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Luminescent studies of Zn_2SiO_4:Mn(1.1%), Eu(1.5%) phosphor

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Abstract

Zn_2SiO_4 doped with Maganese and eueopium ion was synthesized by solid state reaction under air atmosphere. Its characterization were systematically analyzed by SEM, X-ray diffraction (XRD) and photoluminescence spectra (PL). Photoluminescence emission spectra having an excitations at around 254, 265nm revealed that Eu ions were present in trivalent oxidation states. The emission peaks are found at, 511,528 and540nm(green) are observed. Scanning Electron Microscopy (SEM) was implemented to investigate the surface morphology of present phosphor. The obtained results on Zn_2SiO_4:Mn(1.1%), Eu(1.5%) *is suitable for white light source using UV light as the primary excitation.*

1.0 Introduction

Willemite possesses a wide Willemite (α-Zn2SiO4), with phenacite structure occursnaturally and belongs to the group of orthosilicates. Willemite possesses a wide range of applications such as phosphor host, electrical insulators, glazes and pigments, and is also an important component in glass ceramics. Mn-activated willemite (Zn2SiO4 :Mn) is an efficient green phosphor, and it has attracted many researchers for its potential applications to various types of display panels such as plasma display panel ~PDP!, vacuum fluorescent display ~VFD!, and field emission display ~FED!. For enhancing the brightness and resolution of these displays, it is important to synthesize phosphors with high quantum efficiency, controlled morphology and small particle sizes either amorphous or crystalline is of interest. It is also used as a luminescent material for lamp and cathode ray tubes ~CRTs! because of its luminescent efficiency and chemical stability. It has also been tested in thin film electroluminescent ~EL! devices and medical imaging radiation detectors.

Experimental:

To prepare doped with various concentrations of Europium, consists of heating stoichiometric amounts of reactants at 1000 °C for 2 h in a muffle furnace. The Eu^{3+} activated **Zn_2SiO_4** : Mn(1.1% constant) phosphor was prepared via high temperature modified solid state diffusion. The starting materials were as follows: Zinc Oxide and Silicon dioxide and the molar ratio of rare earth Europium oxide Eu_2O_3 (National Chemicals, Baroda, 99.999%) was used to prepare the phosphor .The mixture of reagents was ground together to obtain a homogeneous powder in acetone base. After being ground thoroughly in stoichiometric ratios by using an agate mortar, to ensure the best homogeneity and reactivity, powder was transferred to alumina crucible, and then heated in a muffle furnace at 1200 °C for 2 hr. The phosphor materials was cooled to room temperature naturally. All samples were found out to be white which are studied for photoluminescence. PL spectra were recorded at room temperature using spectrofluorophotometer.

Results and Discussion:

Figure-1 is the PL of Zn_2SiO_4:Mn(1.1%), Eu(1.5%) excited with 254 and 265nm. The PL emission is found at 528nm a perfect green emission. The observed peak starts at 475 nm with meission centered at 528 and continues till 575nm. However the green emission intensity at 528nm dominates and go out of range of the instrument with beginning at 511 and ending at 528nm. The PL intensity monitored at 528nm with 254 nm excitations displays a good green emission from Zn_2SiO_4:Mn^{2+}:Eu^{3+} phosphor system and the same is excited with 265nm the intensity of 528nm peak is increased by 10%. However the The $^4T_1(4G)\rightarrow{}^6A_1(6S)$ transition, is directly responsible for the green light emission at 528nm.The observed peak is allowed transitions of Mn when excited with 254 and 265nm. The reported of Eu^{3+} peaks at 511 and 540nm and other small peaks are basically the allowed transitions of europium in +3 state. They are due to:

1. 511nm emitted peak is due to $^5D_2\rightarrow{}^7F_3$ transition of Europium and is due to electric dipole with energy 2.429 eV.
2. 540nm emitted peak is due to $^5D_1\rightarrow{}^7F_1$ transition of Europium and is due to electric dipole with energy 2.307 eV.

In the present Zn_2SiO_4:Mn^{2+}:Eu^{3+} phosphors sytem Eu acts as senisitzer which enhances the 528nm luminescence

eminssion by 70% when compared to $Zn_2SiO_4:Mn^{2+}$ which is presented in figure 1.A.

