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SYNTHESIZE AND CHARACTERIZATION OF COPPER SULFIDE (CuS) NANOPARTICLE USING PRECIPITATION METHOD

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ABSTRACT

Copper sulfide nanoparticles were synthesized by Chemical precipitation method, formed by the reaction of copper chloride and thiourea in the presence of de-ionized water. X-ray diffraction (XRD), scanning electron microscopy (SEM), Fourier transform infrared (FT-IR) used to characterize the product. The results of synthesis and various studies of ceria nano particles are presented and then discussed. The result nanoparticles have a diameter of about 40-55 nm.

Keywords: Microwave, Nanostructure, Copper sulfide, Characterization.

I INTRODUCTION

Semiconductor transition-metal compounds have been of much interest because of their excellent properties and potential applications [1]. Among these transition-metal compounds, copper sulfide CuS is widely used as a thermoelectric cooling materials [2], optical filers [3], optical recording materials [4], solar cells [5], [6], nano scale switches [7], and superionic materials [8].The stoichiometric composition of copper sulfide varies from Cu_2S (chalcocite), CuS_2 (copper sulphide), CuS (copper monosulphide), $Cu_{1.96}$ S (djurleite), $Cu_{1.94}$ S (djurleite), $Cu_{1.8}$ S (digenite), and $Cu_7 S_4$ (anilite) [9], [10].

There are various methods for preparation of copper sulfide in nanoscale such as hydrothermal/solvothermal[11,12], template assisted growth[13], microwave irradiation[14], grinding, sono chemistry and so on. Herein, we report the synthesis of CuS nanparticles by Chemical precipitation method.

II EXPERIMENTAL SECTION

Experimental Materials

In a typical synthesis all reagents were analytically pure. Copper chloride , Thiourea and ethanol were purchased and used as such without further purification.

Synthesis

Solutions of [$Cucl_2 2H_2O$] 0.4m of copper chloride and 0.4m thiourea were prepared in 100ml de-ionized water separately .[$Cucl_2 2H_2O$] solution was stirred for half an hour separately. Then CH_4N_2S solution was added with [$Cucl_2 2H_2O$]Solution. Finally white colour precipitation was collected from the solution .Immediate floccutation of nano particles occurred. To remove the last traces of adhered impurities , the particles were washed several times using de-ionized water and Acetone. The washed particles were dried at 100̊ C. The mixer was then allowed to cool at room temperature.

Characterization

The X-ray diffraction spectrum of the prepared nanoparticle was recorded using the XPERT-PRO diffractometer system. UV-Vis absorption spectra were recorded on UV-Visible spectrophotometer (SHIMDZU-IRT RACER 100), employing the deionized water as the reference. Fourier Transformation Infrared (FTIR) spectrum was recorded by FTIR spectrometer (SHIMDZU-UV 1601).

III RESULT AND DISCUSSION

XRD Analysis

From the XRD data's , the grain size of the particle, structure of the unit cell , the lattice parameters a , b , c are calculated. Figure 1 shows the typical X –ray spectra of CuS nanoparticle . From the XRD data's the grain size was calculated.

The peaks at 2Ɵ values of Cus naoparticles are observed and compared with the standard powder diffraction card of joint committee on powder diffraction standards (JCPDS) CuS file no 78-2391 having the crystal structure hexagonal and the cell constant is a=3.791 , c=16.360. The estimated size of CuS nanospheres was found to be in the range from 40 -55 nm. Broadening of XRD lines is also associated with small particle size of the coherently diffracting crystallites or strains present within the sample or both.

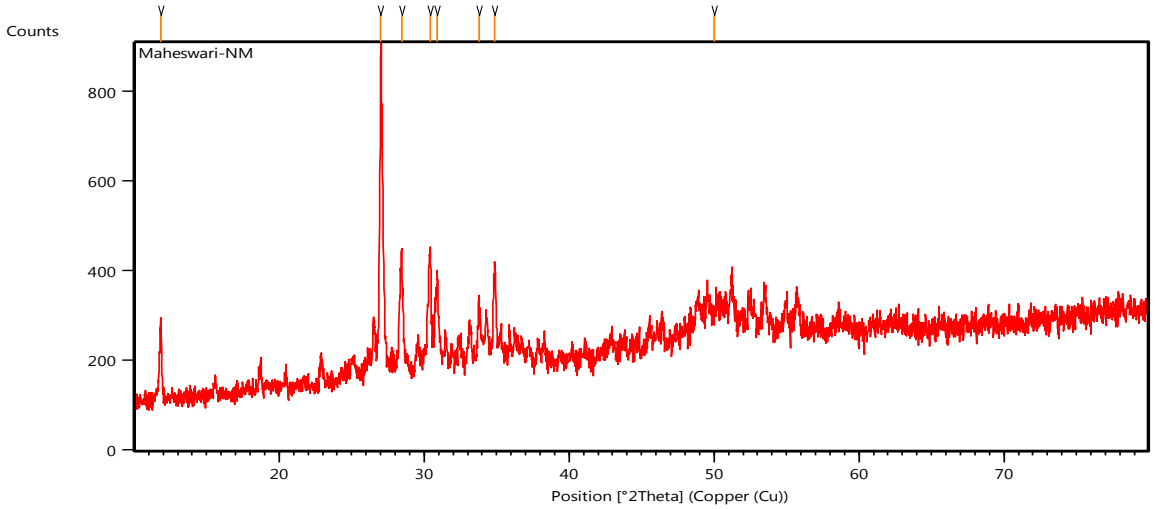

Fig. 1 XRD spectrum for 0.4 molarity of CuS nanoparticle

UV – Visible Spectroscopy

UV spectrum of CuS was drawn by the computer with the wavelength in (nm) along the X-axis and the absorption along the Y-axis. Then from the obtained spectrum the corresponding values of E_g were noted. From the fig [2] the band gaps corresponding to the transitions involved could be determined.

