Luminescent Properties of Phosphors For W-Led Applications

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Abstract*- Motivated by the need for new red phosphors for solid-state lighting applications Eu^{3+}-activated $SrMoO_4$ phosphor has been synthesized by mechanochemically assisted solid state meta thesis reaction at room temperature and an efficient red emission under near-ultraviolet excitation is observed. The emission spectrum shows a dominant peak at 614nm due to the $^5D_0 \rightarrow {}^7F_2$ transition of Eu^{3+}. The excitation spectrum is coupled well with the emission of UV LED (350-410 nm) and blue LED (450-470 nm). The result show that $SrMoO_4:Eu^{3+}$ is a very appropriate red-emitting phosphor for white LEDs.*

Keywords- life time, luminescent materials, phosphor,

I. INTRODUCTION

Recently, white light-emitting diodes (LEDs) have attracted more attention because they have advantages of low energy consumption, long lifetime, without pollutants and so on. It is well-known that there are basically two approaches to generate white light from LEDs [1-3].

Recently, $SrMoO_4$ doped with rare earth are still scarce nowadays and have attracted great attention due to their applications as scintillating materials in electro-optical like solid-state lasers and optical fibers, for instance and it also had become an important luminescent material being used for pc-LED because of their excellent thermal stability and chemical stability [10]. To the best of our knowledge , so for no paper has been published on the preparation of rare earth ion doped SrMoO4 : Eu^{3+}phosphors by SSM. Based on these considerations, in this paper, we report the preparation of SrMoO4 phosphors by SSM process and report their photoluminescence (PL) properties.

II. EXPERIMENTAL

2.1. Preparation of SrMoO4:Eu^{3+} phosphors:

The phosphor $SrMoO_4$: 0.02 Eu^{3+} were synthesized by mechanochemically assisted solid state meta thesis reaction at room temperature . The starting materials were a stoichiometric mixture of analytical grade $SrCl_2$. 6 H_2O, Na_2MoO_4.2H_2O and Eu_2O_3(99.99%).Firstly, the mixture were milled for a period of two hours in a planetary ball mill Pulverisette 7 (FRITSCH). Milling was carried out in two grinding vials of 15 ccm volume containing balls with diameter of 12 mm. Both the container and balls were made of tungsten carbide material. The number of milling balls and of the rotation speed of the planetary system of milling device was kept constant. The solids were washed with water to remove sodium chloride that is a by-product of the reaction and dried around 80 ^oC.

2.2. Measurement procedure

The phase of as-prepared sample was characterized by powder X-ray diffraction (XRD)

(Pan Analytical X'pert pro , Cu Kα, 40 kV, 30 mA). Photo luminescent excitation and emission spectra were measured on a Jobin Yuvon Flurolog -3-11 Spectroflurometer. Optical absorption spectra were recorded using Systronics-2101 UV–visible- double beam spectrophotometer.

III. RESULTS AND DISCUSSION

3.1 XRD analysis of SrMoO4:Eu^{3+} phosphor:

Fig.1 shows the XRD pattern of $Sr_{1-x}MoO_4$:xEu^{3+} prepared by SSM. The position and the intensity of diffraction peaks of the sample is consistent with Joint Committee on Powder Diffraction Standards (JCPDS No.85- 0586), which indicates that the sample is pure phase. The doped Eu^{3+} ions have not caused any significant change in the host structure. So the prepared sample was single-phase $SrMoO_4$ in scheelite structure.The average crystallite size was approximately estimated by the Scherrer's equation using thefull width at half maximum (FWHM) of the most intense peak (1 1 2). As reported in the literature [11], the Scherrer's equation (Eq. (1)) is described as follows:

$$D = 0.9\lambda/B \cos \theta \qquad (1)$$

where λ is the wavelength of Cu-K alpha (1.54059A°), θ is the angle of Bragg diffraction and B is the FWHM.

Based on this equation, the average crystallite size of $SrMoO_4$: Eu^{3+} powder was obtained as 48 nm.

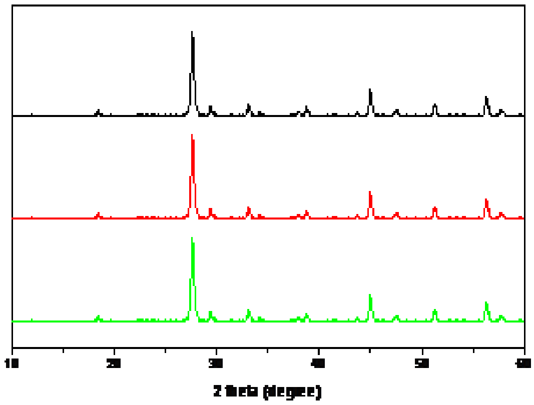

Fig. 1. XRD pattern for SrMoO4 and $SrMoO_4$: 0.04 Eu^{3+} samples.The standard data for scheelite type SMO (JCPDS No. 85-0586) is also presented in the figure.

