

# Optical Properties of DY Doped Strontium Aluminate Nanophosphors

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**Abstract:** Dy 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:Dy with an average particle size of 80 nm is formed. In addition, Scanning electron microscopy (SEM) is 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

**Keywords:** Phosphors, optical properties, luminescence, XRD, SEM, Dysprosium

## 1. Introduction

The importance of rare earth ions as efficient emitter in a variety of solid-state matrices is well known. Among rare earth ions, Eu/Dy is often employed by researchers for making red emitting phosphors, where the prominent 612 nm emission band arises from electric dipole moment allowed transitions [1]. The long lasting phosphors (LLP) oxide materials have been developed to replace the conventional sulfide afterglow materials because of their improved luminescent properties such as high initial brightness, long lasting time, suitable emission color and satisfactory chemical stability [2-4], which result in an unexpectedly large field of applications e.g. luminous paints in highways, airports, buildings and ceramic products [5]. With the development of newer technologies, several kinds of chemical synthesis techniques such as co-precipitation [6], sol-gel [7], reverse micro emulsion [8] and combustion methods [9-10] have been employed to prepare SrAl<sub>2</sub>O<sub>4</sub> and its phosphors [11]. Comparing these methods, sol-gel synthesis possesses some benefits, namely, relatively low preparation temperature, easy control of the stoichiometry, high levels of product homogeneity, and no need for the use of expensive equipment. In this article, we reported the synthesis of nanostructured SrAl<sub>4</sub>O<sub>7</sub> doped with Dy via Sol Gel synthesis and effects on PL properties were investigated.

## 2. Experiment

The materials used for synthesis are strontium nitrate a aluminium nitrate and all other materials are 99.9% pure. The procedure of synthesizing nanoparticles is thoroughly described as follows: 98 wt.% of 2M Strontium acetate [(CH<sub>3</sub>.COO)<sub>2</sub> Sr.2H<sub>2</sub>O] was dissolved in 25ml of 2-methoxyethanol with vigorous stirring. 1 wt.% of 2M

Dysprosium nitrate [(CH<sub>3</sub>.COO)<sub>2</sub> Dy.2H<sub>2</sub>O] was dissolved in 25ml of 2-methoxyethanol with vigorous stirring. Simultaneously, 1 wt.% of 2M Aluminum acetate [C<sub>4</sub>H<sub>6</sub>AlO<sub>4</sub>.4H<sub>2</sub>O] was dissolved in 25ml of 2-methoxyethanol with vigorous stirring and subsequently, it was added to the 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 5h to obtain Dy doped SrAl<sub>4</sub>O<sub>7</sub> nanopowders. For the preparation of the gel precursors with different wt%, the same procedure was repeated with the wt% of Dysprosium nitrate being varied to 0.5,2, 3,4 and 5.

## 3. Characterization

### 1. SEM Analysis

The SEM study is carried out to investigate the surface morphology and the average crystallite size of the synthesized phosphors. Fig. 1 shows the representative SEM micrographs taken for SrAl<sub>4</sub>O<sub>7</sub> :Dy phosphors at different Dy concentrations. Generally the particles are of irregular shape. SEM was used to study the surface morphology of the films. A representative micrograph of the film is shown in Fig. 2. The micrograph also showed that the particles were interlinked with each other, leading to the formation of big crystals and irregular aggregations formed in the sample. The particle sizes are 80,77,78,75,40,49 respectively.

