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Good Blue Emission of Synthesized Zn2GeO4 Phosphor Doped with Eu (0.5%)

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Abstract: The present paper discusses an important phosphor material which is Zn_2GeO_4. The phosphor is prepared by taking appropriate quantities of ZnO and GeO_2 of AR grade. This completes solid state reaction. It is important to note here there is no evolving of the gases. Therefore this solid state reaction can be called as Green chemistry route. The phosphor Zn_2GeO_4: Base and Eu (0.5%) is Excited with 250, 255, 260, 265, 270, 275 nm the PL emission is found around 480nm. For 260nm excitation, the PL emission intensity of 400nm peak is increased by 75%. It can be stated that the increase PL emission peak intensity of 480nm peak is due to Eu^{3+} present in Zn_2GeO_4. This PL emission intensity may be due to the emission from Eu^{3+} and or the energy transfer Eu^{3+} to Ge. One of its promising application is to be used as phosphors in display technology such as field emission display which is considered to be the next generation flat panel displays.

Keywords: Photoluminescence, X-ray diffraction [XRD], Scanning Electron Microscopy [SEM], Energy Dispersion Spectrum [EDS], Particle size Analysis, Solid State Reaction technique.

1. INTRODUCTION

Zinc germinate (Zn_2GeO_4) is a wide band gap semiconducting ternary oxide. In recent years, many efficient sulfide-based compounds have been investigated as possible candidates. But the luminous efficiency drops dramatically due to easy decomposition of cathodes under electron bombardment. Oxide-based phosphors are getting more focused these years, due to their good chemical durability, excellent light output, and an environmental friendliness.

At the present time, only ZnO has the acceptable luminescence performance below 100 V supply voltage. Notably, experimental results of Zn_2GeO_4 with native defects indicate its photoluminescence (PL) is about 40% brighter than that of the commercial ZnO phosphor. Recently various phosphor materials have been actively investigated to improve their luminescent properties and to meet the development of a different display and luminescence devices.

2. MATERIALS AND EXPERIMENTAL METHODS

The phosphor Zn_2GeO_4 prepared with different dopants. The received powder after grinding is transferred into Aluminum crucibles, these crucibles contain mixer covered with lids are transferred into the furnace. This crucibles contained mixer is heated at 1200^0C for 2 hours and allowed to cool to room temperature by switching off the furnace. After 18 hours of cooling the sintered material which is a ceramic phosphor is collected from the crucible and grinded thoroughly to get the uniform size of phosphor grounded using motor and pestle for 30 minutes of each phosphor. All the phosphor samples were characterized by X-ray diffraction using (Synchrotron Beam Indus -II). The Photoluminescence (PL) emission and excitation spectra were measured by Spectrofluorophotometer (SHIMADZU, RF-5301 PC) using Xenon lamp as excitation source at display research Lab, Department of Applied Physics, Faculty of Technology and Engg., M. S. University, Baroda. The emission and excitation slit was kept at 1.5 nm, recorded at room temperature.

