STUDY EFFECT FIXED CONCENTRATION OF DOPANT (EU) ON LUMINESCENCE PROPERTIES OF META-SILICATES

Amol Nande[a*], Swati Raut[b], Nilesh Thakre[c], S. J. Dhobale[b]
[a]Guru Nanak College of Science Ballarpur
[b]Department of Physics, R. T. M. Nagpur University, Nagpur
[c]P. R. Pote Patil College of Engineering, Amravati

A B S T R A C T

In the presented work, europium dopant is used to study comparison luminescence study for different meta-silicates. The prepared inorganic phosphors are BaSiO3 and ZnSiO3 doped with 2 % of europium earth metal. It is observed that both sample shows 4f65d1 to 8S7/2 transition which is closer to violet – blue spectrum. Further it is observe that the emission intensity and peak of the emission spectra is host dependent. It is observed that for BaSiO3:Eu the intensity of emission and excited spectra is higher compared to ZnSiO3:Eu. Further BaSiO3:Eu emission peak is centered at 490 nm which in blue region. However, as ZnSiO3:Eu emission peak is closer to ultra-violet region compared to BaSiO3:Eu emission spectrum, the former one is strong candidate for down-shift luminescence phosphor.

Keywords: Luminiscence, Inorganic phosphors, down-shift, rare-earth material

1. Introduction

Luminescence is always a fascinating subject to deal with optical science. Their fluorescent behavior and the property which converts the light energy into heat energy or electrical energy and vice-versa have many technical applications. Even some of luminescent materials termed as phosphors can get excited in visible or ultra-violet light and remain emitting the light for longer time we called them as long-lasting phosphors(Clabau et al., 2005).

The phosphors research gain more interest in preset days and it is observed that these phosphors can be made in many different ways. The observed luminescence in phosphors is due to defect interaction produced by dopant present in the phosphors(Li, Delsing, De With, & Hintzen, 2005; Reshchikov & Morkoç, 2005). Therefore, the luminescence property of phosphors has always been attracted to researchers and received huge importance. The phosphors also have the potential in display devices including plasma display, panels, and solid state lightings. Solid state lightning are replacing the conventional light source by light emitting diodes (LEDs) because of their low power consumption ability, durability and compact size(Piao, Horikawa, Hanzawa, & Machida, 2006; Xia, Zhang, Molokeev, & Atuchin, 2013). Nowadays the topic grabs more interest due to their unique properties like down-shift luminescence behavior and up-conversion luminescence behavior. These phosphors can be used to increase the efficiency of solar cell(Richards, 2006; Trupke, Green, & Würfel, 2002a, 2002b).

In inorganic phosphors generally rare-ear elements are used as a dopant due to their fair available energy states for transitions. Among all rare-earth materials Europium isone of the most studied dopant due to its ability to present in Eu^{2+} and Eu^{3+} form. The most common emissions for Eu^{2+} ion are $4f^6 5d^1$ to $^8S_{7/2}$ and ^6P_J to $^8S_{7/2}$; the first transition is observed in violet – blue region while the second transition is observed in ultra-violet region. Also in the common emissions for Eu^{3+} ion are $^5D_0$ to $^7F_1$ and $^5D_0$ to $^7F_2$; the first transition is found in orange range and the second transition is observed in red range(Manjunath et al., 2018). Further it is observed that the luminescence properties also depend on their host material as well. In this work we have used the same dopant – europium and doped in different metal silicates, to observe the intensity of emission and excitation spectra and color range it is observed.

In this paper, the presented samples are $BaSiO_3$ and $ZnSiO_3$ doped with 2 % of europium earth metal. The samples were prepared using precipitation method. Later the samples were taken to record emission and excitation spectra.

2. Sample preparation

In this research samples were prepared using precipitation method. Sodium silicate was mixed with double distilled water, and then it is mixed with appropriate metal nitrate (Barium nitrate and Zinc nitrate) in double distilled water. Later europium nitrate solution was added to the mixture. The obtained precipitation was then filtered and washed several times with double distilled water. The obtained precipitation was dried at 100 ºC for 4 hrs.

The obtained phosphor later taken for characterization

3. Result and Discussion

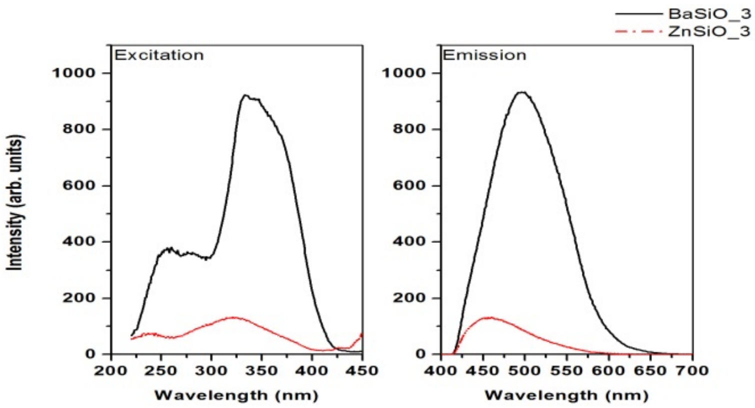

Figure 1Left side: Excitation spectra for $BaSiO_3$:Eu (Black) and $ZnSiO_3$:Eu (Red) sample. Right side: Emission spectra for $BaSiO_3$:Eu (Black) taken at 354 nm excitation and $ZnSiO_3$:Eu (Red) sample taken at 325 nm excitation.

