Synthesis and Characterization of Eu, Tb doped Y_2SiO_5 Phosphors

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Abstract:- The structural and the optical properties of Terbium and Europium doped yttrium silicate phosphor particles were analyzed. The samples were prepared through solid state reaction method and investigated in a doping concentration of Tb(2%) and Eu(1.5%). The prepared phosphors are characterized using X-ray diffraction (XRD), SEM.FTIR and PL emission of Y_2SiO_5 phosphor doped with Tb(2%) and Eu(1.5%) was studied. The observed PL emission is at 380 nm followed by the emissions with good intensity at 487, 545, 586, 613 and 622nm. The present phosphor may be a good candidate for LED.

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1. Introduction

Much work has been reported on the use of lanthanides in the preparation of the phosphors, as they have displayed very well optical properties which make them part of almost every display device. One of the interesting aspects is that in spite of there being so much literature on phosphors, the increase in the luminous output of the rare earthbased devices; research is still being pursued extensively. Y_2SiO_5 is a promising candidate for oxidation-resistant or environmental/thermal barrier coatings due to its excellent high-temperature stability, low elastic modulus and low oxygen permeability[1]. A white light emitting phosphor has therefore been synthesized by solid state reaction method.

2. Experimental

The samples were synthesized by standard solid state reaction (SSR) technique. To prepare Y_2SiO_5 host phosphor, the starting chemicals, yttrium oxide and silicon dioxide of purity of 99.9% were taken in appropriate stiochiometry of 2:1. The materials were weighed, mixed and grounded using agate mortar and pestle. The samples were heated at 1200^{o}C for 3 hours using muffle furnace with a heating rate of 4^{o}C/min and the samples were allowed to cool in the furnace and taken out when the muffle temperature is 100^{o}C. . The same procedure was followed to prepare Eu(1.5%),Tb(3%) Y_2SiO_5 doped phosphor. The photoluminescence spectra were recorded using Spectrofluoro photometer (JOBIN VYON, Fluoromax-3), XRD using Synchrotron Beam line at Indus-II and SEM using XL 30 CP Philips, studies are done on the prepared samples.

3. Results and Discussions

3.1.XRD Analysis

The crystalline structure of the powders was analyzed by X-ray powder diffraction (XRPD). The diffractometer used was an Angle Dispersive X-ray Diffraction (ADXRD) beam line No. 12 with λ = 0.895 A^{0}. Figure 3.1 shows the XRPD data for one of the samples studied in this work Y_2SiO_5: Eu (1.5%),Tb(2%). The crystalline phases were identified with the International Centre for Diffraction Data (ICDD) database card number 74-2011. All the diffraction peaks were well indexed and confirms the compound is in single phase. It clearly indicates that the heat treatment and time of cooling were sufficient to form the phosphor majority in single phase. The crystallite size was determined using the Scherrer equation D = k_λ /_βcosθ_, where k is the constant (0.94), λ is the wavelength of the X-ray (0.895 A), β is the full-width at half maxima (FWHM) and θ the Bragg angle of the XRD big peak. Using Scherer's formula the particle size calculated is 61 nm.

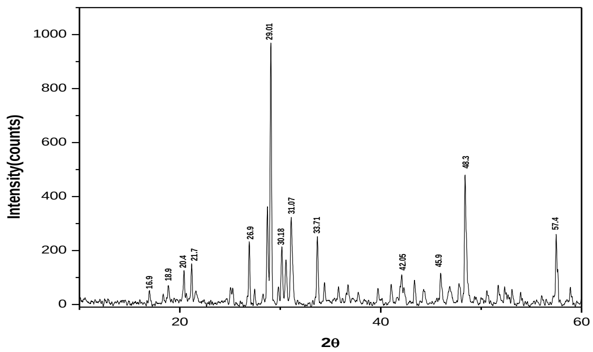

Fig.3.1.XRD of Tb(2%),Eu(1.5%) doped Y_2SiO_5

3.2 SEM

Characterization of particles, surface morphology and size of nano crystals is done routinely using scanning electron microscope. The main advantage of SEM is that they can be used to study the morphology of prepared nano particles and nano composites.From the Scanning Electron Micrographs of Y_2SiO_5:Tb,Eu Phosphor ,it is found that the particles are irregular in shape with nano sizes.

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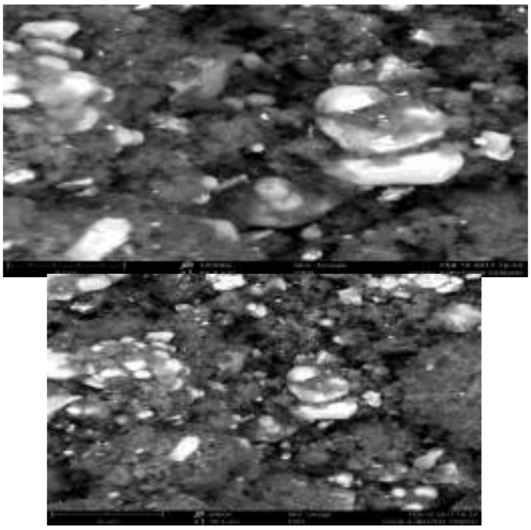