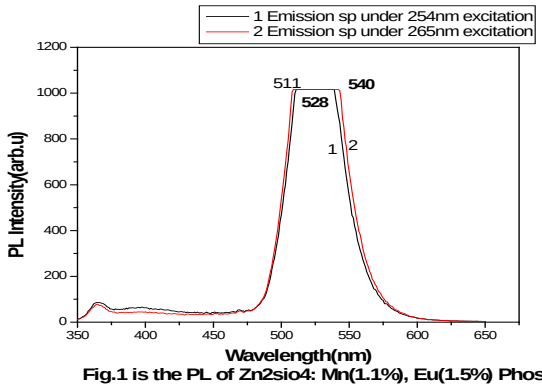
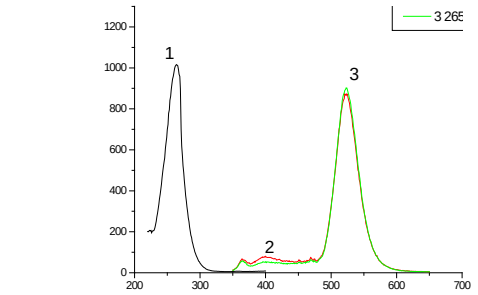


Fig.1 is the PL of Zn2sio4: Mn(1.1%), Eu(1.5%) Phosphor



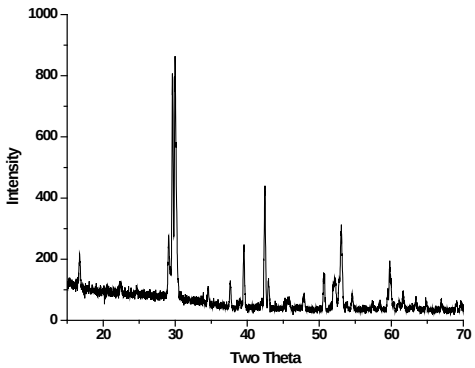


Fig.: 2 XRD of ASL: Eu 0.5

Fig 2: XRD of **Zn_2SiO_4:Mn(1.1%), Eu(1.5%)**

Fig. 2 is XRD of **Zn_2SiO_4:Mn(1.1%), Eu(1.5%)**. The calculated crystallite size using Scherer's formula d=K.λ/ β Cosθ, 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) (0.29^0), 'θ' the Bragg angle of the peak highest intensity is 29.0^0, Cosθ = 0.9660 and for 0.5% Eu doped is around 29.33 nm The morphological investigation of Eu doped $Zn_2SiO_4:Mn^{2+}:Eu^{3+}$ was carried out by scanning electron microscopy (SEM). The typical SEM image is shown in Fig. 3. SEM image reveals that the particles size and shape is irregular and size varies from 2-5μm.

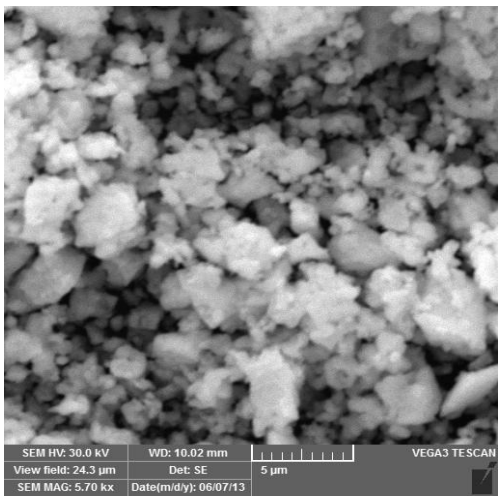


Fig3: SEM of **Zn_2SiO_4:Mn(1.1%), Eu(1.5%)**

4. CONCLUSION

Zinc silicate doped with Mn^{2+} and Eu^{3+}phosphors were prepared via high temperature solid state reaction in air medium. Overall results show that the PL intensity monitored at 528nm with 254 nm excitations displays a good green emission from $Zn_2SiO_4:Mn^{2+}$ phosphor system. The $^4T_1(^4G)\rightarrow{}^6A_1(^6S)$ transition, is directly responsible for the green light emission at 528nm. The presence of Eu in Zn_2SiO_4:Mn enhances the 528nm intensity by 70% which is due to the sensitization of Eu^{3+} ions. However the mechanisum is to be understood well. The obtained results on Zn_2SiO_4:Mn(1.1%), Eu(1.5%) Eu is suitable for green light source using UV light as the primary excitation.

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