



Preparation and photoluminescence property of One dimensional $Sr_3(VO_4)_2: Eu$ Nano fiber

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Abstract

One dimensional $Sr_3(VO_4)_2: Eu$ nanofibers were prepared by dispersion of ultrasonicated sol-gel derived nanoparticles of $Sr_3(VO_4)_2: Eu$ annealed at $950^\circ C$ for two hours after ultrasonicated then dispersed in PVA solution. The fibers were drawn by using convenient electrospinning process. The nanofibers sheet was characterized through XRD, and SEM for their structural and morphological conformation. Moreover the paper reveals the comparative PL study of nanopowder (sol-gel derived) and nanofibers.

Keywords: electrospinning, photoluminescence (PL), nanofibers, vanadates.

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1. INTRODUCTION

Nowadays much attention has been paid towards the synthesis and preparation of one dimensional (1 D) nonmaterial like nanofibers, nanorod, quantum dots etc. due to their novel physical and chemical properties, superior mechanical toughness, metal insulator transition and huge ratio of diameter to length [1,2]. These materials have potential application in many fields such as electronic, photonics, mechanics and sensing [3]. There are number of methods for drawing the one dimensional nanoscales wires, belts, tubes and fibers that have been reported earlier [4,5]. There are many methods for the preparation of one dimensional nonmaterial such as drawing, template synthesis, phase separation, self-assembly, electrospinning [6]. Electrospinning is the most suitable method for the preparation of the one dimensional nanofibers, because it is an efficient, relatively simple and low cost way to produce polymer and composite fibers with diameters ranging from several nanometers to a few micrometers by applying a high voltage to a polymer solution or melt ejected from a micro-syringe pump [7]. The basic set up of electrospinning is as shown in figure 1.

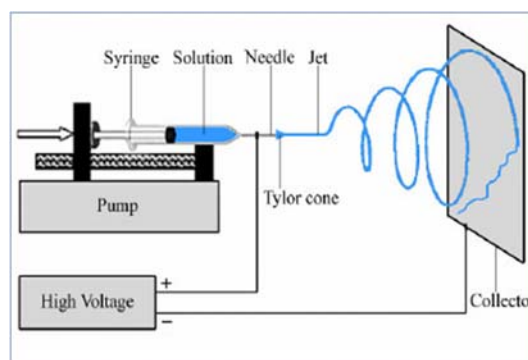


Figure1: Basic set up of electrospinning

Vanadate containing VO_4 group are known to be good luminescence materials due to their chemical and physical properties [8]. The alkaline earth metal ortho vanadates with the general formula $A_3(VO_4)_2$ have attracted much attention because of the broad and deep charge transfer (CT) absorption bands in the near-UV [9]. In vanadate, the charge transfer phenomenon from oxygen to metal ions is basically due to non-radiative mechanism [10,11]. If trivalent rare-earth ions such as Eu^{3+} , Sm^{3+} and Dy^{3+} are introduced into a vanadate host, bright luminescence due to the dopant ions can be observed due to efficient energy transfer processes from the vanadate ions [12]. Due to its properties, vanadates have many potential applications in lamps, X-ray detectors, and solid state lighting [13].

The sol-gel with electrospinning method is preferred for the preparation of material and

drawing the nanofibers. To our best knowledge, we first time report $\text{Sr}_3(\text{VO}_4)_2:\text{Eu}^{3+}$ nanofibers.

2. EXPERIMENTAL

2.1 Preparation of $\text{Sr}_3(\text{VO}_4)_2:\text{Eu}^{3+}$

$\text{Sr}_3(\text{VO}_4)_2:\text{Eu}^{3+}$ was prepared by using sol-gel method. The precursor $\text{Sr}(\text{NO}_3)_2$, NH_4VO_3 and Eu_2O_3 were all are of A.R. grade. All precursors were dissolved in a dilute nitric acid and then mixed with water and citric acid (1:2) as chelating agent for the metal ions. After vigorous stirring, the solution was slowly heated for the removal of water. During heating, a black mass with powder precursors was obtained. Then the obtained material was annealed at 750°C for 1 hour and 950°C for 2 hours.

2.2 Electrospinning process:

The solution was prepared by mixing PVA in distilled water (1:12) along with $\text{Sr}_3(\text{VO}_4)_2$ particles, the solution was stirred for 2 to 3 hours to obtain a homogeneous solution for electrospinning. Flow rate for solution was 1.0 ml/hour, the tip to collector distance was 12 cm and applied voltage was 27 kV.

