citric acid flux and without flux synthesized by the method of solid state reaction method. The photoluminescence analysis of the rare-earth Eu^{3+} doped and CaO red phosphor with varying Eu molar concentration as Eu (0.5, 1.0, 1.5, 2.0 mol %). Powder samples were prepared by firing stoichiometric mixtures of CaCO_3 as raw material and Eu_2O_3 as activator at 1200°C for 2 hours. The photoluminescence spectra were obtained by using a spectrofluorophotometer with an 80-W Xe lamp and 0.25-m mono chromators. Slit widths were 0.05 mm for emission and 1.56 mm for excitation. The excitation spectra of synthesized phosphor at 613 nm monitoring were composed of a broadband and a series of sharp peaks, the strongest excitation peak at 272 nm. The main emission spectra of samples under 272nm excitation is Eu^{3+} ions ${}^5\text{D}_0 \rightarrow {}^7\text{F}_2$ electric dipole transition with a strong red light, so that the phosphors may be a better candidate for red component for white light generation in display and lamps. The emission spectrum of Eu^{3+} site in CaO shows maximum intensity at 613 nm and 617nm corresponding to ${}^5\text{D}_0 \rightarrow {}^7\text{F}_2$ transition, and the transition of ${}^5\text{D}_0 \rightarrow {}^7\text{F}_1$ around 595nm is observed with low intensity in this phosphor. The excitation spectrum monitored at 613 nm radiation has a broad band at about 254-300nm of CaO with low good intensity. Both excitation bands correspond to the $[\text{Eu}^{3+} - \text{O}^{2-}]$ charge-transfer transitions. It is known that the position of the $[\text{Eu}^{3+} - \text{O}^{2-}]$ charge transfer transition is more or less fixed in octahedral VI coordination but moves to lower energy with increasing Eu-O distance

Keywords—Photoluminescence, wavelength, phosphor, doping, host lattice

1. INTRODUCTION

Recently various phosphors has been good commercial red phosphor materials have been actively investigated to improve their luminescent properties and to meet the development of different display and luminescence devices. Inorganic compounds doped with rare earth ions form an important class of phosphors as they possess a few interesting characteristics such as excellent chemical stability, high luminescence efficiency, and flexible emission colors with different activators. As a new red luminescent material, Eu doped CaO phosphor has been widely studied since it was found by different preparation methods. The rare-earth Eu^{3+} doped and CaO red phosphor is synthesized by solid state reaction method. The excitation spectra of synthesized phosphor at 613 nm monitoring were composed of a broadband and a series of sharp peaks, the strongest excitation peak at 272 nm. The main emission spectra of samples under 272nm excitation is Eu^{3+} ions

${}^5\text{D}_0 \rightarrow {}^7\text{F}_2$ electric dipole transition with a strong red light, so that the phosphors may be a better candidate for red component for white light generation in display and lamps.

2. EXPERIMENTAL

Powder samples were prepared by solid state reaction method firing stoichiometric mixtures of CaCO_3 as raw material and Eu_2O_3 as activator of purity (99.9%) were used as starting materials for the host phosphor. All the compounds were weighed, added in appropriate proportions synthesized in order to analyze the dopant nature i.e. the effect of concentration and its emission lines in the host phosphor. Europium oxide Eu_2O_3 is used as activator ion at different concentration (0.5, 1.0, 1.5, and 2.0 mol%). And grounded into a fine powder using agate mortar and pestle about An hour and added NH_4F again grounded for 10 min. The grounded phosphors were placed in an alumina

crucible and heated in air atmosphere at 1200°C for 2 hours in a muffle furnace the phosphors were characterized by the photoluminescence spectra were obtained by using a spectrofluorophotometer with an 80-W Xe lamp and 0.25-m monochromators. Slit widths were 0.05 nm for emission and 1.56 nm for excitation. The emission spectrum of Eu^{3+} site in CaO shows maximum intensity at 613 nm and 617nm corresponding to ${}^5\text{D}_0 \rightarrow {}^7\text{F}_2$ transition, and the transition of ${}^5\text{D}_0 \rightarrow {}^7\text{F}_1$ around 595nm is observed with low intensity in this phosphor. The excitation spectrum monitored at 613 nm radiation has a broad band at about 254-300nm of CaO with low good intensity. Both excitation bands correspond to the $[\text{Eu}^{3+} - \text{O}^{2-}]$ charge-transfer transitions. It is known that the position of the $[\text{Eu}^{3+} - \text{O}^{2-}]$ charge transfer transition is more or less fixed in octahedral VI coordination but moves to lower energy with increasing Eu-O distance.

