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Synthesis and Characterization of ZnS Nanoparticles by Chemical Co- Precipitation Method

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ABSTRACT

ZnS nanoparticles are prepared by simple chemical co-precipitation method. The structural and chemical properties of as synthesized nanoparticles are investigated by X-ray Diffraction and, Fourier transform infrared spectroscopy. FTIR confirms the chemical composition of synthesized nanoparticles. The x-ray diffraction pattern exhibits a zinc-blended crystal structure and average particle size is about 22.53 nm by the Debye- Scherrer formula.

Keywords: nanoparticles, Zinc sulfide, coprecipitation

I. INTRODUCTION

Nowadays due to wide variety of potential applications of nanomaterials due their high aspect ratio, lighter weight and higher strength, researchers find out number of new techniques to synthesises of nanomaterials [1]. Zinc sulphide nanoparticle used as optical devices[2-3] and optical sensors [4]. Zinc sulphide nanoparticles are synthesised by mechanochemical route required short reaction time without using diluents[5]. Zinc sulphide nanoparticles are synthesised by solgel method, The factors that influenced this method is reaction time for gel formation, PH conditions and chemical reagents [6]. Zinc Sulphide nanoparticles are synthesized by hydrothermal method, required high reaction time, consume more energy and expensive stainless steel autoclave and Teflon[7]. Pruthvi Raju et al. [8] the growth of nanoparticles by SH synthesis exhibits non-linear behaviour and higher current density than the HT method. Nanoparticles of ZnS can be synthesized by various methods while the chemical method is one of the most important method due to its simplicity. Dasari Ayodhya et al. [9] ZnS nanoparticles are prepared by coprecipitation method using various capping agents like PVP (polyvinylpyrrolidone), PVA (polyvinylalcohol) and PEG-4000 (polyethyleneglycol),UV-Visible absorption spectra are used to find the optical band gap and the values obtained have been found to be in the range of 3.80-4.00eV. Iranmanesh Parvaneh et.al [10] Synthesis ZnS nanoparticles are prepared by homogeneous chemical co-precipitation method using EDTA as a stabilizer and capping agent. The ultraviolet absorption spectrum shows the blue shift in the band gap due to the quantum confinement effect. Due to an ease of synthesis and low cost, comparable to different synthesis method, ZnS nanoparticles are synthesized by Chemical Co-Precipitation method in present work.

II. MATERIALS & METHOD

All the chemicals used in this work are Zinc Sulphate heptahydrate ZnSO4·7H2O and Sodium sulphide (Na2S) . All metal solutions were prepared from deionised water.

Synthesis of ZnS Nanoparticles:-

Preparing a clear stock solution of 0.1 M ZnSO4 and Na2S in different beaker with 100 ml deionised water separately. Take 100 ml DI water add 20 ml ZnSO4 stir continuously for 15 minutes, then add 20 ml of Na2S drop by drop with vigorous stirring for 20 minutes till the milky white precipitate obtained in the beaker. The reaction follows as

$ZnSO4 + Na2S \longrightarrow ZnS + SO4 + 2\,Na$

To remove the impurities of sodium Obtained precipitate were filter and washed several times with deionised water. After washing precipitate were dry at 3000 C in muffle furnace. Dry nanoparticles were milled in the motor paster to achieve fine power for characterization.

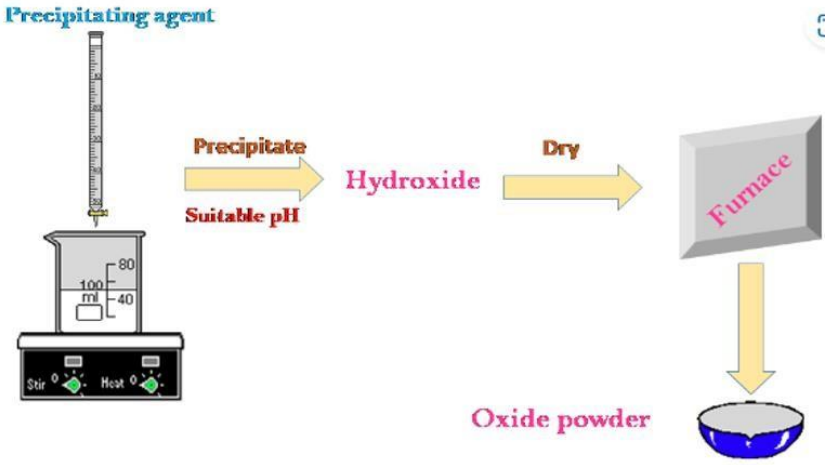

Fig.1: synthesis of ZnS nanoparticles

III.RESULTS & DISCUSSIONS

The X-Ray diffraction pattern of synthesized ZnS sample is show that cubic Zinc blende structure. The typical peak at 28.56, 47.50 and 56.11 in the XRD spectra corresponding to the plane(111) (220) and (311) are in good agreement with the cubic zinc blend structure of ZnS by comparing with JCPDS card (JCPDS-5-560). The broadening of peaks were observed which implies that the size of nano-particles is small. The size of NPs was calculated using Debye- Scherrer formula using peak (111) from XRD pattern. The Debye- Scherrer formula for particle size determination is given by,

$$D = \frac{0.9\,\lambda}{\beta \cos\theta}$$

Where, λ- wavelength of x-ray β- FWHM

θ – Angle of diffraction

D- Particle crystalline size

The calculated size of ZnS NPs was found to be 22.53 nm.

