SOL GEL SYNTHESIS AND CHARACTERIZATION OF THE $SrAl_4O_7$: Mn NANO PHOSPHORS

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Mn doped SrAlO nano phosphors were synthesized by adopting a simple Sol-Gel Method. X-Ray Diffraction (XRD) profile confirms the monoclinic nature of Mn doped SrAlO nano phosphors. The results show that SrAlO:Mn with an average particle size of 80 nm is formed. In addition, Scanning electron microscopy (SEM), Energy Dispersive X-ray Spectroscopy (EDS) and Fourier-Transform IR spectroscopy (FTIR) were also used to characterize the synthesized phosphor. The efficiency of the prepared phosphors was analyzed by means of its emission spectral profiles. We also observed a rich IR emission from the prepared phosphors under a Ultra-Violet (UV) source. Such luminescent powders are expected to be applied as IR sensor and MRI device applications.

INTRODUCTION

Semiconductor nanomaterials have received great attention. Among these various semiconductor oxide nanomaterials, strontium aluminium oxide is a versatile material because of its physic-chemical properties such as; mechanical, electrical, optical, magnetic and chemical sensing properties. Now a days, various routes have been used for the synthesis of SrAlO nanomaterials, such as; sol–gel synthesis, hydrothermal/solvothermal meth-ods, microemulsion method, precipitation, and physical vapor deposition. Sol-gel method gives homogenous, high-purity, and high-quality nanopowders. The morphology of the nanoparticles can be changed by changing the solvents.

By Sol-gel method $CaOSrOAl_2O_3$ thin films using metal alkoxides were prepared and its characteristics were analysed [1]. Structural and optical properties of $CaOSrOAl_2O_3$ thin films were derived by sol-gel dip coating process [2]. Doped alkaline earth aluminates processed doped alkaline earth aluminates were synthesized by using sol-gel method [3]. Luminescent properties of europium-activated phosphors were synthesized by using sol-gel method [4]. Characterization study of Zno nanoparticles were synthesized by using solar lamp and plasma display phosphors are based on compounds in the alkaline-earth–rare-earth–aluminate systems. A variety of activators were used of which the most important are Eu, Ce, Tb, and Mn. This work is concerned with the systematic relations between luminescence emission and crystal structure for Dy and Mn-activated alkaline earth aluminates.

EXPERIMENT

In our paper we prepared $SrAl_4O_7$: Mn powder using Sol-gel method. All the reagents used in the experiments were in analytical grade and used without any further purification. The procedure of synthesizing nanoparticles is thoroughly described as follows: 98 wt.% of

2M Strontium acetate $[(CH_3.COO)_2\ Sr.2H_2O$ was dissolved in 25ml of 2-methoxyethanol with vigorous stirring. 1 wt.% of 2M Manganese nitrate $[(CH_3.COO)_2\ Mn.2H_2O]$ was dissolved in 25 ml of 2-methoxyethanol with vigorous stirring. Simultaneously, 1 wt.% of 2M Aluminum acetate $[C_4H_6AlO_4.4H_2O]$ was dissolved in 25 ml of 2-methoxyethanol with vigorous stirring and subsequently, it was added to the first solution to reach 50 ml in total. Then it was stirred for 30 min at room temperature for the second time. Ammonia was slowly added to this solution with a constant stirring until a pH of 10.5 was achieved. After the stirring of the solution for 30min, acetic acid and ethylene glycol in the ratio1:1 was added to the solution. The sol was heated at 80°C while being mechanically stirred with a magnetic stirrer. As the evaporation proceeded, the sol turned into a viscous gel. The gel was aged for 2h and then dried at 100°C for about 5h. The resulting materials were well grinded and annealed at 950°C for 2h to obtain Mn doped $SrAl_4O_7$ nanopowders. For the preparation of the gel precursors with different wt%, the same procedure was repeated with the wt% of Manganese nitrate being varied to 0.5, 2, 3, 4 and 5.

Results and dissection

Morphological Study

Figure 1 shows the SEM image of $SrAl_4O_7$: Mn .The micrograph indicates that nearly all the powder particles were composed of same shape nanoparticles. The presence of bigger particles is attributed to the growth of small particles, which is a result of the sol–gel synthesis. Under the reaction time and temperature, some of the tiny particles underwent a self- induced process, aggregate and growth forming bigger particles.