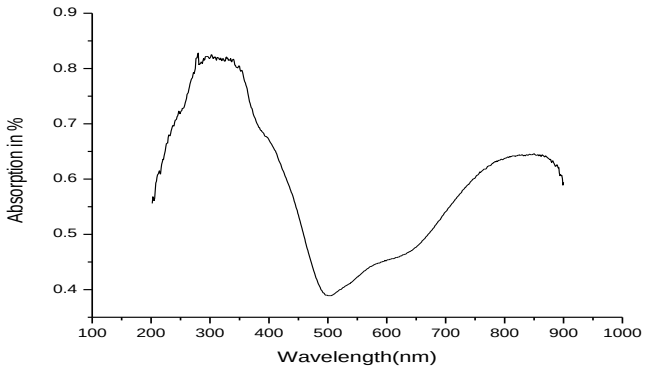

Fig.2 UV data for 0.4 molarity of CuS nanoparticle

Band gap (E_g) of the CuS particle was determined by the formula $E_g = h\,c\,/\,\lambda$ in ev. The band gap value for the prepared nano particle was 2.284 ev. The peak gradually decreases with the prolonged time. The UV-Vis spectrum

is much broader in the visible range. It indicated that the structure of CuS leads to the broadening of optical absorption, therefore CuS structure have great potential in the field of opto electronics.

FTIR Analysis

Fourier transform infrared spectroscopy (FTIR) spectra were measured for synthesized samples supported in KBr over the frequency range of 4000 – 400 cm-1 .The Fourier transform of IR spectrum is taken for obtaining details for the presentation of compounds in the sample. Finally the spectrum was drawn by the computer with the wavelength (cm^{-1}) along the X-axis and the transmission (%) along the Y-axis. Then from the obtained spectrum the corresponding peaks were noted. Copper sulfide nanoparticles formations were studied using FTIR. Fig (3) shows the FTIR spectrum of CuS.

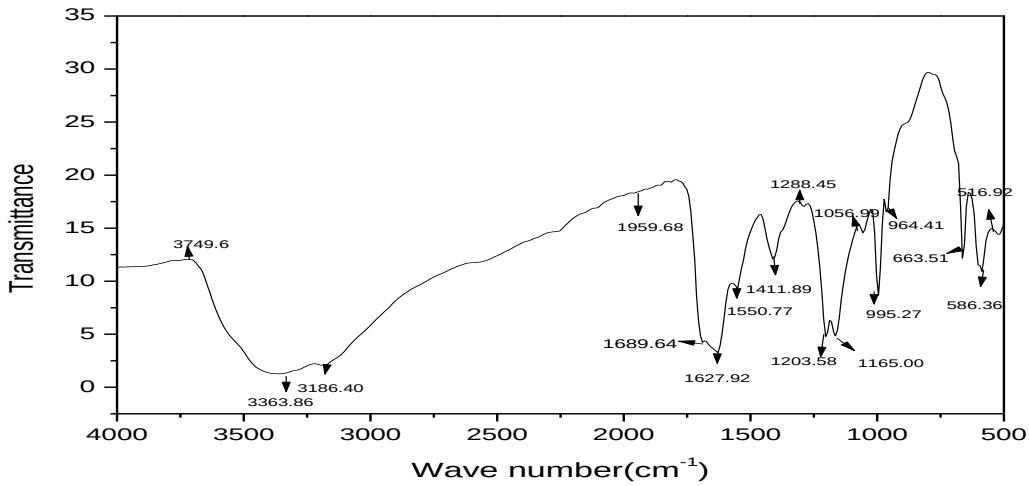

Fig. 3 FTIR spectrum of CuS

Table 1: Interpretation of the peaks obtained by the FTIR Spectra of the synthesized CuS Nanoparticles

S.No	Region(cm^{-1})	Interpretation
1	3363.42	N-H stretching(TU)
2	1627.92	O-H stretching(water)
3	1380-1420	C-H bending of CH3 (Acetone)
4	1056-1203	C-O or S-O (acetone or sulphate)
5	675, 619 (600-700)	C-S Stretching
6	516.12	CuS

IV CONCLUSION

In summary, CuS Nano particles have successfully synthesized via a simple Chemical precipitation method by employing the water as the reaction solvent. Conventional thermal treatment of prepared at 100°C in air for 2h resulted in the formation of CuS nano particles. The size of ceria nano spheres can be controlled by adjusting the reaction time. It clearly states this work provides a versatile route to synthesize sphere like metal sulphide nano structures, and we believe that it is very beneficial to fabricate the size controlled nano spheres due to the novel physical and chemical property.

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