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Synthesis of Cu doped ZnS nanostructures on flexible substrate using low cost chemical method

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Abstarct. Flexible electronics is one of the emerging area of this era. In this paper we have reported synthesis of Cu doped Zinc sulphide nanostructures on filter paper flexible substrates. Zinc chloride and Thio urea were used as a precursor for Zinc and Sulphur. The structures were characterized by XRD, FE-SEM and UV visible spectrometer. All the peaks identified for cubic structure of ZnS. Appearance of small Cu peaks indicates incorporation of Cu into ZnS lattice. Zns nanostructures assembled as nanobelts and nanofibers as shown in FE-SEM micrographs. Compound Structures provide the reasonable electrical conductivity on filter paper. Absorption in UV region makes them suitable for flexible electronic devices.

INTRODUCTION

Lot of work has been reported on synthesis and characterization of various nanostructures in the last two decades [1]. Recently chalcogenides also considered as suitable candidate at nanoscale due to their unique and tunable electrical, optical and electrical properties with respect to their particle size. Among various Chalcogenide materials ZnS is a wide band gap II-VI semiconductor, more stable and technologically better than other chalcogenides. Having vast potential applications in optoelectronic devices like ultraviolet light emitting diode, flat panel display and thin film electroluminescent devices [2-6], development of flexible electronics, possess new challenges to scientific community. These challenges are related with requirement of suitable substrates as well as materials to be deposited with reasonable performance. This provides new directions to synthesize the nanostructure on flexible substrates and their characterization. Various flexible substrates and various synthesis methods (bath deposition, spray pyrolysis, PVD, Sol gel) has been reported [8-9]. Out of which sol gel have received increasing attraction due to low cost and high performance. Doping of various optically active luminescent materials has also been reported to improve various properties specially increase in intensity of emission in wide range of wavelength [7]. Doping of various dopents has been reported in which Cu doping have received much attention due to strong dependence properties on concentration. It attracts the different energy levels resulting in luminescent spectra [10].

In this we have reported low cost synthesis of Cu doped ZnS nanostructure on filter paper flexible substrates using sol gel route and their optical, electrical, structural characterizations.

EXPERIMENTAL SECTION

Cu doped ZnS were grown by sol-gel route on filter paper substrates. AR grade chemicals supplied by Ranbaxy were used as starting material. At first ethylene glycol and ethanol were mixed together in a specific ratio and stirred for one hour. Zinc chloride (.01M) and thiourea (.01M) were added in the solution and stirred for 3 hours at 60^0C, transparent sol was obtained. Cuprous chloride (.01M) was mixed in the 50 ml of double distilled water and

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stirred for complete homogenization of the solution and added drop by drop into the above solution obtained whilst being stirred. Then the solution was kept for 24 hours for aging process. Finally Gel was obtained. To obtain layers gel was again diluted by ethanol and stirred well. Filter paper was used as substrate to grow self assembled the Zns nanostructures. The sol was dropped on the substrates and allowed to self assembled. Finally thin film has been grown on the filter paper substrate. The products were analyzed by X-ray diffractometer (Bruker D8 Advance X-ray) with Cu Kα line in the scan range of 20-80. Microstructures and crystal structures of thin film on filter paper substrate were studied by FE-SEM using FE-SEM QUANTA 200 FEG. The compositional analysis was performed by an Energy dispersive X-ray analyzer (EDAX) attached with FE-SEM. Absorption spectra were recorded using Perkin Elmer Lambda 25 in the range 200 to 800 nm.

RESULTS AND DISCUSSION

X-ray diffractograms of sol gel synthesized Copper doped ZnS nanostructures on filter paper flexible substrates Shown in fig 1. (111), (200), (311), (400) and (331) peaks are observed for identified for ZnS cubic structure. [ICDD PDF 65-1691. However for the samples doped with Cu, reflection peaks observed of CuO crystalline structure marked with (*) in its corresponding XRD pattern arises. This means a small part of CuO may have been incorporated into the ZnS lattice or decomposed [11].

