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Synthesis and characterization of nano sized (Zn,Cd)S mixed phosphors

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Abstract
Present paper reports synthesis and characterization of (Zn,Cd)S mixed phosphors. Sample was synthesized with modified chemical route method which is suitable for large scale production and economical with pollution free technique. Prepared sample was characterized by PXRD (Powder X-ray Diffraction technique) and average crystalline sizes were calculated by Debye-Scherer formula which was verified by FEGSEM (Field emission gun scanning electron microscopy) technique. The average particles sized were found at 5-55nm range.

Keywords: Nanoparticle; synthesis and characterization; (Zn, Cd)S mixed phosphors.

INTRODUCTION

Materials with nanoscopic dimensions such as quantum dots, nanowires, nanorods and nanotubes, have attracted a great deal of attention during the last four decades [1, 2]. Due to their applications in solar cells [3], catalysis [4], light emitting devices [5, 6], resonant tunneling devices [7] and lasers [8]. Blue shift in the optical absorption spectra, size dependent luminescence, enhanced oscillator strength and nonlinear optical effect is some of the interesting properties exhibited by these nanocrystals [9]. The doping of transition metal ion such as Mn, Cu, Co etc opens up possibilities of forming new class of material and new properties of the materials are expected. The transition metal doped nanoparticles show different optical properties corresponding to their host counterparts. These nanoparticles have found tremendous application in optical light emitting diodes [10-13].

EXPERIMENTAL

Synthesis of (Zn, Cd)S mixed phosphor

Nanoparticles of (Zn, Cd)S are prepared by wet chemical route method. For synthesis, 10^{-2}M aqueous solution dilutes solution of Cadmium acetate and sodium sulphide (Na_2S) were mixed in presence of (capping agent) Thioglycerol [$C_3H_8O_2S$].

The aqueous solution of Thioglycerol [$C_3H_8O_2S$] was added drop wise in the solution of Zinc acetate with the help of burette at the rate of 1 ml per minute while stirring the solution continuous Na_2S was mixed drop by drop in an ice bath with constant stirring into the solution. Subsequently a white colour was obtained. This solution was kept 24 hours till precipitate settles down in the bottom of the flask. This precipitate is removed and washed several times with double distilled water. The unreacted Thioglycerol [$C_3H_8O_2S$] and Na_2S are removed by washing the solution several times. This washed solution centrifuged and finally the precipitate was spread over a glass substrate and air dried at room temperature. Similar method is used to prepare the samples of (Zn,Cd)S for 10^{-1}M and 1 M concentration of capping agents.

All the samples were characterized at Inter University Consortium (IUC) Indore for X-ray diffraction studies with Cu K_α radiation (λ=1.5418 Å). XRD data were collected over the range 200-700 at room temperature. X-ray diffraction patterns have been obtained by Rigaku Rotating Anode (H-3R) diffractometer. The particle size was calculated using the Debye-Scherrer formula. The particle size and morphologicalinvestigations of the nanoparticle (Zn, Cd)S prepared by this process were carried out with a scanning electronmicroscope (SEM, LEO 440 system).

RESULTS AND DISCUSSION

The XRD patterns of the samples are shown in Figure 1. Seven different peaks are obtained at 2Θ values of 31.66^0, 34.33^0, 36.14^0, 47.41, 56.59, 63.04^0. This shows that the samples have cubic structure. The XRD peaks correspond to Bragg diffraction at (111), (200) and (220) planes of cubic (Zn, Cd)S. The broaden peaks indicates nanocrystalline behavior of the (Zn, Cd)S sample. The width of the peak increases as the size of the particle decreases. The size of the particles has been computed from the full width half maximum (FWHM) of the intense peak using Debye Scherer formula. The particle size was calculated using the Scherrer's formula. The Scherrer formula is given by:

$$D = 0.9\,\lambda / \beta \cos\theta \quad \text{----------(1)}$$

where D is the average particle size perpendicular to the reflecting planes, λ is the X-ray wavelength, β is the full width at half maximum

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(FWHM), and θ is the diffraction angle.The particle size of the sample is in the range 52nm. (Zn, Cd)S is well known self-activated luminescent material. (Zn, Cd)S belongs to the family of II-IV semiconductor. It has a direct band gap of 2.4 eV. (Zn, Cd)Snanoparticles exhibit strong quantum size effect in the nanometer range.

