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Synthesis and Photoluminescence Studies of $Mg_{0.5}ba_{0.5}ga_2o_4$:$0.1eu^{3+}$ Phosphor For White Led Applications

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Abstract: $Mg_{0.5}Ba_{0.5}Ga_2O_4$ doped with 0.1 Eu^{3+} has been synthesized by high temperature solid state reaction using powders of high purity (99.99%) $MgCO_3$,$BaCO_3$, Ga_2O_3, Eu_2O_3. Characterization of $Mg_{0.5}Ba_{0.5}Ga_2O_4$:0.1 Eu^{3+} includes X-ray diffraction analysis, SEM and photoluminescence (PL) studies to know about the photoluminescence application of the material.XRD studies revealed that the prepared ceramic is single phase with hexagonal structure and PL emission spectra of was recorded by exciting the sample at 393 nm corresponds to strong emission peaks centered at 613 nm.

Key Words: XRD,SEM,PL

INTRODUCTION

White light-emitting diodes (LEDs) have attracted much attention today because of its low energy consumption and environmental friendliness. Rare earth doped materials are currently used for white LED applications [1]. Here our interest of study is $Mg_{0.5}Ba_{0.5}Ga_2O_4$ doped Eu^{3+} ion.

Gallium oxide host materials have attracted many interests due to its applicability in electroluminescent devices [2] Generally in optoelectronic devices, gallium oxide is used as phosphors .The host material Gallium oxide Ga_2O_3 belongs to conducting transparent

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semiconducting oxides (TSO) family [2].BaGa2O4 is an oxide phosphor having photoluminescence spectrum of broad emission between 350-650 nm. Generally $BaGa_2O_4$ shows emission in the bluish region. The emission range slightly varies in $Mg_{0.5}Ba_{0.5}Ga_2O_4$ as compared to BaGa2O4. Doping Eu^{3+} with $Mg_{0.5}Ba_{0.5}Ga_2O_4$, the emission changes to red region

EXPERIMENTAL METHODS

Synthesis

The $Mg_{0.5}Ba_{0.5}Ga_2O_4$:0.1Eu^{3+} was prepared via high temperature solid state reaction method. The starting reagents were high purity purchased from SigmaAldrich. The raw materials were weighted stoichiometrically and mixed thoroughly for 2 hrs in an agate motor and pestle. The slurry is dried using hot air oven. Then sample is finally grounded.

Characterization

Characterization of $Mg_{0.5}Ba_{0.5}Ga_2O_4$ doped 0.1 Eu3+ includes X-ray diffraction analysis for phase identification, the morphology of the sample is studies by SEM analysis and photoluminescence studies to know about the photoluminescence application of the material.

RESULTS AND DISCUSIONS

XRD Analysis

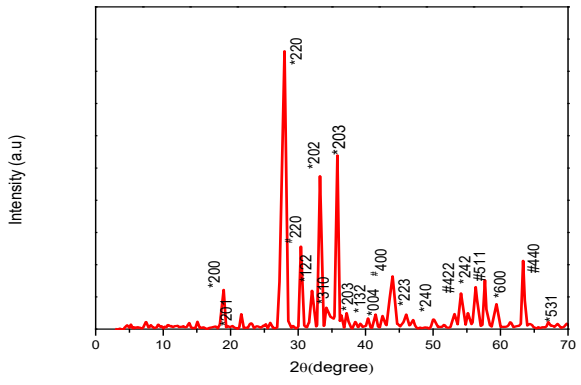

Fig.1.XRD pattern of $Mg_{0.5}Ba_{0.5}Ga_2O_4$:0.1 Eu^{3+}

XRD of $Mg_{0.5}Ba_{0.5}Ga_2O_4$: 0.1 Eu^{3+} matches with the JCPDS card no 46-0415 and 89-3082 $MgGa_2O_4$. The sharp peaks in the XRD pattern of the sample reveals the crystallanity of the sample prepared by high temperature solid state reaction method [3].Substitution of dopant has no role in changing the structure of the sample [4].

MORPHOLOGY

Fig.2. shows the SEM image of $Mg_{0.5}Ba_{0.5}Ga_2O_4$: 0.1 Eu^{3+}.The practices crystallised to irregular shapes were show in the SEM micrographs. Agglomeration of particles occurs due to high temperature solid state reactions were observed here. The SEM image shows that the particle size of the prepared sample varies from1 to 5 µm.

