Volume : 2 | Issue : 7 | July 2013 • ISSN No 2277 - 8179

Research Paper

A study on structural ,morphological and chemical composition of zinc sulphide nanoparticles synthesized by a simple chemical technique

Physics

KEYWORDS : zinc sulfide, nanoparticles, aqueous chemical synthesis

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ABSTRACT

The main advantage of the newly synthesized ZnS nanoparticles of diameter 29 nm is that the sample is prepared by using of cheap precursors in a cost effective and eco-friendly way by simple aqueous chemical technique. The structural, morphological and chemical composition of the spherically shaped nanoparticles have been investigated by X-Ray Diffraction(XRD),Scanning Electron Microscopy(SEM),Fourier transform infrared (FTIR) spectroscopy and energy dispersive X-.Ray spectrometry(EDAX).

Introduction

Synthesis of nanoparticles has become an important area in nanostructured materials research owing to their low dimensions characteristics which differ from the bulk materials[1]. Nanomaterials are increasingly gaining the attention of not only the scientific community but also the public due to their unique properties, which lead to new and exciting applications. The physical and chemical properties of the nanomaterials tend to be exceptionally closely dependent on the size and shape or morphology. It is interesting to note that by changing the preparation parameters, nanomaterials having wide range of varying morphology such as spherical nanoparticles, nanowires, nanorods and nanotubes can be synthesized[2]. The particular area of nanostructure formation has tremendous scope and is a driving force for the electronic industry. Synthesis and self-assembly strategies of nanomaterials require precursors from liquid, solid or gas phase [3,4].Zinc sulphide is a simple inorganic compound known for its practical applications in photoconductors, solar cells, field effect transistors, sensors transducers, optical coatings and light emitting materials[5]

In view of the above information on the importance of Nanoparticles and their application, nanoparticles of ZnS was prepared in our laboratory with the help of a simple aqueous chemical technique and was characterized by modern techniques.

Materials & Methods

Chemical compounds: Analar ZnCl2 and Na2S were purchased from Merck, Germany , these were allowed to react to produce ZnS nanoparticles.

Method of preparation of Zinc Sulphide nanoparticles

Synthesis of ZnS nanoparticles was carried out by aqueous chemical method using ZnCl2 and Na2S as source materials. All the reagents were of analytical grade and used without further purification. The entire process was carried out in distilled water for its inherent advantages of being simple and environment friendly. All steps of the synthesis were performed at low temperature and ambient conditions. In a typical preparation solution of 1M Na2S was added drop by drop to 1M ZnCl2 solution which was kept on stirring using a magnetic stirrer at 70 ^{o}C for 2 hours,this resulted in formation of ZnS nanocolloid. The nanoparticles were collected by centrifugation at 2000 rpm for 15 minutes and further purification was made in ultrasonic bath. The resultant product was finally dried at 120 ºC for 2 h.

Characterization of ZnS nanoparticles

The prepared sample was subjected to characterization by X-ray diffraction (XRD) (Model D8, Bruker AXS) to determine the phase purity and average particle size of the sample, using CuKα radiation at 1.5409Å (2θ = 10^{0}-70^{0}, scan speed = 0.2 s/step, increment = 0.02, operating voltage = 40 kV and operating current = 40 mA). The nanophase was identified by comparing peak positions and intensities (finger print method).

To determine the structural features of all the samples, Fourier transform infrared (FTIR) spectroscopy was carried out using an FTIR spectrometer (FTIR-8400s, Shimadzu), with 150 scans for wave numbers ranging from 400-4000 cm^{-1} and resolution 4 cm^{-1}. The KBr pellet method was used to prepare the samples[6]

To investigate the morphological structure of sample surfaces, surface textures were examined by field emission scanning electron micrography (FESEM) and energy dispersion X-ray fluorescence spectroscopy (EDAX) (JSM6700F JEOL LTD, Tokyo, Japan), was also carried out to ascertain the composition.

X-Ray Diffraction (XRD) analysis

From the XRD results as shown in figure 1, it is clear that the pure ZnS nanoparticles have been obtained in powder form. The broadened peaks in the XRD pattern indicate the formation of ZnS nanocrystals with small crystallites. The three diffraction peaks at 2θ values of 28.978^{0}, 47.62^{0}, 56.65^{0} correspond to the (111), (220) and (311) diffraction planes, respectively of the spherical nanocrystalline structure of ZnS were observed. These values were very close to those reported by Jia Xiang Yang et.al[7].

The average crystallite size (D) was calculated from the full-width at half-maximum (FWHM) of the most intense peak of the (111) plane of ZnS nanoparticles using the Debye-Scherrer formula for spherical particles [Eq. (1)].

$$D = 0.89\lambda / (\beta \cos \theta) \quad (1)$$

Where λ is the wavelength (Cu Kα), β is the full width at the half-maximum of the ZnS nanoparticles and θ is the diffraction angle.

From this equation the average particle size was estimated to be 29 nm which was also supported from FESEM.

Fourier transforms infrared (FTIR) studies

Figure 2 shows the FTIR spectrum of the ZnS nanoparticles. The spectra exhibit strong bands appearing in the 1114, 1259, 1384 & 3200–2900 cm^{-1} correspond to ZnS nanoparticles[6]. The peaks at 612 cm^{-1} is assigned to the ZnS band (i.e., corresponding to sulphides)[7,8]. The O–H bending region due to absorbed water appears at 1620 cm^{-1}. The stretch vibration adsorption of ZnO at 420–460 cm–1 is not detected which indicates that ZnS was not oxidized to ZnO during the preparation as reported by She Yuan-yuan et.al[9].