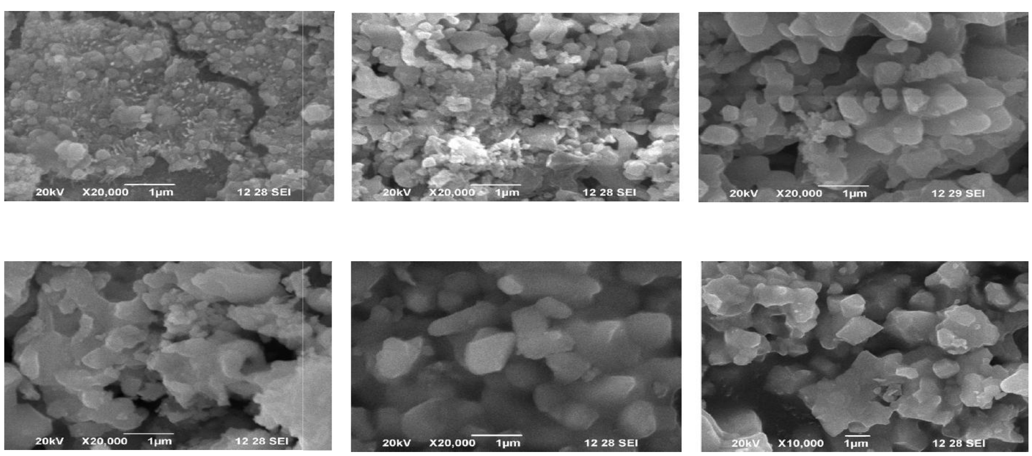

Fig. 1. The SEM image of $SrAl_4O_7$: Mn

X-Ray Diffraction (XRD)

The structure and phase purity of the SrA1O : Mn phosphor were investigated by XRD. The XRD patterns were obtained and are shown in Fig. 2 for SrA1O: Mn. Diffraction patterns were obtained using CuKα radiation (λ = 1.54051 A^0), at 30kV and 15 mA. Measurements were made from $2\theta = 10^0$ to 80^0 with steps of 0.02°. The XRD patterns of the powders revealed that the structure of $SrAl_4O_7$ is Monoclinic, which is match with JCPDS data card No. 25-1289. The crystallites are less than approximately 50-90nm in size appreciable broadening in the X-ray diffraction lines. SEM images $SrAl_4O_7$: Mn, which is un-uniform and may be due to the formation of fractal attribution to sort of self organization. SEM image of $SrAl_4O_7$ sintered at 900ºC for 3hrs appears to be irregular shape.

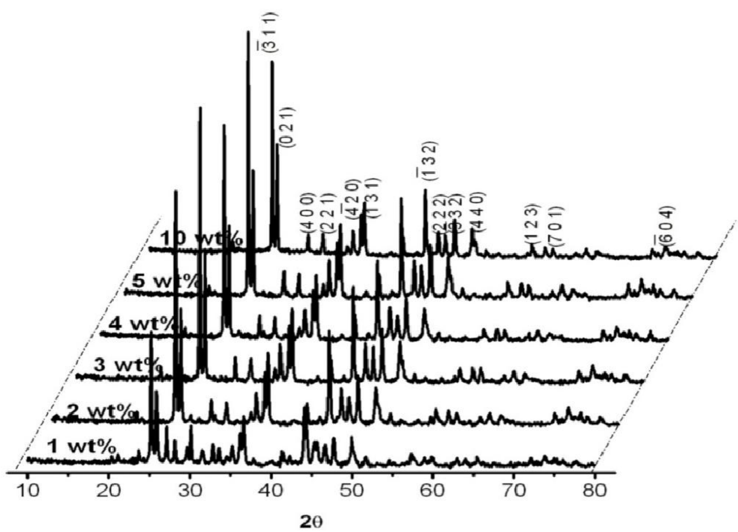

Fig. 2. XRD images of Mn doped $SrAl_4O_7$ at different wt%

FTIR study.