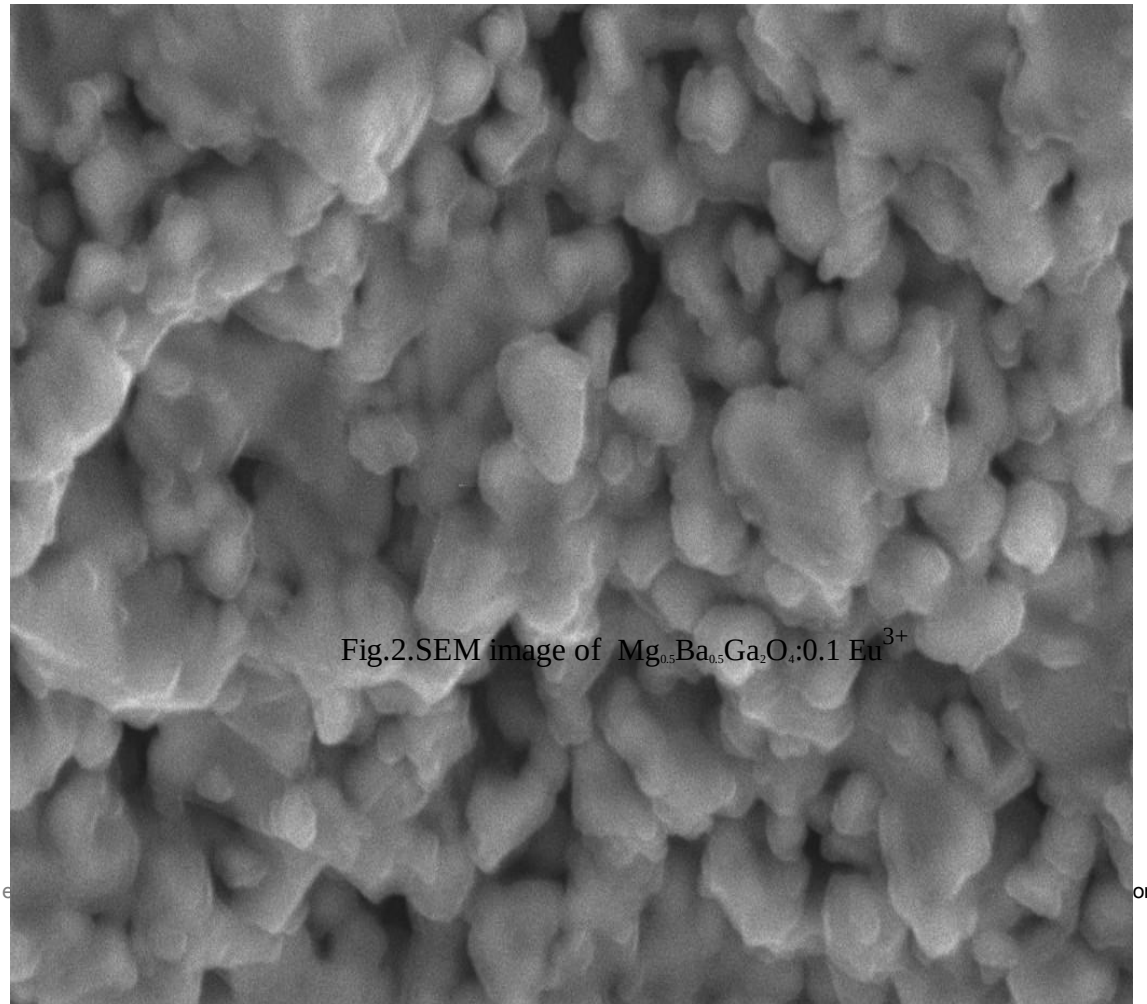

Fig.2.SEM image of $Mg_{0.5}Ba_{0.5}Ga_2O_4$:0.1 Eu^{3+}

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PHOTOLUMINESCENCE STUDIES: The Photoluminescence excitation spectrum of sample is shown below. The excitation spectra consist of a broad band ranging from 230-350 nm with maximum at 285 nm and a series of narrow lines ranging from 350-550 nm.The Photoluminescence excitation spectrum of sample is shown below. The excitation spectra consist of a broad band ranging from 230-350 nm with maximum at 285 nm and a series of narrow lines ranging from 350-550 nm.

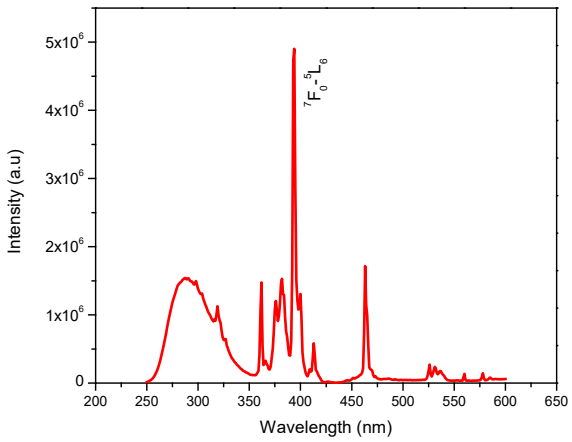

Fig. 3. PL excitation spectrum of $Mg_{0.5}Ba_{0.5}Ga_2O_4$:0.1 Eu^{3+}

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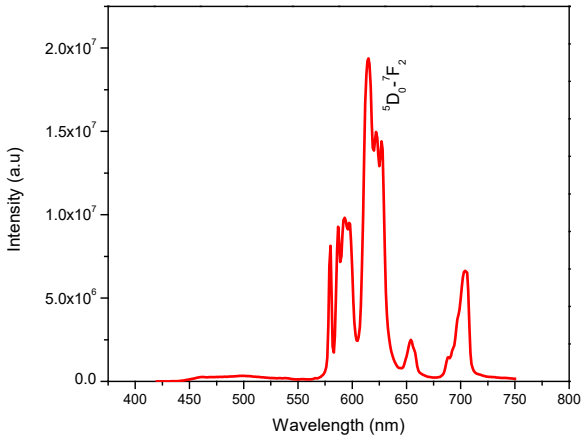