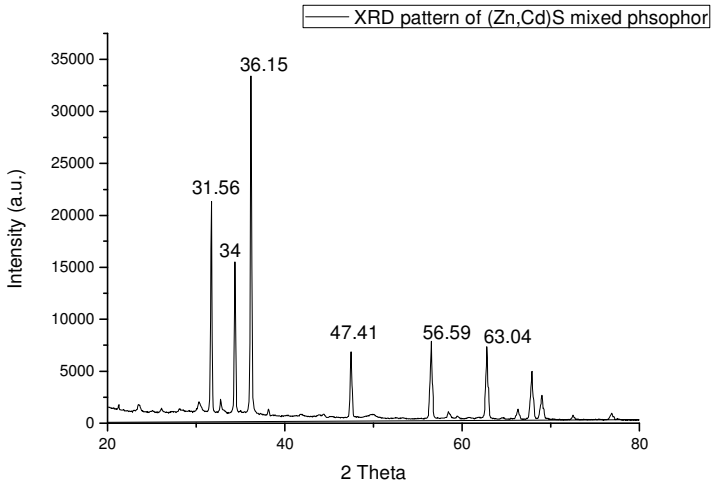

Fig 1. XRD pattern of (Zn, Cd)S mixed phosphor

SEM Result

The SEM micrographs of (Zn,Cd)S nanoparticle is shown in figure 2. The (Zn,Cd)S nanoparticle showed compact distribution over the surface and good connectivity between grains.It shows flake type formation with particle size distribution about 25nm.

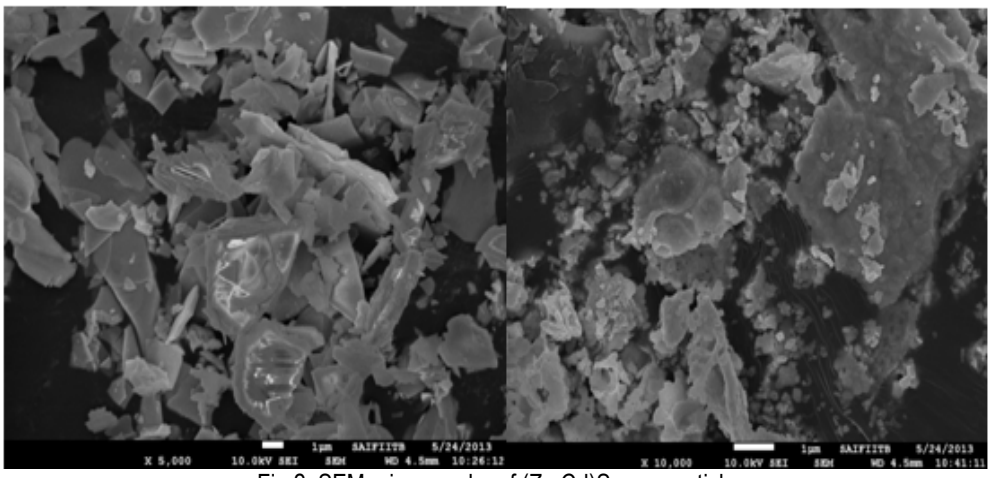

Fig 2. SEM micrographs of (Zn,Cd)S nanoparticle

CONCLUSION

From above study it is found that sample was synthesized by modified chemical route method which is most suitable method for large scale production of nano sized phosphors. This phosphor is may be very useful for optical devices and act as a single host for light emitting diodes. From XRD and FEGSEM studies it is found that synthesized sample was nano range.

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