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Sol-Gel Derived Luminescent $SrAl_4O_7$:Mn Nanophosphors

KEYWORDS: XRD, FTIR, UV-VIS, sol–gel method,Photoluminescence

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ABSTRACT *In this paper, monoclinic SrAl4O7:Mn phosphor was synthesized by low temperature sol–gel method for 5 weight percentages of Dy. The prepared samples were characterized by X-ray diffraction (XRD) analysis, UV-VIS and photoluminescence emission spectra (PL). The XRD analysis showed that SrAl4O7 have monoclinic structure. It was found that PL emission was obtained at 395 nm, 520 nm,790 nm corresponding to blue, green and IR region of the spectrum, respectively.*

Introduction

In last decade nano sized materials have drawn the attention of scientists and researchers worldwide because of their potential impact in many fields like photonics, electronics, sensing and catalysis [1]. These materials possess large number of applications in the areas of organic solar cells, carbon nano tubes (CNTs), solid state batteries, super plastic ceramics, multifunctional materials, molecular electronics, biosensors and lasers [2]. Such materials take advantage of size induced changes in structural, optical and electronic properties to create enhanced luminescent materials, whose properties differ from the corresponding bulk phase [3].The interest in the rare earth doped alkaline earth aluminates has been largely due to their high luminescence efficiency under UV excitation and their ability to maintain their phosphorescence for several hours. The paper by Matsuzawa et al. [4]describes the phosphor SrAl2O4:Eu2 +, Dy3 + and states that the phosphorescence of this new phosphor is so bright and long lasting that it can be perceived almost throughout the entire night. Many authors have concentrated their efforts in understanding the mechanism of long duration phosphorescence in these materials [5,6]. This work is concerned with the systematic relations between luminescence emission and crystal structure for Mn activated alkaline earth aluminates.

EXPERIMENT

The materials used for synthesis are strontium nitrate and aluminium nitrate and all other materials are 99.9% pure. The preparation of the samples are as described in the flowchart.

figure.1 flowchart for the preparation of $SrAl_4O_7$:Mn

Characterization.

1. XRD Analysis

In order to determine the crystal structure and to establish chemical nature of the product, XRD study is carried out. $SrAl_4O_7$ has two phases, a high-temperature hexagonal phase (β-phase) and a low temperature monoclinic phase (α-phase). The XRD patterns of the powders revealed that the structure of $SrAl_4O_7$:Mn is monoclinic. Figure does not shows any variation of peak positions for peaks with Mn doping. This result indicates that the lattice parameter remains unchanged within the experimental error. No diffraction peaks of Mn or other impurities phases are detected in all samples, indicating that Mn ions would uniformly substitute into the Sr sites or interstitial sites in SrAlO lattice

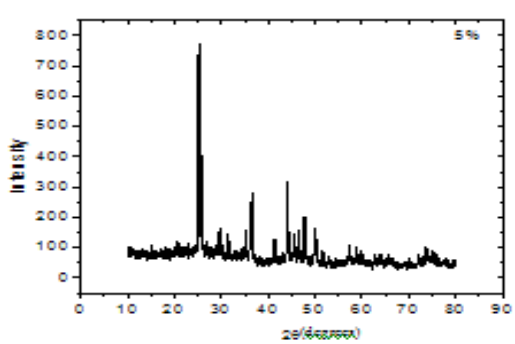

figure.2 XRD analysis of $SrAl_4O_7$: Mn

2.TG–DSC

To investigate the reaction that took place in the process of sample preparation, simultaneous TG–DSC testing was conducted from room temperature to 1000˚C. The TG–DSC curves of the precursor are shown in Fig. 3. From the figure three discrete weight loss regions are detected at the temperature ranges of 150–200˚C, 350–500˚C and 850–950˚C. The first weight loss results from desorption of the adsorbed moisture and the evaporation of organic solvents. The weight loss in the temperature range of 350–500˚C is attributed to the combustion of the organic constituents. The weight loss in the temperature range of 850–950˚C correspond to the marked weight loss process, which indicates that the precursor decomposes and strontium aluminate compounds form at this temperature.

