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Photoluminescence spectroscopy of monoclinic $SrAl_2O_4$ phosphor

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Abstract

Photoluminescence behaviour of monoclinic $SrAl_2O_4$ was studied for nano size strontium aluminate $SrAl_2O_4$, which was synthesized via solution combustion method (CSM). Structural and morphological properties were confirmed by X-ray diffraction and electron microscopic analysis including scanning electron microscopic method. The crystal size was obtained between 12-19 nm. The emission spectrum was recorded under 254 nm excitation and consist peaks in UV and visible region. The peak in UV region is intense then visible emissions.

Keywords: Combustion Synthesis, $SrAl_2O_4$, XRD, TEM.

Introduction

Alkaline earth aluminates MAl_2O_4 (M = Ca, Sr, and Ba) are the most widely used members; one of them is strontium aluminates. Among all those various phosphors, $SrAl_2O_4$ has attracted much interest in recent years owing to its excellent luminescent properties such as long duration and high brightness[1,2]. In addition, $SrAl_2O_4$ material is chemically more stable than sulfide phosphors. $SrAl_2O_4$ materials present interesting luminescence properties and attractive optical characteristics. As one of the most promising phosphors, $SrAl_2O_4$ shows strong luminescence and especially long persistent luminescence in green region[3,4]. Among of all other technique, combustion synthesis method is easy to prepare the oxide materials within few minutes. This method is based on redox reaction, in which liberated heat energy is used for the preparation of the phosphor. The preparation of phosphor takes place at low ignition temperature[5-9].

Materials and methods

In the Present paper $SrAl_2O_4$ phosphor was successfully synthesized by combustion method. Analytical results implied that the phosphor powders have monoclinic phase with the average particles size of about 10-15 nm. Which in confirm by the scanning electron microscope (SEM).

Synthesis: Combustion synthesis method was used for preparation of $SrAl_2O_4$ phosphor. The starting materias are the Strontium nitrate [$Sr(NO_3)_2$ (99.90 %)], aluminium nitrate [$Al(NO3)_3$.9H2O (99.90 %)] and urea [NH_2CONH_2 (99.99 %)]. Urea was used as fuel. Strontium nitrate [$Sr(NO_3)_2$ (99.90 %)], aluminium nitrate [$Al(NO3)_3$.9H2O (99.90 %)] and urea [NH_2CONH_2 (99.99 %)] were weighted according to the stoichiometric amounts and aqueous solution was prepared. This solution was stirred for 2 h at 70°C to obtain transparent gel, transferred to silica crucible. Crucible was placed into a preheated furnace, maintained at 600°C. The mixture undergoes spontaneous ignition results in fluffy powdered phosphor material (Figure-1)[10-12]. This powder was further annealed at 900°C for 1 h.

Results and discussion

X ray diffraction (XRD) Results: The crystal structure of the prepared $SrAl_2O_4$ Phosphor was characterized by powder XRD analysis. Powder XRD pattern was obtained from PAN-analytical X-ray powder diffractometer using CuKα radiation and the data were collected over the 2θ range 20-70. The crystal size was calculated by using Scherrer's equation $D = k\lambda/\beta\cos\theta$, where *D* is the crystallite size for the (*hkl*) plane, k is the constant, λ is the wavelength of the incident X-ray radiation [CuKα (0.154 nm)], β is the full width at half maximum (FWHM) in radiations, and θ is the diffraction angle for the (*hkl*) plane[12,13]. The crystal size was obtained around 12-19 nm.

Scanning Electron Microscope (SEM) Results: The morphological features of the $SrAl_2O_4$ phosphor nanophosphors sintered at 1000°C were investigated by taking the FESEM. The typical morphological image is shown in Figure-2. The crystal showed agglomerated crystal and smooth surface morphology. The crystal size is in good agreement with the calculated crystallite sizes from XRD patterns.

Photoluminescence property: Figure-3 represents the photoluminescence spectra of pure $SrAl_2O_4$ phosphor monitored with 254nm excitation. The spectra consists emission bands in UV and blue region. The emission bands in UV region centered at 365nm and 394 nm. The emission bands in blue region are centered at 450 nm - 492 nm. Emission band at UV region is more intense than blue emissions. The emitted colour by the prepared phosphor was determined by using CIE coordinate diagram. The CIE coordinates have values X=.304 and Y=.324, which resembles with the white light emission[1,2].