FESEM analysis

Figures 3 and 4 show the FESEM/EDAX results of as prepared ZnS nanoparticles. It is seen that the ZnS nanoparticles are homogenously dispersed and almost spherically shaped with an average diameter of about 29 nm.

Volume : 2 | Issue : 7 | July 2013 • ISSN No 2277 - 8179

Conclusion

The present study clearly indicates that ZnS nanostructures could be successfully synthesized by a simple and cost effective aqueous chemical method using pure aqueous route resulting in primary particle sizes of 29 nm. This particle size was calculated from Debye –Scherrer formula. FESEM image was used to study the morphology of the synthesized nanoparticles. FTIR spectra showed the possible stretching and bending modes of the ZnS nanoparticles. EDAX studies helped us to determine the chemical composition of the prepared sample.

Figures:

Fig 1. XRD pattern of ZnS nanoparticles synthesized by aqueous chemical method.

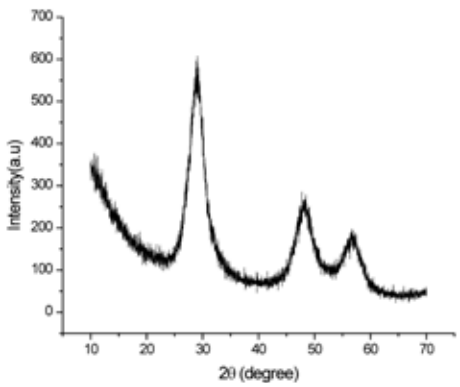


Fig 2. FTIR spectra of the synthesized ZnS nanoparticles.

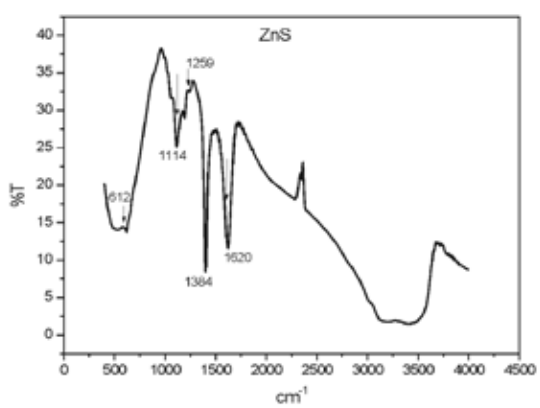


Fig 3. FESEM micrographs of the synthesized ZnS nanoparticles.

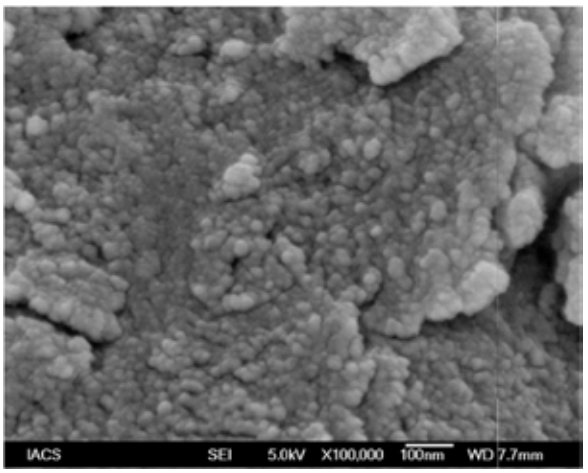
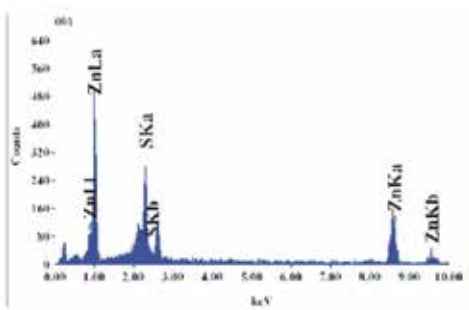


Fig 4:EDAX data of the prepared ZnS Nanoparticles.



Ele...	Cl...	(keV)	mass%	Error%	At%
S K		2.307	26.45	0.40	42.30
Zn K		8.630	73.55	2.40	57.70
Total			100.00		100.00

REFERENCE

1. K.X. Yao, R. Sinclair, and H.C. Zeng, Journal of Physical Chemistry, 11, 2032-2039 (2007). | 2. B.A Korgel and D. Fotzmaurice, Advanced Materials, 10, 661 (1998). | 3. Routkevitech D, Bigioni J, Moskovits M et al., Journal of Physical Chemistry, 100, 14037 | (1996). | 4. C. Liu, J.A.Zapien, Y.Yao et al., Advanced Materials, 15, 838 (2003). | 3. John R & Sasiflorence S, Optical,structural and morphological studies of bean like ZnS nanostructures by aqueous chemical method, Chalcogenide Let. 7 (2010)269. | 5. Criado M, Ferna´ndez-Jime´nez A , Palomo A, Microporous and Mesoporous Materials. 106(2007)180 | 6. Yang J X, Wang S M, Zhao X, Tian Y P, Zhang S Y, Jin B K, Hao X P, Xu X Y, Tao X T, Jiang M H, Preparation and characterization of ZnS nanocrystal from Zn(II) coordination polymer and ionic liquid, J.Crystal Growth. 310 (2008) 4358 | 7. Rema Devi B S, Raveendran R, Vaidyan A V, Synthesis and characterization of Mn+2 doped ZnS nanoparticles pramana-j.phy. 68 (2007) 679 | 8. Yuan-Yuan S, Juan Y, Ke-qiang Q, Synthesis of ZnS nanoparticles by solid liquid chemical reaction with ZnO and Na2S under ultrasonic bath. Transactions Of Non Ferrous Metals Society Of China. 20 (2010) 211