Fig.3.2.SEM Image of Tb(2%),Eu(1.5%) doped Y_2SiO_5

3.3FTIR Analysis:

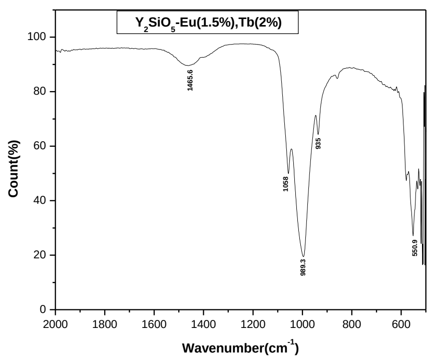


Figure-3.3 Emission spectrum of Eu(1.5%),Tb(2%) doped Y_2SiO_5 phosphor

In order to determine the atomic bonds in a molecule FTIR analysis was carried out. Fig.3.3 shows the FTIR spectrum of

Eu 1.5% doped and Tb(2%)co doped Y_2SiO_5 phosphor. From FTIR spectrum it is observed that the absorption peaks at 989 and 550 are assigned to stretching and bending vibrations,

respectively.

3.4 Photoluminescence Study

Figure-3.4.1 is the excitation spectrum of Eu(1.5%) and Tb(2%) doped Y_2SiO_5 phosphor monitored under 615nm. It is broad excitation band from 240 to 350nm. The intense broad band is attributed to the transition between Eu^{3+} and Tb^{3+} states. Figure-3.4.2 shows the PL emission spectrum of Eu(1.5%),Tb(2%) doped Y_2SiO_5 phosphor under the excitation of 254nm. PL emission mainly concentrates around 380nm followed by the primary Tb and Eu emissions with good intensity bands centred at 484, 545, 586, 613 and 622nm. It is interesting to note the emitted colors are three primary colours.

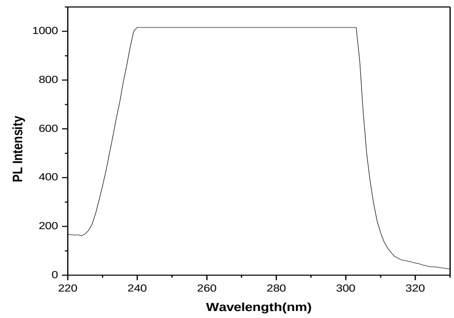


Figure-3.4.1 Excitation spectrum of Eu(1.5%) and Tb(2%) doped Y_2SiO_5 phosphor monitored under 615nm.

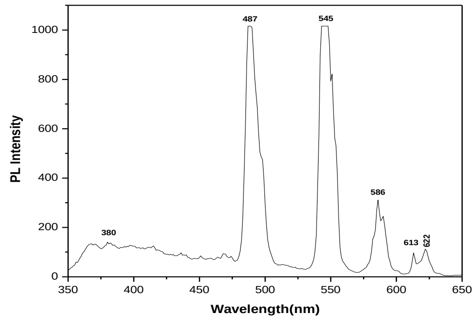
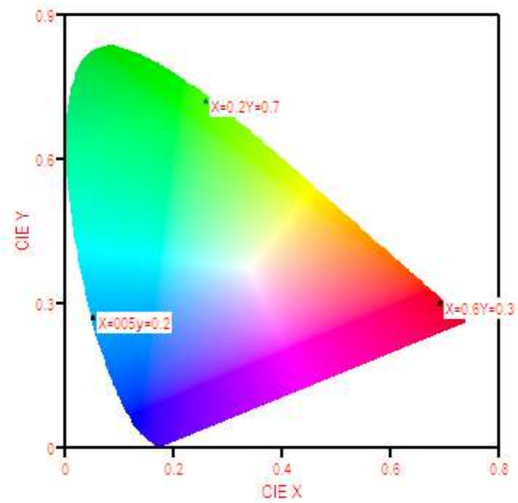


Figure-3.4.2 Emission spectrum of Eu(1.5%),Tb(2%) doped Y_2SiO_5 phosphor under the excitation of 254nm.

3.5.CIE Coordinates:

The CIE co-ordinates calculated by the Spectrophotometric method using the spectral energy distribution of the sample Eu(1.5%),Tb(2%) doped Y_2SiO_5 phosphor are shown in Fig. 3.5. From figure it is clear that this phosphor having excellent color tenability from blue to red.



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4. Conclusion

i)Y_2SiO_5: Eu(1.5%),Tb(2%) has been successfully synthesized and the mechanism of the luminescence is due to stabilization of Europium in the trivalent state.
ii)The calculated crystallite size-64nm confirms the formation of nano crystallite phosphor.
iii)PL emission spectrum of Eu(1.5%),Tb(2%) doped Y_2SiO_5 phosphor when excited with 254 nm emits good bluish, green and red colour.
iv)The PL intensity of the Tb and Eu emission shows that ,the given phosphor can be used as a LED.

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