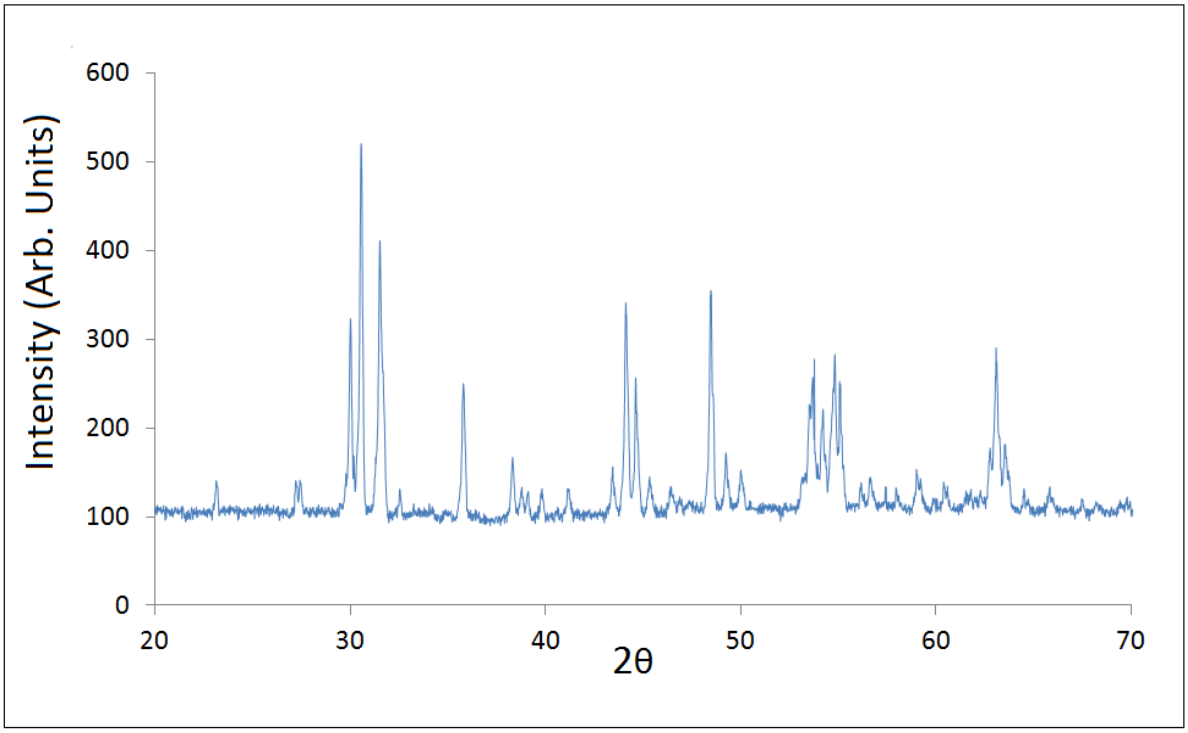

Figure-1: XRD patterns of $SrAl_2O_4$ phosphor.