3. RESULTS AND DISCUSSIONS

3.1 Photoluminescence Studies of Zn2GeO4: Base and Eu^{3+} phosphors

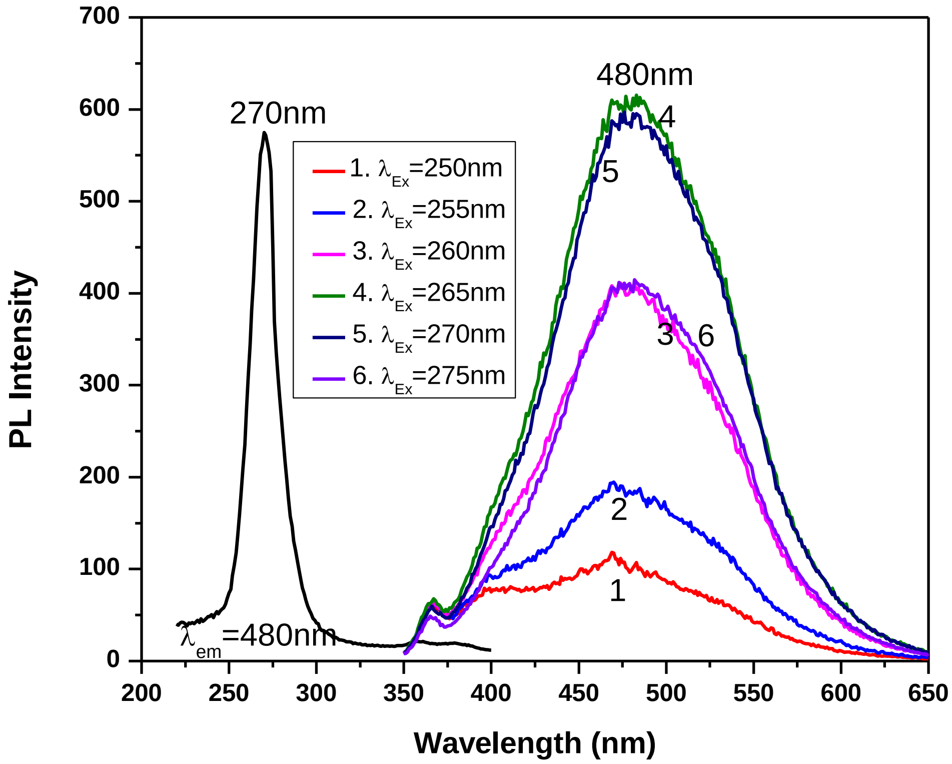

Fig.1 PLE and PL spectra of Zn_2GeO_4 phosphor

Fig 1 is the PL emission and excitation of the Zn_2GeO_4 phosphor. This the phosphor is Excited with 250, 255, 260, 265, 270, 275 nm the PL emission is found around 480nm. When the PL excitation is recorded monitoring at 480nm and excitation is found at 270nm. From the fig 1, it is observed as the excitation wavelength increases the PL emission Increases linearly up to 265nm and this decreases marginally. The highest intensity for 265nm excitation of the 480nm peak of Zn_2GeO_4 is due to resonance energy transfer from Zn to Ge.

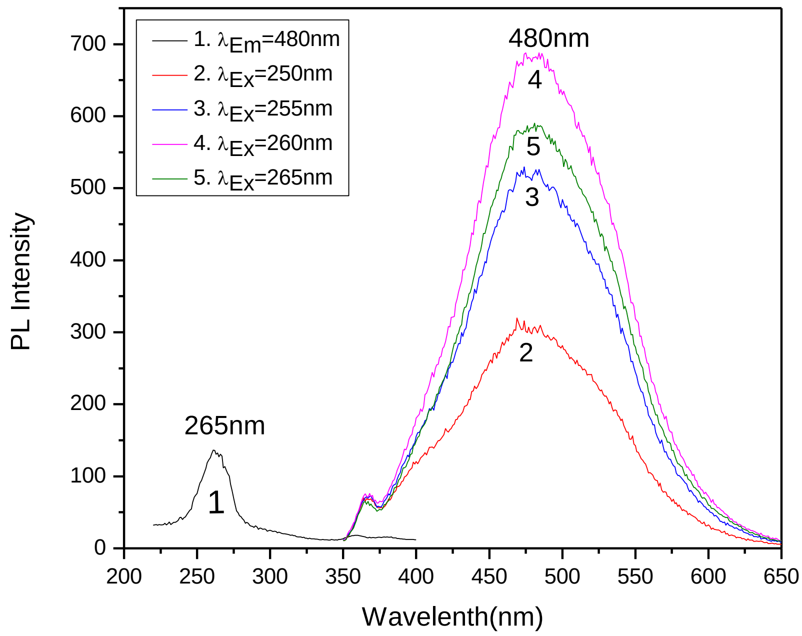

Fig.2 PLE and PL spectra of Eu (0.5%) doped Zn_2GeO_4 phosphor

Fig 2 is the PL emission and excitation spectra of Eu doped Zn_2GeO_4 phosphor. Fig 2 curve 1 is the excitation spectra when monitored at 480nm. Curve2, 3, 4, 5 are the PL emissions for different excitations. As the excitation wavelength increases, the PL emission also increases linearly up to 260nm excitation and reduced marginally for 265nm. The PL emission of Eu doped Zn_2GeO_4 spreads near UV to 620nm peaking at 480 nm (Blue region).