3. RESULTS AND DISCUSSIONS

3.1 Photoluminescence Study

The emission spectrum of Eu^{3+} site in CaO shows maximum intensity at 613 nm and 617nm corresponding to ${}^5\text{D}_0 \rightarrow {}^7\text{F}_2$ transition, and the transition of ${}^5\text{D}_0 \rightarrow {}^7\text{F}_1$ around 595nm is observed with low intensity in this phosphor. The excitation spectrum monitored at 613 nm radiation has a broad band at about 254-300nm of CaO with low good intensity. Both excitation bands correspond to the $[\text{Eu}^{3+} - \text{O}^{2-}]$ charge-transfer transitions. It is known that the position of the $[\text{Eu}^{3+} - \text{O}^{2-}]$ charge transfer transition is more or less fixed in octahedral VI coordination but moves to lower energy with increasing Eu-O distance.

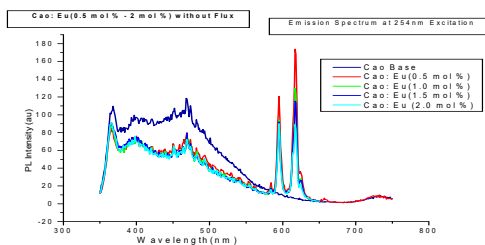


Fig. 1: Emission Spectrum at 272nm Excitation

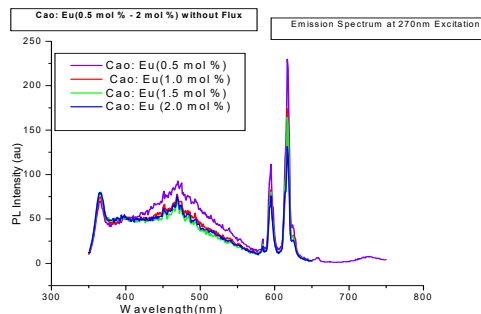


Fig. 2: Emission Spectrum at 272nm Excitation

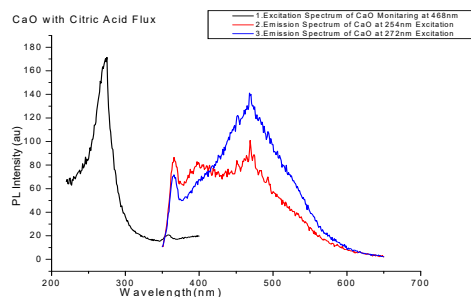


Fig. 3: Emission at 254nm & 272nm Excitation

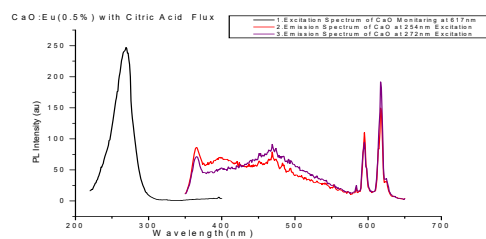


Fig. 4: Emission at 254nm & 272nm Excitation

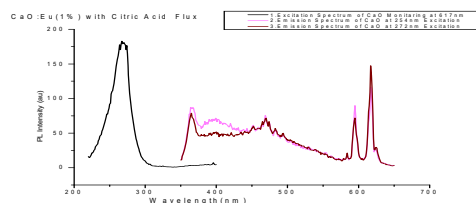


Fig. 5: Emission at 254nm & 272nm Excitation

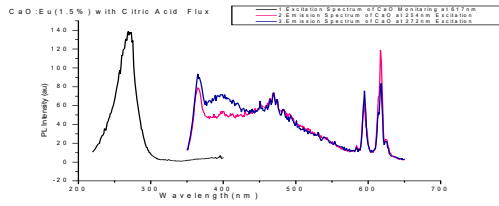


Fig. 6: Emission at 254nm & 272nm Excitation

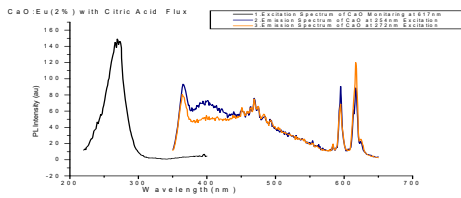


Fig. 7: Emission at 254nm & 272nm Excitation



Fig.8: 1200°C heating process



Fig. 9: After heating with citric acid flux





Fig. 10: After heating without citric acid flux

Figure 1 shows the PL excitation and emission of Eu (0.1, 1.0, 1.5 and 2.0 mol %) doped CaO phosphor under 254nm excitation 616nm with good intensity. Fig. 2 shows the PL excitation and emission of Eu (0.1, 1.0, 1.5 and 2.0 mol %) doped CaO phosphor under 272nm excitation 616nm with good intensity. Fig. 3 shows the PL excitation and emission of Eu (0.1, 1.0, 1.5 and 2.0 mol %) doped CaO phosphor under 254nm excitation 616nm with good intensity. Fig. 4 shows the PL excitation and emission of Eu (0.1, 1.0, 1.5 and 2.0 mol %) doped CaO phosphor under 272nm excitation 616nm with good intensity. These different intensities because of Eu doped