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Synthesis and characterization of Cu doped ZnS Nanoparticles Prepared by CBD method.

Physics

KEYWORDS: ZnS nanoparticle; X-ray diffraction, Microstrain, TEM etc.

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ABSTRACT We have synthesized Cu doped ZnS nanoparticles by chemical bath deposition method. The synthesized ZnS are characterized by X-ray diffraction and which shows that the size of the crystallites is in the range of 2.9- 4.5nm. The mean crystalline size was calculated from the FWHM of XRD lines by using the Scherer equation.The prepared nanoparticles are characterized by X-ray diffraction, UV absorption and Transmission Electron Microscopy techniques.The average particle sizes are found to be of the order of 3 nm to 4 nm.The XRD studies shows that the samples are cubic in nature and the broadening of peaks tends to increase with increasing weight of Sodium Hexa Meta Phosphate (SHMP) showing decrease in particle size. Some samples are characterized by TEM and size of the particle are almost same as obtained by the XRD. The band gap obtained by U-V absorption for cu doped ZnS are 4.76 ev.

1. Introduction: ZnS are prototypical II-IV semiconductors. ZnS exists in two main crystalline form. In each form, the coordination geometry at Zn and S is tetrahedral. The more stable cubic form is known also as zinc blende, or sphalerite.[1-2] The hexagonal form is known as the mineral wurtzite. Both sphalerite and wurtziteare intrinsic, wide bandgap semiconductor. Zinc blende(cubic form) has a band gap of about 3.54 electron volts (eV) at 300 kelvin, but the wurtzite (hexagonal form) has a band gap of about 3.91electronvolts. ZnS is a intrinsic semiconductor and both can be doped as either in n-type or p-type semiconductor. ZnS is widely used as a phosphor in optical devices due to its wide band gap of 3.68 eV at room temperature. II-VI groups of semiconductors exhibit interesting size-tunable optical properties due to the strong quantum confinement effect[3-4]. There is wide range applications of doped ZnS nanoparticles like phosphors, light emitting displays, optical sensors and electroluminescence devices. Etc.[5-7] Accordingly we give importance to study these doped Zns nanoparticles and prepared this paper for undoped ZnS and cu doped nanoparticles by chemical bath diposition method in presence of the Sodium Hexa Meta Phosphate (SHMP) as capping agent. Then the undoped and doped ZnS nanopartilces are characterized by the X-ray diffraction. The mean crystalline size calculated from the full width half maximum (FWTH) of XRD lines by using Scherrer equation. The size of the particle of some sample are verified by Transmission Electron Microscopy technique. Then its optical study also done by U-V absorption technique.

2. Experimental

2.1 Chemical

For the Cu doped ZnS nanoparticles the chemicals used were Sodium Hexa Meta Phosphate (SHMP){M=611.77, (NaPo3)6}, zinc acetate {M=219.49, Zn (CH3COO)22H2O}, Cuper acetate {M=199.65, Cu (CH3COO)2H2O}, Sodium sulphide {M=240.18, Na2S.9H2O}. All chemicals used were from thermo fisher Scientific India Pvt. Ltd and used without further purification.

2.2 Synthesis

Different weight (1.5gram ,3gram 4.5, 6gram, 7.5 gram) Sodium Hexa Meta Phosphate (SHMP) was separately dissolved in de-ionized water and then each of it an solution of zinc acetate of .25 M and cupper acetate of 1mM was mixed together with constant stirrer with heat till boiling. After cooling to room temperature , .025M Sodium sulphide was added drop by drop wise in an ice bath with constant stirring then formed ZnS: Cu nanoparticles immediately. After washing the particles with de-ionized water , the samples dried with a oven up to 800c .

2.3 Characterization

The X-ray diffraction pattern were recorded on a fully automated computerized powder x-ray diffractometer of Model X' Pert Pro, make PANalytical, x-ray tube:Cu. The diffraction pattern of undoped and doped ZnS of different concentration of Cu are shown in fig.1, 2, & 3.

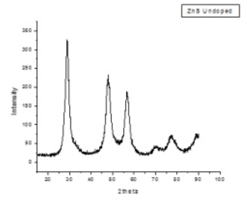

Figure 1: Under ZnS

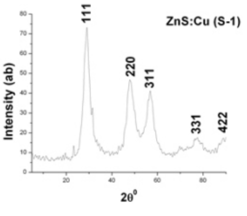

Figure 2: Cu 1.5gm doped ZnS

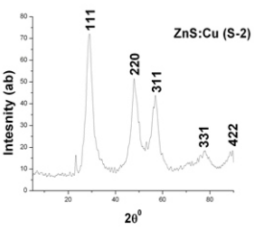

Figure 3: Cu 3gm doped ZnS

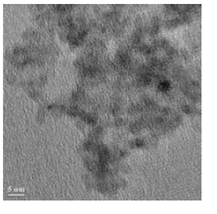

Figure 4: TEM Image of Cu doped ZnS

The diffraction patterns of ZnS is matched with the ICDD card no 800020. The structure of ZnS nanoparticles is cubic in nature. The peaks are obtained at 28.91^0, 48.11^0, 57.10^0, 70.41^0, 77.83^0 2θ which are indexed as (111), (220), (311), (400), (331) respectively. The peak centers of Cu doped ZnS and their indexed planes are indicated in fig. 1, & 2 for different concentration of Cu. The particle size are calculated using Scherrer's equation (no-1) [8] which are found to be of the order of 3.8 nm, 3.3nm and 2.9nm for ZnS and Cu doped ZnS respectively.

D= kë/âcosɵ (1)

Where D is the particle size, k is a constant whose value is 0.89 for spherical shape of particle, **ë** is the wavelength, **â** is the FWHM of the diffraction peak. The Scherrer's equation gives a rough estimate of particle size which mainly calculated from the width (FWHM) of the diffraction peak. The width of the diffraction peak is affected by various effects viz. particle size, microstrain etc.

Concluion: Cu doped and undoped ZnS are successfully prepared. The crystalline nature of the nanoparticles are confirmed by XRD study. The average size of the nanoparticle are measured by XRD and TEM studies. The size of the ZnS nanoparticles is decreased when we doped it with different concentration of Cu. The optical band gap of the nanoparticles is measured with the UV- absorption techniques. The size of the nanoparticle measured with the help of XRD are confirmed with TEM analysis.

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