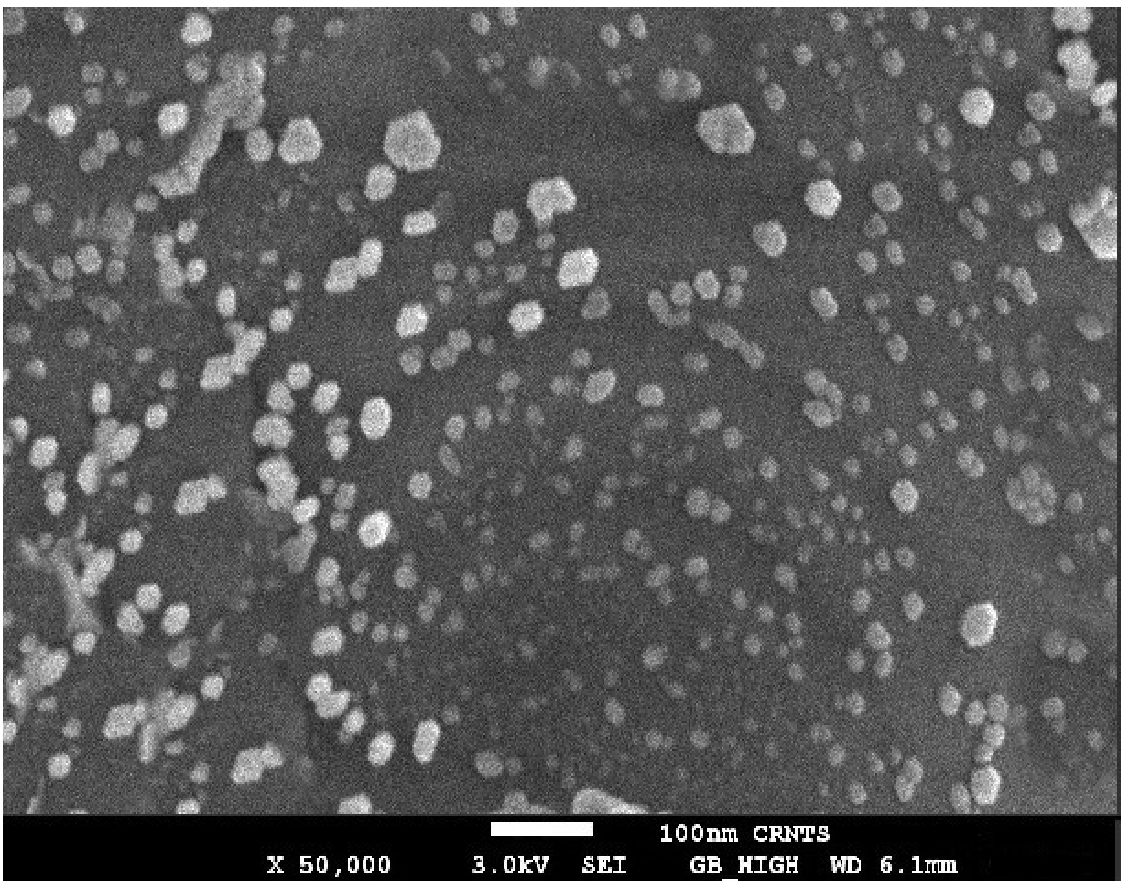

Figure-2: SEM image of $SrAl_2O_4$ phosphor.

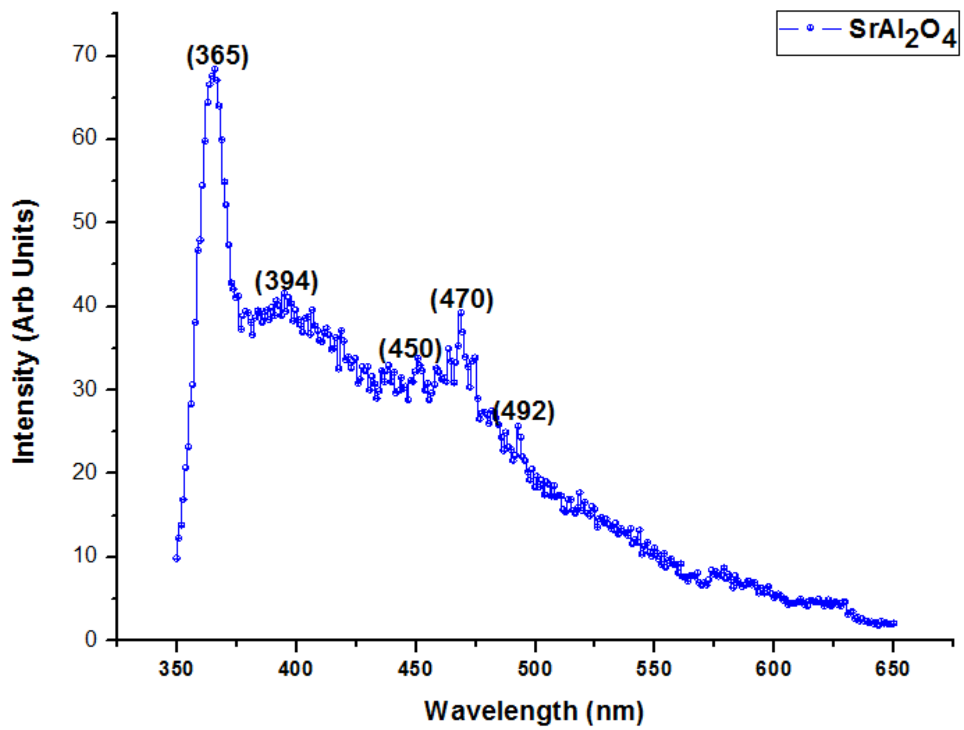

Figure-3: $SrAl_2O_4$ pure emission spectra monitored with 254nm.