The figure 3 shows typically metal-oxygen absorption peak at 857 cm^{-1} and 550 cm^{-1}. The strong IR absorption at 857 cm^{-1} indicates the stretching vibrations of Sr–O bonding and vibration peak at 550 cm^{-1} is attributed to Al–O bonding. The absorption peaks in the 550–850 cm^{-1} region are attributed to the SrAlO characteristic absorption corresponding to the Al–O stretching and bending modes in AlO_4 tetrahedral . There is a distinguishable and repeatable peak near 3540 cm^{-1}; assigned to the stretching vibration of O–H on the films surface

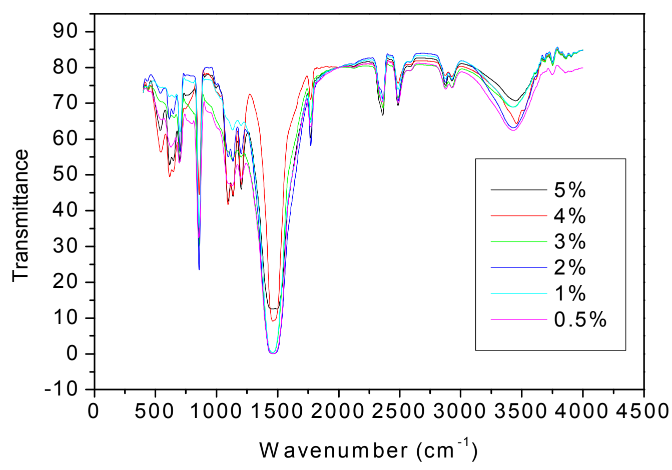

Fig. 3. FTIR spectra of Mn doped $SrAl_4O_7$ at different wt% of Mn.

Optical Study

The photoluminescence emission spectra of the $SrAl_4O_7$:Mn shown in the Figure 4, The PL properties of $SrAl_4O_7$:Mn nanopowders were measured at room temperature. In this figure, the PL spectra of both Dy and Mn doped $SrAl_4O_7$ consisted of three parts: one strong peak in the blue region, one weak band in green region and other emission bands in UV light region. $SrAl_4O_7$:Mn nanocrystals are found to have increased photoluminescence efficiency associated with the magnetic impurity Mn2+. For small particles like the $SrAl_4O_7$: Mn nanocrystals, majority of the Mn2+ ions are at the near surface sites and occupy axial or lower symmetry .

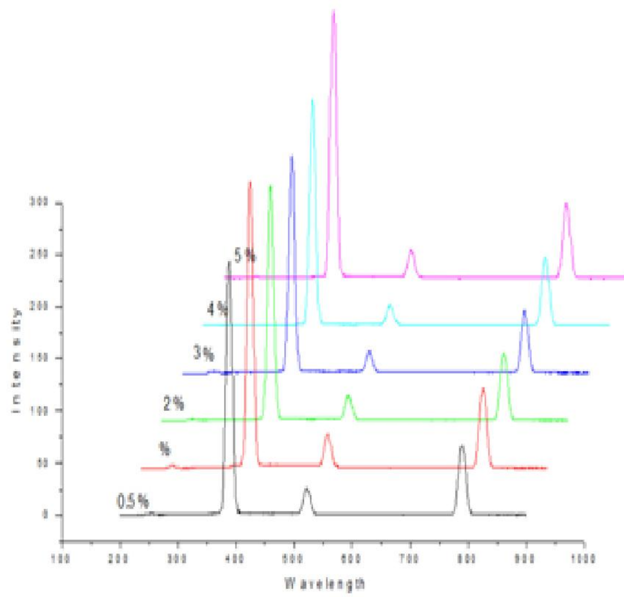

Fig. 4. Photoluminescence spectra of Mn doped $SrAl_4O_7$ at different wt% of Mn

Conclusion

In this paper, by using sol-gel method $SrAl_4O_7$: Mn nanoparticles were synthesized. Materials characterization such as; X-ray diffraction (XRD), photoluminescence (PL) emission spectra, scanning electron microscopy (SEM) were analysed. In the results, we report the Mn doped phosphor generates a strong emission at 395 nm,520nm in green region. The prepared $SrAl_4O_7$: Mn nanoparticles are applicable for fluorescent lamp and plasma display applications. The prepared Strontium Aluminate nano powder exhibits monoclinic structure.

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