Table 1: Excitation wavelength and intensity of 480nm emission peak of Eu doped Zn_2GeO_4 phosphors

S.No	Sample	Excitation Wavelength(nm)	Intensity of 480 nm Emission Peak
1	Zn_2GeO_4: Eu(0.5%)	250	321
2		255	533
3		**260**	**692**
4		265	591

Here Table 1 is the excitation wavelength and intensity of 480nm emission peak of Eu doped Zn_2GeO_4 phosphor. It is found from the fig. as excitation wavelength increases, the emission intensity of 480nm peak linearly increases upto 260nm excitation for better understanding.

3.2 XRD Pattern of Zn2GeO4: Base and Eu (0.5%) Phosphors

From the XRD pattern, it can be observed both the phosphors looks mostly in a single phase. The crystallite size is calculated using Scherrer's formula d=Kλ/ β cosθ, where 'K' is the Scherer's constant (0.94), 'λ' the wavelength of the X-ray (1.54060 Å), 'β' the full-width at half maxima (FWHM), 'θ' the Bragg angle of the XRD big peak. Using the Schrieffer's formula the crystallite size.

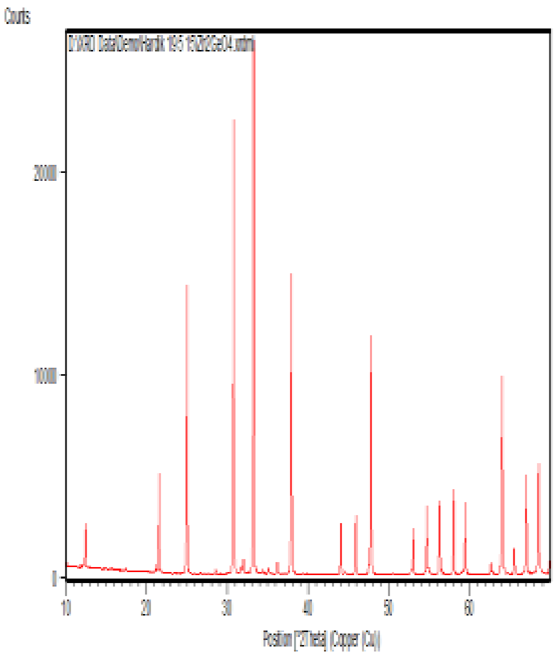

Fig.3 XRD pattern of Zn_2GeO_4 phosphor

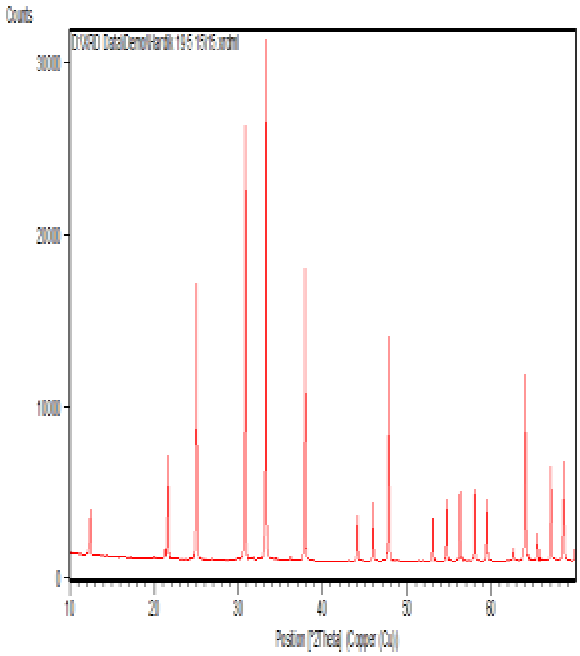

Fig.4 XRD pattern of Eu (0.5%) doped Zn_2GeO_4 phosphor

The calculated crystallite size for the base Zn_2GeO_4 phosphor is 6.35nm and doping of Eu the crystallite size is around 6.89nm. From overall XRD study, the phosphor under study the addition of dopants to the host material did not change their crystallite size significantly.