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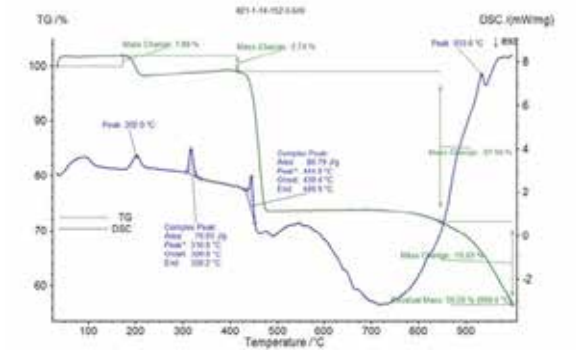

figure.3 TG–DSC analysis of $SrAl_4O_7$: Mn

3.EDS

The compositional analysis of the samples were determined by EDS is shown in Figure.4.

As can be seen in Fig. 4, the eight X-ray emission peaks at 0.53, 1.27, 1.50, 1.82, 6.52, 9.66, 14.22 and 15.8 keV can be attributed to the characteristic X-ray emissions of O(Kα1),Mn (Mα1), Al(Kα1), Sr(Lα1), Mn(Mα1), Au(Mα1) & Au (Lα2) and Sr(Lα1)respectively. These data indicate that the Mn^{3+} ions have entered in to the host $SrAl_4O_7$.

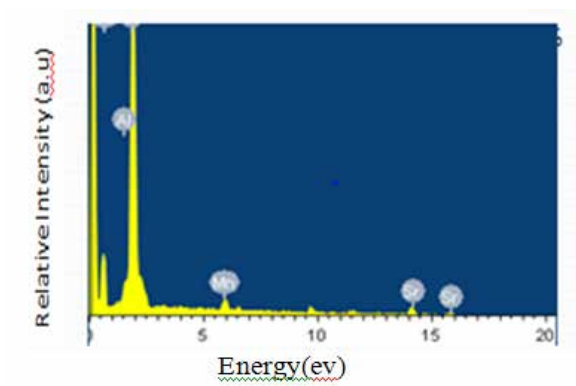

figure.4 EDS spectra of $SrAl_4O_7$: Mn

4.Photoluminescence

The Photoluminescence emission spectrum of doped $SrAl_4O_7$ phosphor is shown in Fig 5. Which obtained under the excitation wavelength 360nm . when the pure $SrAl_4O_7$ phosphor excited with 360nm emission peak at 395nm and 520nm, a perfect exciton emission and green emission with very good intensity. However the effect of Mn is not effectively modified the emission wavelength of pure phosphor.

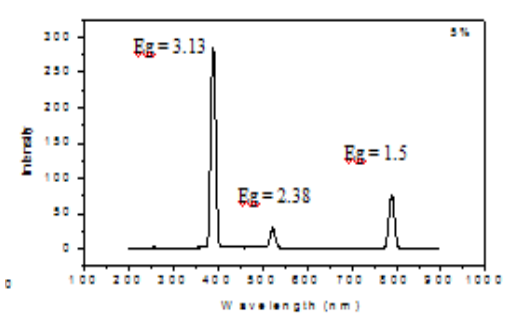

figure.4 Photoluminescence spectra of $SrAl_4O_7$: Mn

Conclusion

The phosphors $SrAl_4O_7$:Mn at 5wt% of Mn with a monoclinic structure were successfully prepared by Sol-Gel method. The characteristic peaks of $SrAl_4O_7$:Mn phosphors were observed and they are located at 395 nm, 520 nm and 790 nm which are corresponding exciton emission and the green emission.The compositional analysis of the samples were determined by EDS. Three discrete weight loss regions are detected at the temperature ranges of 150–200˚C, 350–500˚C and 850–950˚C. From XRD,no diffraction peaks of Mn or other impurities phases are detected in all samples, indicating that Mn ions would uniformly substitute into the Sr sites or interstitial sites in SrAlO lattice.

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