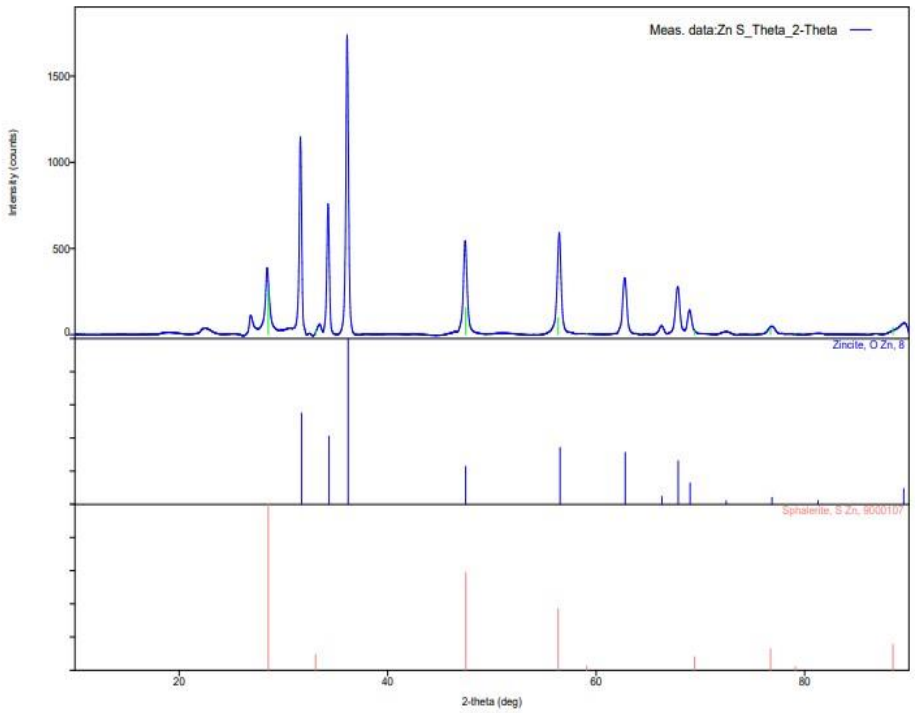

Fig. 2: The x-ray diffraction pattern of ZnS sample

The FTIR Spectrum of ZnS nanoparticles are shown in fig.3 spectrum shows IR absorptions due to various vibration modes. The characteristics major peaks of ZnS were observed at about 1141 cm-1, 983 cm-1 and 625 cm-1 which are in good agreement with the reported result in reference [9]. The observed peaks 1500 cm-1 – 1700 cm-1 are assigned to the C=O stretching modes and broad absorption peaks in the range of 3200 cm-1 – 3600 cm-1 corresponds to the O-H stretching mode shows absorption of water molecules on the surface of nanoparticles.

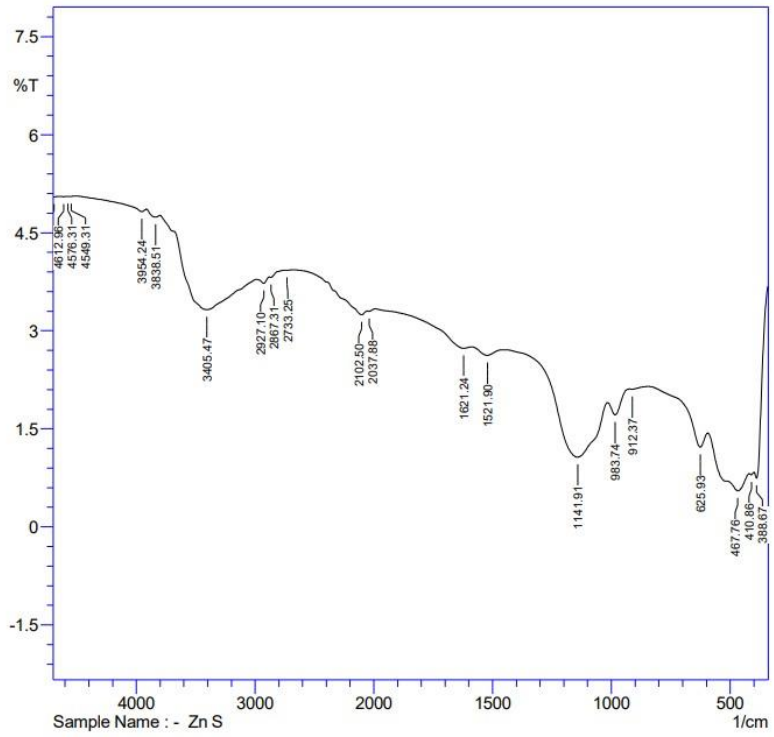

Fig 3: FTIR Spectrum of ZnS nanoparticles.

IV. CONCLUSIONS

ZnS nanoparticles are successfully synthesized by chemical co- precipitation method. The structural properties of samples are characterized by X- ray diffraction to identify crystal structure and chemical properties are characterized by FTIR to identify chemical bonding. The particle size are found to be 22.53 nm by The Debye-Scherrer formula.

V. ACKNOWLEDGEMENT

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