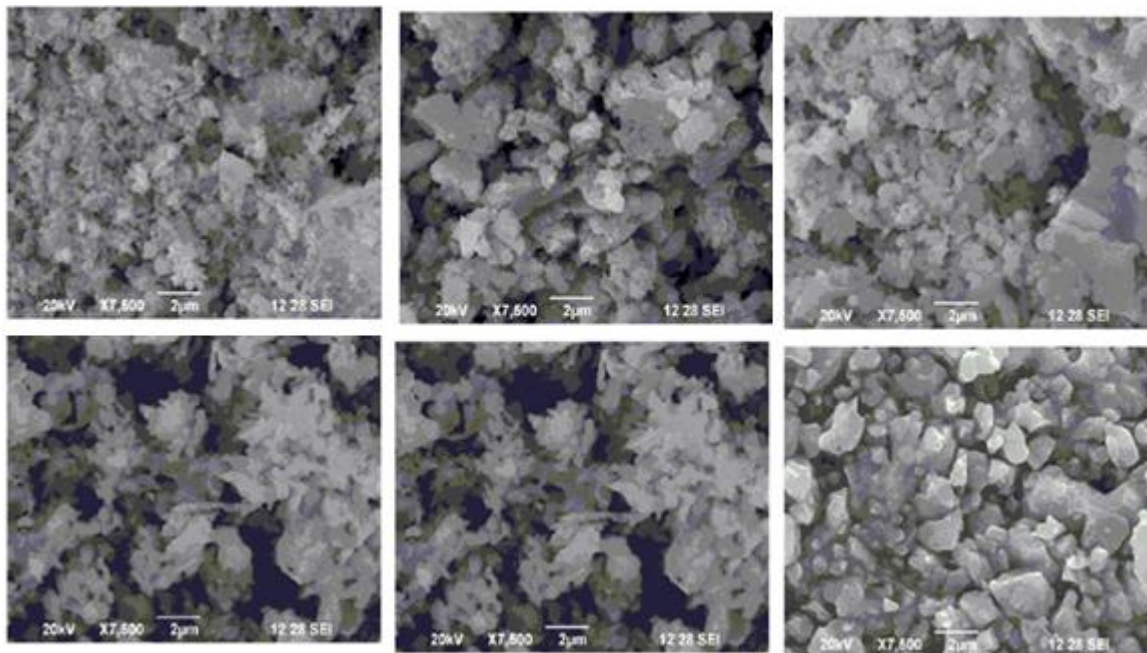


Figure 1: SEM pictures of SrAl<sub>4</sub>O<sub>7</sub>:Dy

## 2. X-Ray Diffraction (XRD)

The structure and phase purity of the SrAl<sub>4</sub>O<sub>7</sub>:Dy phosphor were investigated by XRD. The XRD patterns were obtained and are shown in Fig.2 for SrAl<sub>4</sub>O<sub>7</sub>:Dy. Diffraction patterns were obtained using CuK $\alpha$  radiation ( $\lambda=1.54051 \text{ \AA}$ ), at 30kV and 15mA. Measurements were made from  $2\theta=10^\circ$  to  $80^\circ$  with steps of  $0.02^\circ$ . The XRD patterns of the powders revealed that the structure of SrAl<sub>4</sub>O<sub>7</sub> 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<sub>4</sub>O<sub>7</sub>:Dy, which is un-uniform and may be due to the formation of fractal attribution to sort of self organization. SEM image of SrAl<sub>4</sub>O<sub>7</sub> sintered at 900°C

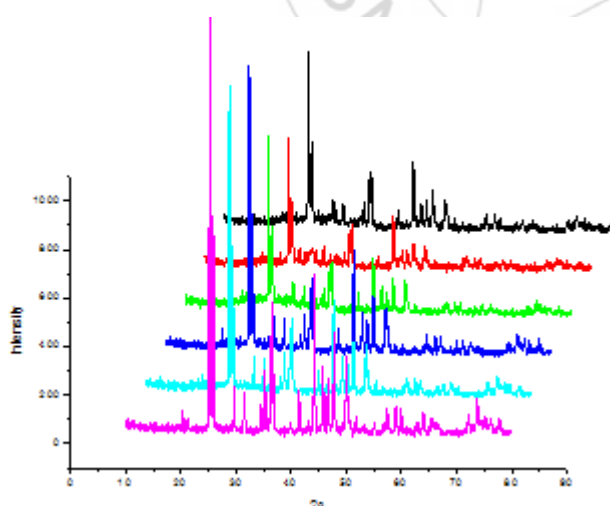


Figure 2: XRD patterns of SrAl<sub>4</sub>O<sub>7</sub>:Dy

## 3. Photoluminescence

The photoluminescence spectra of SrAl<sub>4</sub>O<sub>7</sub>:Dy nanoparticles under 360 nm excitation wavelength is shown in Fig3. The PL emission spectra of all samples exhibit three emission bands with corresponding peak wavelengths of 395 nm, 520 and 790 nm under excitation of 360nm. The strong

peak showing blue emission at 395 nm was due to the exciton emission, and weak green emission at 520 nm was due to oxygen interstitial. The strong UV emission corresponds to the exciton recombination related near-band edge emission of nanoparticles. The green emissions are possibly due to surface defects in the nanoparticles.

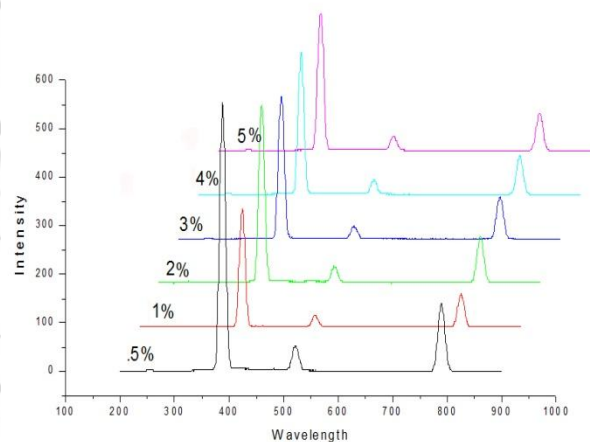


Figure 3: Photoluminescence Spectra of Dy doped SrAl<sub>4</sub>O<sub>7</sub> at different wt% of Dy

## 4. Conclusion

The phosphors SrAl<sub>4</sub>O<sub>7</sub>:Dy (at 0.5, 1, 2, 3, 4 and 5 wt% of Dy) with a monoclinic structure were successfully prepared by Sol-Gel method. The characteristic peaks of SrAl<sub>4</sub>O<sub>7</sub>:Dy phosphors were observed and they are located at 395nm, 520nm and 800nm which are corresponding exciton emission and the oxygen interstitial. The luminescent intensity of Dy doped SrAl<sub>4</sub>O<sub>7</sub> nanoparticles increases with increase in the Dy dopant concentration at first and then it decreases. The maximum intensity was achieved for about 1 mol% Dy<sup>3+</sup>. The photoluminescence investigations reveals that the emission mechanism is governed mainly by defect controlled processes.

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