3.3 Photoluminescent properties of SrMoO4:Eu^{3+}

The excitation and emission spectrum of *SrMoO4:Eu^{3+}* phosphor prepared by Mechanochemically assisted solid state meta thesis reaction is investigated in this study.

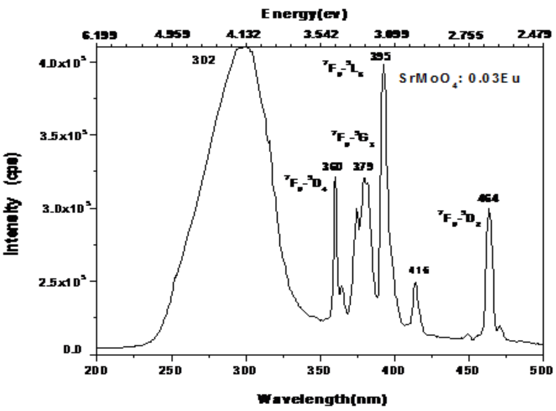

Fig.3. UV excitation spectrum of $SrMoO_4$:0.04 Eu^{3+} phosphor monitored at 615nm

The excitation spectrum by monitoring $^5D_0$-$^7F_2$ emission of Eu^{3+} in $SrMoO_4$: Eu^{3+} phosphor is given in Fig.3. The broad excitation band from 225 nm to 350nm is ascribed to the Eu-O charge-transfer (C-T) transition while the lines in 350–500 nm range belong to the transitions between the ground level $^7F_0$ and the excited levels $^5D_4$, ^5G_J, $^5L_6$, $^5D_2$, respectively. The narrow peaks located at wavelengths longer than 350 nm include 369($^7F_0$-$^5D_4$), 379($^7F_0$-^5G_J), 395($^7F_0$-$^5L_6$), 464($^7F_0$-$^5D_2$). The $^7F_0$-$^5L_6$ and $^7F_0$-$^5D_2$ transitions at 400 and 468 nm are two of the strongest absorptions in the region of 350-500 nm. It is good phenomenon that our novel phosphor can strongly absorb ultraviolet light (400 nm), which is nicely in agreement with the near-UV wavelengths of GaN based LED chips.

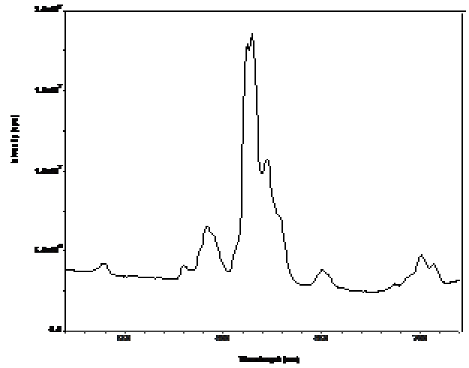

Figure.4. PL emission spectrum of $SrMoO_4$: 0.02 Eu^{3+} phosphor at 395 nm excitation.

Fig.4 shows the emission spectra of $SrMoO_4$:Eu^{3+} under direct excitation the $^7F_0$-$^5L_6$ transition of Eu^{3+} at 395 nm. The $SrMoO_4$:Eu^{3+} is composed of a series of linear spectra. Typical linear emission peaks of Eu^{3+} can be observed in the range of 550–700 nm and ascribed to the transition $^5D_0$ level to $^7F_1$, $^7F_2$,$^7F_3$ and $^7F_4$ levels of Eu^{3+}, respectively, such as $^5D_0 \rightarrow {}^7F_1$ (589nm, 593nm), $^5D_0 \rightarrow {}^7F_2$ (610 nm, 623nm), $^5D_0 \rightarrow {}^7F_3$ (651 nm), and $^5D_0 \rightarrow {}^7F_4$ (682 nm). It is well known that the $^5D0 \rightarrow {}^7F_1$ transition belongs to magnetic dipole transition which scarcely changes the crystal field strength around the Eu^{3+} ions and this transition is independent of the symmetry and the site occupied by Eu^{3+} ions in the host. While the transition of $^5D_0 \rightarrow {}^7F_2$ belongs to a forced electric dipole transition and its intensity is very sensitive to the site symmetry of the Eu^{3+} ions.

IV. CONCLUSIONS

In the present work, the $SrMoO_4$:Eu^{3+} phosphor has been synthesized by mechcanochemically assisted solid state meta thesis reaction at room temperature for the first time. The phosphors exhibit a red emission with the strongest emission peak at 614nm. The strongest excitation peak is located at 395 nm in the UV and blue light region.The results indicate that SrMoO4:Eu^{3+} is a potential phosphor for UV LED due to a strong excitation peak at 395 nm.

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