The prepared sample were taken to photoluminescence spectrometer with 150 W Xenon lamp with ozone self – dissociation function and photomultiplier R372 F detector for measurements. The resolution of the light beam was 1.5 nm with minimum band pass. Figure 1 depicts excitation and emission spectra for $BaSiO_3$:Eu and $ZnSiO_3$:Eu phosphors. The emission spectrum for $BaSiO_3$:Eu is recorded at 354 nm excitation. It is observed that the prominent peak for the emission spectrum is observed at ~ 490 nm which is blue region. However $ZnSiO_3$:Eu phosphor shows emission peak ~ 450 nm when it is excited at 325 nm. This emission is violet region and closer to ultraviolet region. This suggests that the phosphor shows emission in blue to violet region with intensity higher than the observed for $ZnSiO_3$:Eu phosphor. The observed emission band in $ZnSiO_3$:Eu and $BaSiO_3$:Eu are due to $4f^6 5d^1$ to $^8S_{7/2}$ transition.

Looking at the emission and excitation spectra for both the sample, it can be claimed that $ZnSiO_3$:Eu can be used as a down-shift phosphors better than $BaSiO_3$:Eu phosphor. The study can extend to other metal-silicates for fixed concentration of the same dopant or by changing the dopant which definitely used to find out the better combination for down-shift phosphor.

Color purity can be visualized in the chromaticity diagram (Figure 2) as bluish and violet regions, using the emission color coordinates of the luminescent material. So, using the luminescence emission spectra of Eu^{2+}(2%), activated $BaSiO_3$ and $ZnSiO_3$ samples, we obtained the chromaticity diagrams with the aid of the Breault Research Organization (BRO4304) Software supported by Advanced Systems Analysis Program (ASAP). For any given color there is one setting for each three number X, Y, and Z known as tristimulus values that will produce a match. Based on emission spectra of Eu^{2+}, activated $BaSiO_3$ and $ZnSiO_3$ sample, the chromaticity (x, y) color coordinates were determined with the following values (x, y)= (0.066, 0.276), and (0.172,0.005), represents the chromaticity (x, y) color coordinates respectively shown in Figure 2.

From the mentioned results it is observed that the metal silicates with europium doping can be made successfully using precipitation method. The emission as well as excitation spectra depend on host and dopant. For the same dopant one can get the different emission and excitation spectra with huge change in their intensity.

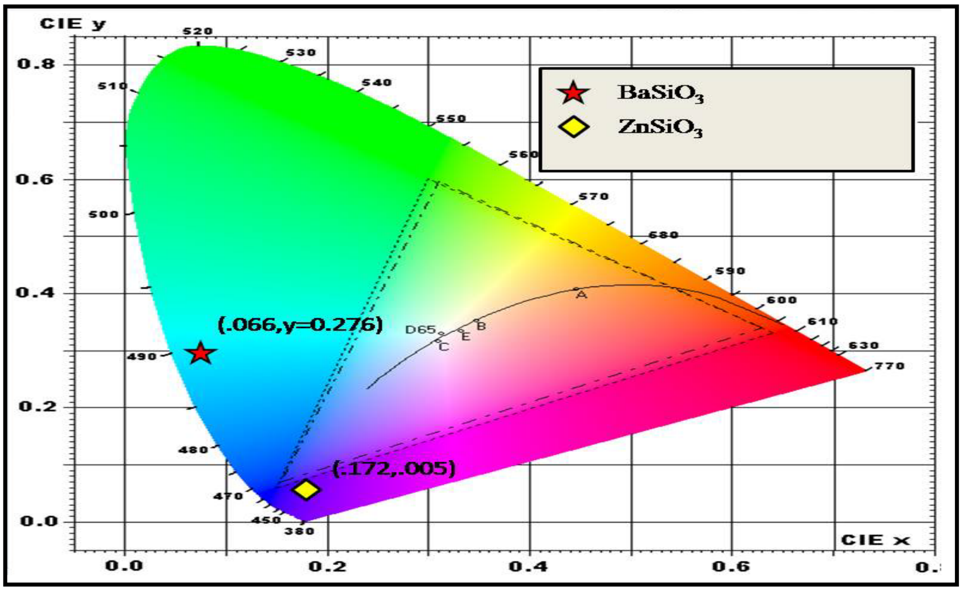

Figure 2CIE chromaticity diagram of euoropium doped BaSiO3 and ZnSiO3 phosphors showing the highest emission intensity at (Eu2+= 2) mol %.

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