3.3 SEM diagram of Zn2GeO4: Base and Eu (0.5%) Phosphors

Fig 5 is the SEM of Zn_2GeO_4 phosphor. From the micro graphs, it is found that particles are looks like broken pieces without any shape.

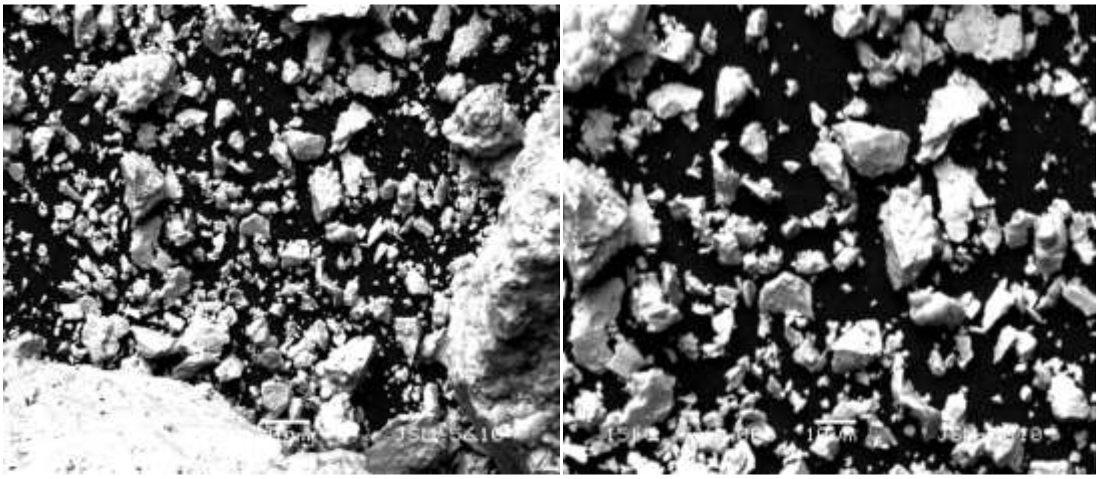

Fig.5 SEM image of Zn_2GeO_4 base phosphor

Fig 6 is the SEM of Eu (0.5%) doped with Zn2GeO4 phosphor. From the micro graphs, it is found that particles are looks like broken pieces without any shape.

