Engineering Sciences International Research Journal
ISSN (Print) : 2330 – 4338 ; Volume 1 Issue 1 ‖ February. 2013 ‖

Synthesis and Photoluminescence Study of Various Calcium Silicates Containing Fluorine – A Comparative Study

T. Malathi Rekha[1], B. Vinod Kumar[2], B. Walter Ratna Kumar[3]

Abstract: The present paper reports the photoluminescence study of $Ca_3Si_3O_8F_2$, $Ca_5Si_2O_8F_2$ and $Ca_7Si_3O_{12}F_2$ compounds. The interest of studying these compounds is to get data about the relationship between the crystal chemical peculiarities of hosts and there after to study the spectroscopic properties of hosts doped with optically active rare earth ions, since they are having different systems ie., triclinic, monoclinic and orthorhombic respectively. The samples were prepared with Standard Solid State Reaction method. The firing temperature is 1200°C for 3 hours in a muffle furnace by adding 10% of urea as a flux. The photoluminescence spectra were taken at room temperature.

Keywords: Photoluminescence, emission spectrum, excitation spectrum, LEDs.

1. INTRODUCTION

Now a days a great attention is paid to the research and development in the field of lighting technology in relation to the global problem of saving energy. One of the rapidly developing technologies is based on using very efficient light emitting diodes (LEDs) in light sources for general lighting. Such LED-based white-light emitting lamps consist of the blue or UV LEDs covered by the layer of yellow phosphor or the blend of three color phosphors. The interest under taking these compounds is to develop a new series of hosts, namely fluorine containing alkali-earth silicates, as potential phosphors for white LEDs and to get data about the relationship between the crystal chemical peculiarities of hosts and there after to study the spectroscopic properties of hosts doped with optically active rare earth ions, since they are having different systems ie., triclinic, monoclinic and orthorhombic respectively. It is supposed that adding of Fluorine in to the matrix can remarkably reduce thermal quenching of luminescence intensity. The samples were prepared under solid state reaction method and synthesized at 1200^{o}C for 3 hours.

2. EXPERIMENTAL

The compounds $Ca_3Si_3O_8F_2$, $Ca_5Si_2O_8F_2$ and $Ca_7Si_3O_{12}F_2$ were prepared by taking CaF_2, $CaCO_3$ and SiO_2 as a starting material at appropriate stoichiometry.

The basic reactions are:

$$CaF_2 + 2CaCO_3 + 3SiO_2 \rightarrow Ca_3Si_3O_8F_2 + 2CO_2 \uparrow$$

$$CaF_2 + 4CaCO_3 + 2SiO_2 \rightarrow Ca_5Si_2O_8F_2 + 4CO_2 \uparrow$$

$$CaF_2 + 6CaCO_3 + 3SiO_2 \rightarrow Ca_7Si_3O_{12}F_2 + 6CO_2 \uparrow$$

The samples were prepared with Standard Solid State Reaction method. The compounds were obtained into a fine powder by grinding the starting materials with appropriate stoichiometry using agate mortar and pestle for two hours with intermediate grindings and fired at 1200°C for 3 hours in a muffle furnace. The Photoluminescence spectra were taken at room temperature.