3. RESULT AND DISCUSSION:

3.1 XRD Analysis:

The structural confirmation of $\text{Sr}_3(\text{VO}_4)_2$ was done by using XRD Rigaku miniflex II X-ray diffractometer with scan speed of $2.000^\circ/\text{min}$ and $\text{Cu K}\alpha$ ($\lambda = 0.15406\text{ nm}$) radiation in the range 10° to 90° . The X-ray diffraction pattern of $\text{Sr}_3(\text{VO}_4)_2$ phosphor matched well with the standard ICDD File no. 01-081-1844. The prepared sample crystallize in the trigonal phase and high intensity peaks were observed at 28.78, 31.83, 43.44, 48.99, 54.85 and 56.70 which are corresponding to (015), (110), (205), (101), (125) and (300) respectively. The XRD also showed that the prepared material is completely crystalline and was in single phase, where $a = b = 5.619\text{ \AA}$ and $c = 20.10\text{ \AA}$. Figure 2 shows the XRD pattern with the ICDD file as shown below.

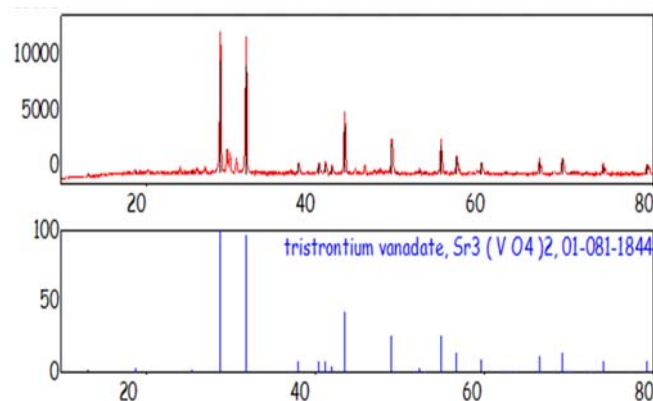


Figure 2: XRD pattern of $\text{Sr}_3(\text{VO}_4)_2$

3.2 SEM Analysis:

Figure 3 shows the morphology of fiber as prepared by the electrospinning with the diameter ranging from 200 nm to $1\mu\text{m}$. SEM photograph clearly shows the formation of the fiber with rod like structure. The formation of fiber is due to the PVA polymer.

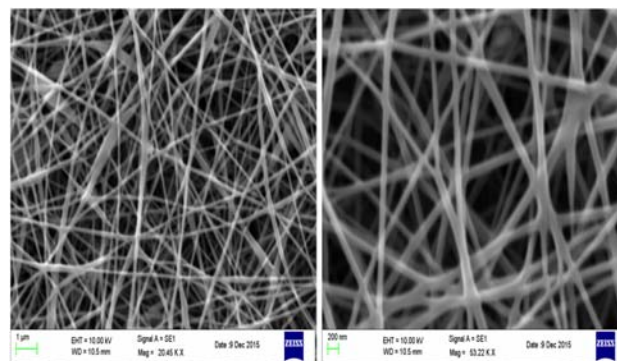


Figure 3: SEM Image of $\text{Sr}_3(\text{VO}_4)_2$

3.3 Photoluminescence:

Figure 4 shows the results of comparative study of photoluminescence (PL) of $\text{Sr}_3(\text{VO}_4)_2:\text{Eu}^{3+}$. We observed that as compared to powder, the photoluminescence intensity of fiber decrease drastically; but as compared to the bulk material the properties such as the dependence of electronic transport and optical properties can be better investigated in the nanomaterial [14]. The PL spectra of $\text{Sr}_3(\text{VO}_4)_2:\text{Eu}^{3+}$ with the concentration of 0.05 mole % the spectra is

shown in figure. The emission of Eu^{3+} depends on its site and the structure of the phosphor [15]. The emission of Eu^{3+} is in the red region; sharp emission of Eu^{3+} is observed at 614 nm due to ${}^5\text{D}_0 \rightarrow {}^7\text{F}_2$ transition [12] upon excitation at 330 nm.

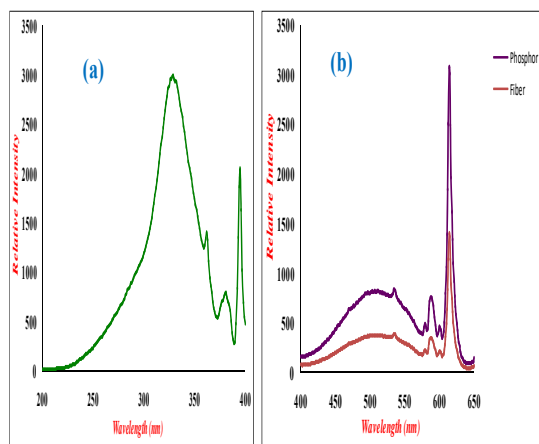


Figure 4: (a) shows the PL excitation spectra (b) shows PL emission spectra of $\text{Sr}_3(\text{VO}_4)_2:\text{Eu}^{3+}$

4. CONCLUSION:

$\text{Sr}_3(\text{VO}_4)_2:\text{Eu}^{3+}$ was prepared by the sol-gel method and the fibres drawn by the electrospinning method. The sample XRD matched well with the ICDD file. In PL spectra, Eu^{3+} emission was observed at 614nm for excitation with 330 nm light. The intensity in fiber goes down as compared to powder; this is due to the more surface area to volume in nanoscale as compared to macro scale.

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