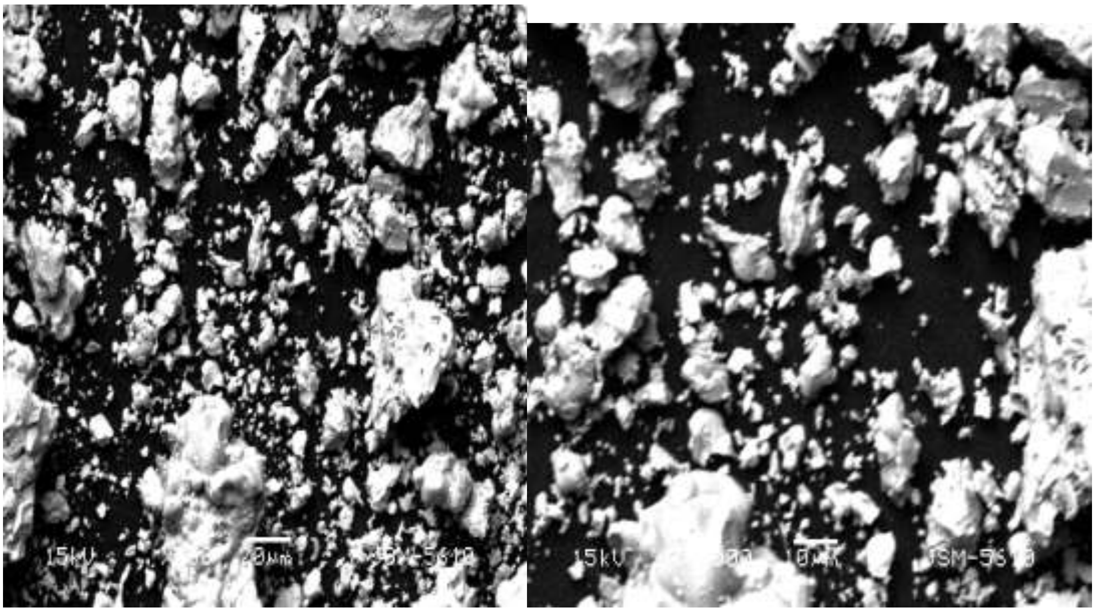

Fig.6 SEM image of Eu (0.5%) doped Zn_2GeO_4 phosphor

3.3 EDS Spectrum of Zn2GeO4: Base and Eu(0.5%) Phosphors

EDS is recorded in the SEM machine where in SEM micrographs are recorded. Here Fig 7 and Fig 8 are the EDS spectra of the phosphors mentioned. In EDS spectrums mostly elements of base materials are seen. However, in the few of the EDS spectrums magnesium is seen which are adjacent elements of the host elements and their contribution to PL is negligible. Therefore, in general, it is normally concluded that the phosphors under EDS study are pure without any impurities.