in CaO when Eu concentration is increased the intensity is also increased the observed peaks at 468, 537, 587 and 616nm are from transitions $^5D_2 \rightarrow ^7F_0$, $^5D_1 \rightarrow ^7F_1$ and also from $^5D_1 \rightarrow ^7F_{1,2}$ respectively. It is also observed that the intensity of peak at 616nm is increasing as the Eu concentration increases while the intensity of peaks at 460, 530 and 582nm decreases. The peak around 610-620nm is due to the electrical dipole transition of $^5D_0 \rightarrow ^7F_2$ which is induced by the lack of inversion symmetry at the Eu^{3+} sites. It is well known that the $^5D_0 \rightarrow ^7F_2 / ^5D_0 \rightarrow ^7F_1$ intensity ratio is a good measure of the site symmetry of rare earth ions in a doped material.

Conclusions: The emission spectrum of Eu^{3+} site in CaO shows maximum intensity at 613 nm and 633nm corresponding to $^5D_0 \rightarrow ^7F_2$ transition. However when we used a citric acid as a flux the intensity slightly decreasing but we can conclude that this one of the best material to use as red phosphor materials the Ca is replaced with Eu the intensity of 613nm is doubled apart from other emissions. This may be due the presence of Eu ion whose atomic radius is nearly same as Eu ion in the crystal matrix.

References:

1. K.V.R. Murthy et al, Journal of Lumin., Vol.124, Issue 2, (2007), Pages 217-220.
2. Phosphor Hand book, second edition edited by William M. Yen, Shigeo Shionoya, Hajime Yamamoto, Yen, W.M., and Weber, M.J., Inorganic Phosphors (Compositions, Preparations and optical Properties, CRC press, Boca Ration, 2004.
3. Murthy, K.V.R. et al, MRB, Vol.41, 10, (2006), 1854-1860.
4. Murthy, K.V.R., et al Philosophical Magazine Letters, Vol.90, No.9, Sept 2010, 653-662.
5. R. L. Kohale and S. J. Dhoble, Luminescence, (2012), DOI 10.1002/bio.2411.
6. K. N. Shinde, S. J. Dhoble, J. Opt. Ect. and Adv. Mat. 13 (2011)
7. R. P. Rao and D. J. Devine RE-activated lanthanide phosphate phosphors for PDP Applications, Journal of Luminescence 87-89 (2000) 1260-1263.
8. Murthy, K.V.R. Luminescence associated with Eu^{3+} in two host lattices (2010) Philosophical Magazine Letters, 90 (9), pp. 653-662