Fig.4. shows the PL emission spectra of $Mg_{0.5}$ $Ba_{0.5}Ga_2O_4$:0.1 Eu^{3+}

The broad band corresponds to charge transfer band from o^{2-} Eu^{3+} and the sharp lines at 373 ($^7F_0$-$^5D_4$) ,393($^7F_0$-$^5L_6$), 450 ($^7F_0$-$^5D_3$) ,465 ($^7F_0$-$^5D_2$) corresponds to the intra-configurational 4f-4f transitions of Eu^{3+} [5,6]. The increase in the excitation strength of $^7F_0$-$^5L_6$transition contribute the enhancement of red emission in the 0.1 Eu^{3+} doped $Mg_{0.5}Ba_{0.5}Ga_2O_4$ phosphor.The emission spectrum obtained with an excitation wavelength of 393 nm in $Mg_{0.5}Ba_{0.5}Ga_2O_4$: 0.1 Eu^{3+} shows a strong emission peak and two weak emission peaks in the red region.. Multiple peaks were observed from 560 to 750 nm range which may be due to D_0^5-$F_J^7{}_{(J=0,1,2,3)}$ transitions of Eu^{3+} [4,7]. The peaks at 592, 613, 660, 702 are corresponding to $^5D_0$-$^7F_1$, $^5D_0$-$^7F_2$, $^5D_0$-$^7F_3$, $^5D_0$-$^7F_4$ transitions. The emission spectrum of $Mg_{0.5}Ba_{0.5}Ga_2O_4$: 0.1 Eu^{3+} shows a strong red emission

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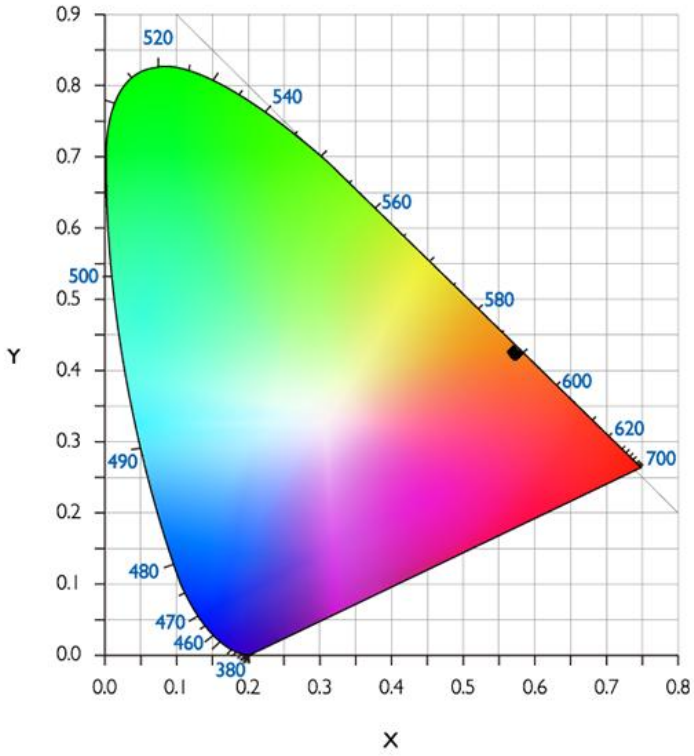
transition of $^5D_0$-$^7F_2$ at 615 nm [8].The spectrum dominated by red emission and is in need for white LED application.



From CIE diagram it is clear that the calculated value of x, y coordinate from the photoluminescence emission spectra lies in the red region of the diagram. The value of the X,Y co-ordinates are (0.57,0.42). The material show orange-red emission and hence $Mg_{0.5}Ba_{0.5}Ga_2O_4$: 0.1 Eu^{3+} is applicable for general lighting sources as white light LEDs.

CONCLUSION

$Mg_{0.5}Ba_{0.5}Ga_2O_4$: 0.1 Eu^{3+} sample was successfully synthesised by solid state reaction method. The sample was successfully synthesized by solid state reaction method. The sample was characterized by Powder XRD. Morphology of the sample was studied by SEM analysis.When the sample is doped with 0.1 Europium, a strong red emission transition of $^5D_0$-$^7F_2$ at 615 nm

observed. The PL emission spectrum of the sample shows orange-red emission. This confirms that the material is applicable for white LED generation.

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