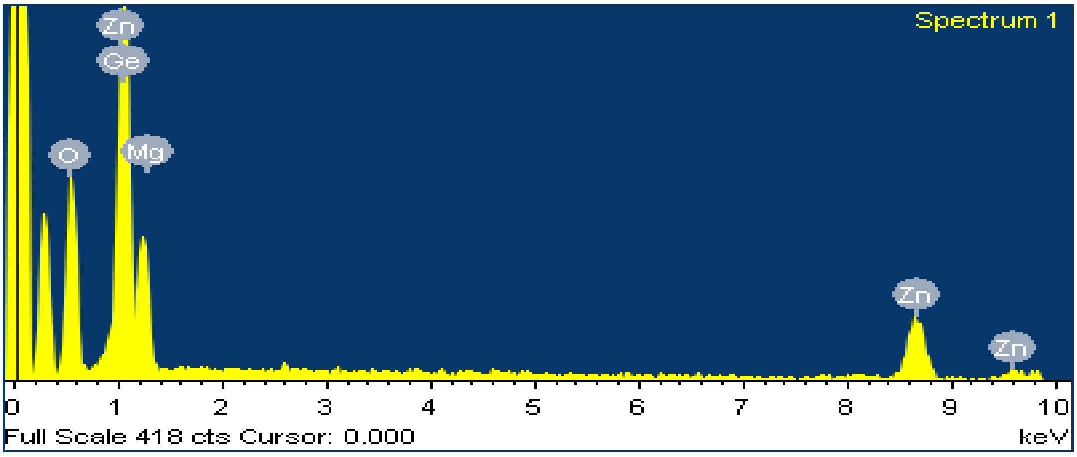

Fig.7 EDS of Zn_2GeO_4 phosphor

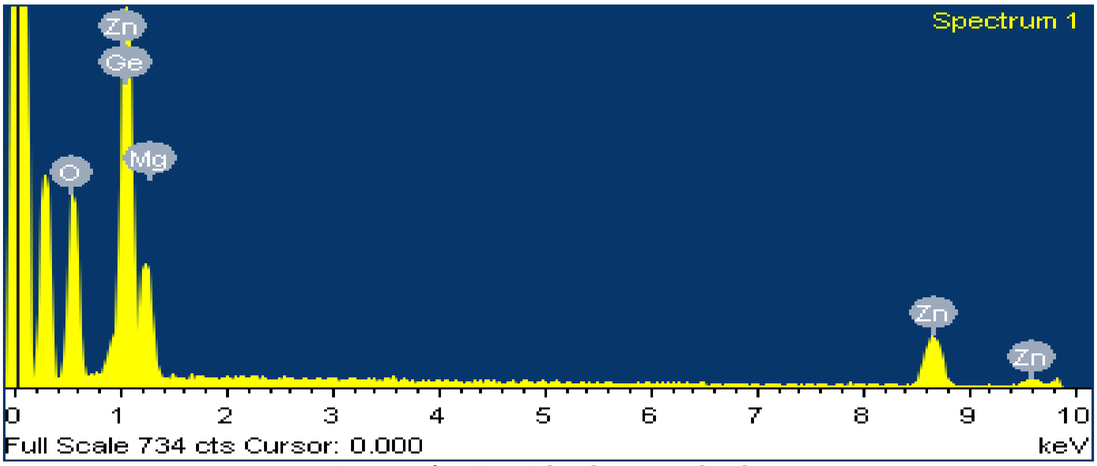

Fig.8 EDS of Eu (0.5%) doped Zn_2GeO_4 phosphor

6.4: PARTICLE SIZE ANALYSIS

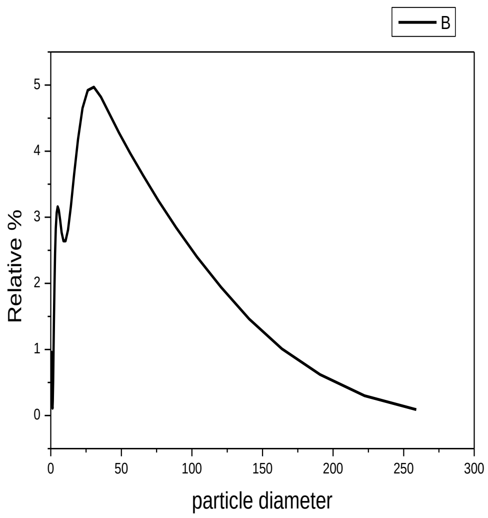

Fig.9 particle size histogram of Zn_2GeO_4 Base phosphor

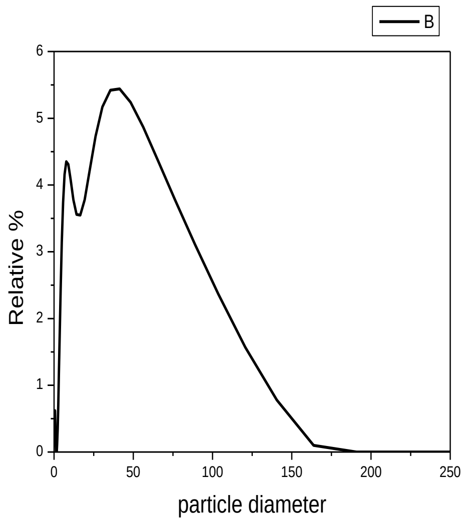

Fig.10 particle size histogram of $Zn_2GeO_{4:\,Eu}$(0.5%) phosphor

Fig.9 and Fig.10 are the particle size histogram of Zn_2GeO_4 base and Eu(0.5%) doped phosphors. For Zn_2GeO_4 the specific surface is 1.125 and for Eu doped, it is 0.816. The specific surface area of the particle reduces gradually as the doping increases.

CONCLUSIONS

- From the fig 1, it is observed as the excitation Wavelength increases the PL emission Increases linearly up to 265nm and this decreases marginally.
- The PL emission of Zn2GeO4 Base when excited to 250 to 275nm found from 350 to 600nm. The maximum PL intensity is found for 265 nm excitation and the emission peaking at perfect blue region peaking at 480nm. This is an interesting observation in Zn_2GeO_4 phosphors.
- The highest intensity for 265nm excitation of the 480nm peak of Zn_2GeO_4 Base is due to resonance energy transfer from Zn to Ge.
- The PL emission of Eu doped Zn_2GeO_4 spreads near UV to 620nm peaking at 480 nm (Blue region).
- It is found from the fig.2 as excitation wavelength increases, the emission intensity of 480nm peak linearly increases upto 260nm excitation.
- XRD study the calculated crystallite size for the base Zn_2GeO_4 phosphor is 6.35nm and doping of Eu the crystallite size is around 6.89nm.
- SEM investigation it is found that particles are looks like broken pieces without any shape.
- EDS study it is normally concluded that the phosphors are pure without any impurities.
- From particle size analysis study the specific surface area of the particle reduces gradually as the doping increases and comparing the particle size histogram it is suggested high power ball milling to get a uniform size. Hence we are can use this phosphor on display devices

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