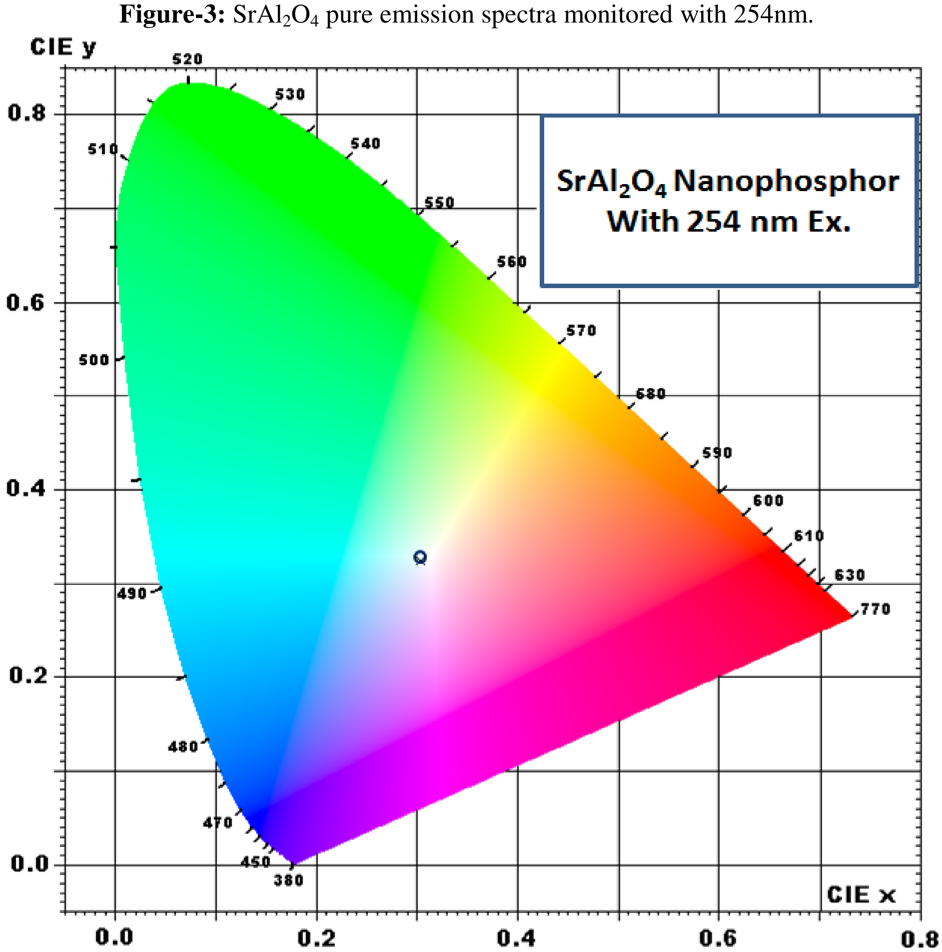

Figure-4: CIE diagram of $SrAl_2O_4$ phoshor.

Conclusion

Pure $SrAl_2O_4$ phosphors in nano range were successfully synthesized by solution combustion method. The phosphor has monoclinic phase, which was confirmed by using XRD analysis. Crystal size was obtained around 12-19 nm. The morphology of the prepared phosphors was evaluated by SEM analysis and the parameters are in good relation with XRD results. Emission spectra recorded under 2564 nm excitation have peaks centred at UV and visible emission. Intense peak was obtained at 365 nm along with weak visible emissions centred in blue region in between 450-492 nm. The CIE coordinate values represent visible white light emission by the phosphor.

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