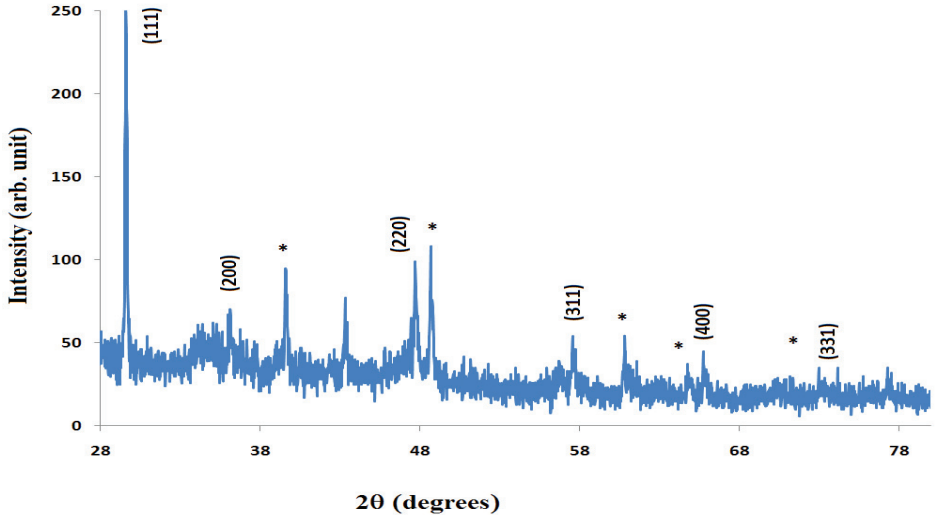

FIGURE 1. X-ray diffractograms of Cu doped ZnS nanostructure.

FE-SEM images of Cu doped ZnS shown in Fig. 2 (a) and (b) . Interconnected network of fibres is observed. It shows that the deposition of ZnS particles on the flexible substrates maintain the original morphology of the fibers of the filter. The ZnS nanostructures distributed in the interconnected ribbons of 20 nm size. The samples also give exhibits good electrical conductivity about $3.45\times10^{-6.}$ These wire like or ribbon like structures provides suitable path for electrical conduction in flexible substrates.

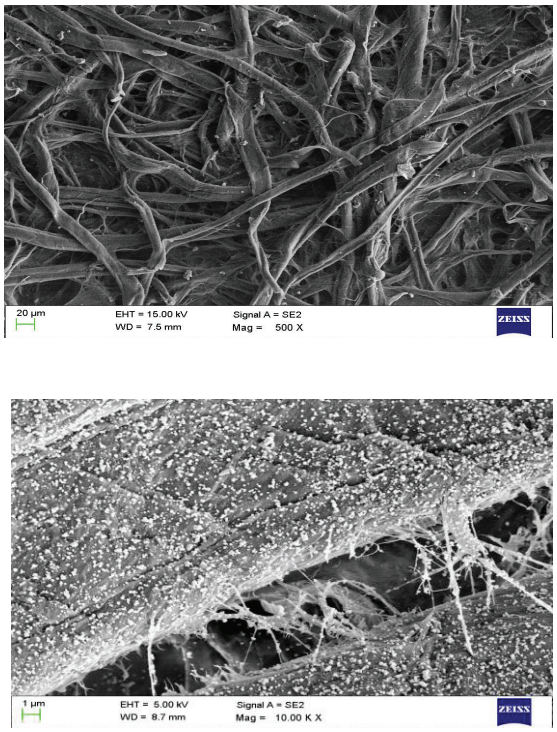

FIGURE 2. (a) and (b) FE-SEM micrographs of the Cu:ZnS at various magnifications.

The corresponding EDX spectrum shown in Figure 3. The spectrum confirms the presence of Copper , Zinc and sulphide in the sample.

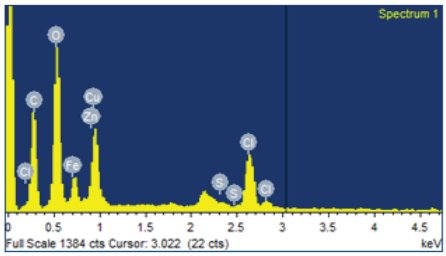

FIGURE 3. EDAX Spectrum of Cu:ZnS

Optical Transmission spectra for Cu doped ZnS sample shown in fig.4. the spectrum shows transparent nature throughout visible region form 400 nm to 800 nm The absorbance occurs at wavelength 300 nm then increases gradually till 400 nm. The band gap energy (E_g) of Zinc sulphide has been evaluated and found to be 3.4eV same as reported earlier.

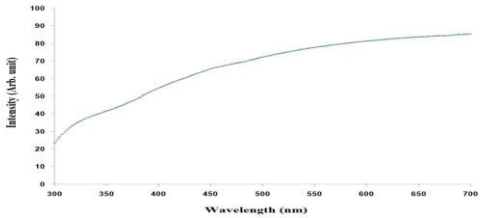

FIGURE 4. Transmittance spectra for Cu doped ZnS nanostructures.

CONCLUSIONS

Fiber like nanostructure networks of Cu doped ZnS were obtained on the filter paper flexible substrates using low cost sol gel route. X ray diffractogram confirms the the cubic strucgture of ZnS with small peaks of all major peaks of ZnS with few peaks for Cu. Addition of copper in ZnS nanostructures improves the conduction behavior of ZnS. ZnS exhibited almost transparent behavior in visible region and good conductivity make them suitable for future flexible electronic devices.

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