3. RESULTS AND DISCUSSION

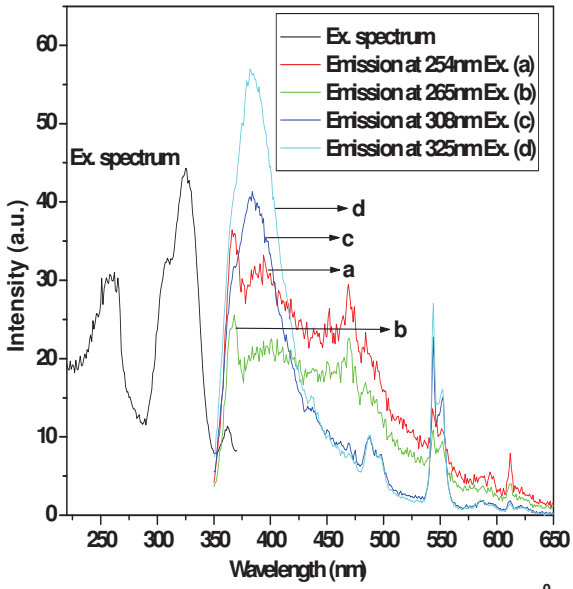

Fig1:Excitation and Emission spectra of $Ca_3Si_3O_8F_2$ at 1200^{0}C

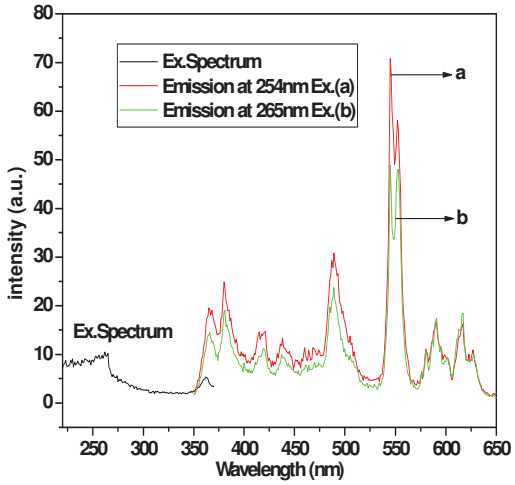

Fig2:Excitation and Emission spectra of $Ca_5Si_2O_8F_2$ at 1200^{0}C

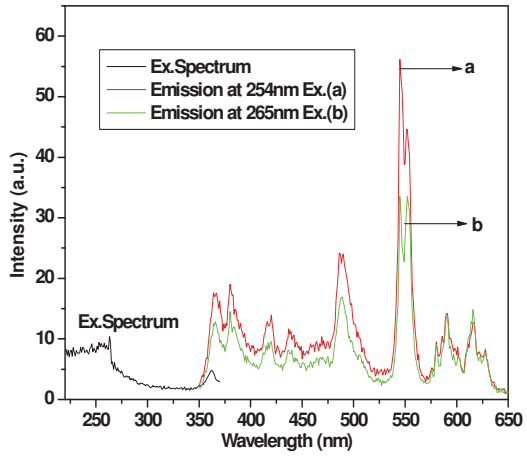

Fig3: Excitation and Emission spectra of $Ca_7Si_3O_{12}F_2$ at 1200^{0}C

For $Ca_3Si_3O_8F_2$ sample heated at 1200°C, the excitation spectrum has peaks at 254nm, 265nm, 308nm and 355nm. For the excitation of 254nm, the emission spectrum has peaks at 394nm, 469nm, 543nm and 612nm. For the 265nm excitation, the emission spectrum has peaks at 401nm, 469nm and 544nm. For the excitation of 308nm, the emission spectrum has peaks at 384nm and 544 nm. For the excitation of 325nm, the emission spectrum has peaks at 382nm and 544 nm respectively.

For $Ca_5Si_2O_8F_2$ and $Ca_7Si_3O_{12}F_2$ samples heated at 1200°C, the same excitation spectrum was obtained with peaks at 254nm and265nm. For the excitation of 254nm and also with 265nm, both the samples reveals respectively the same emission spectra with peaks at 380nm,420 nm, 439nm,486 nm,545nm, 591nm and 617nm.

For $Ca_3Si_3O_8F_2$ sample emission is broad and high around 394nm wavelength, and sharp and low at other wavelengths. The excitation and emission spectra are same for both $Ca_5Si_2O_8F_2$ and $Ca_7Si_3O_{12}F_2$. The emission peaks are sharp and high at 545nm and sharp and low at other wavelengths. However $Ca_5Si_2O_8F_2$ has higher intensity in comparison with $Ca_7Si_3O_{12}F_2$.

4. CONCLUSIONS

Un-doped $Ca_3Si_3O_8F_2$ may be useful in UV lamps.

$Ca_5Si_2O_8F_2$ and $Ca_7Si_3O_{12}F_2$ may be useful in CRT's.

Optically rare earth ions like Ce^{3+}, Eu^{3+}, Tb^{+3}on doping may give emission around green, yellow and red regions, the convincing ranges for white LED's and tricolor lamps.

5. REFERENCES

[1] K.H. Jang, E.S. Kim, L. Shi, N.M. Khaidukov, H.J. Seo. Luminescence properties of Eu^{3+} ions in K_2YF_5 crystals. Optical Materials 31, 1819–1821, 2009.

[2] J. Marcazzó, N.M. Khaidukov, E Caselli, C Dangelo, and M Santiago. Optically stimulated luminescence of hydrothermal K_2YF_5:Pr^{3+} crystals. Physica Status Solidi (a) 206 (11), 2593 – 2598, 2009.

[3] P.A. Tanner, C-K. Duan, V.N. Makhov, M. Kirm, N.M. Khaidukov. Vacuum ultraviolet excitation spectra of lanthanide-doped hexafluoroelpasolites. J. Phys.: Condens. Matter 21 395504 (10 pp), 2009.

[4] N. Kristianpoller , W. Chen, N. Khaidukov, R. Chen. Optical properties of some fluoride compounds and their application to dosimetry. Radiation Measurements 45, 566–568, 2010.

[5] Huynh Ky Hanh, Nicholas M. Khaidukov, Vladimir N. Makhov, Vu Xuan Quang, Nguyen Trong Thanh, Vu Phi Tuyen. Thermoluminescence properties of isostructural K_2YF_5 and K_2GdF_5 crystals doped with Tb^{3+} in response to α, β and X-ray irradiation. Nuclear Instruments and Methods in Physics Research Section B: Beam Interactions with Materials and Atoms 268, 3344-3350, 2010.

* * *

[1]*Head, Department of Chemistry, Hindu College, Machilipatnam,*
[2]*Asst.Professor, Dept. of Chemistry, Universal College of Engineering and Technology, Dokiparru, Guntur,*
[3]*Lecturer in Physics, P.B.N. College, Nidubrolu, e-mail: walter_rkb@yahoo.com*