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Characterization of Divalent Zn (II) and Cd (II) nanoparticles and their composites by FTIR

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ABSTRACT

In this paper herewith characterization of divalent Zinc and Cadmium as ZnS nanoparticles and its composites with CdS were grown by simple chemical precipitation method in aqueous medium at room temperature and pressure. All chemicals were of analytical grade and used as received, without further purification. ZnS NP have versatile potential applications in ultraviolet light-emitting diodes. And further analyzed by Fourier Transform Infrared Spectroscopy.

KEYWORDS : ZnSNP, CdS NP, FTIR.

INTRODUCTION

ZnS nanoparticles can be prepared in the forms of thin film, powder or colloid using different synthesis techniques such as sputtering[1], thermal evaporation[2], sol-gel[3], sonochemical synthesis[4-5], micro-wave irradiation[6], chemical precipitation method[7], ultrasonic irradiation[8], solid state reaction[9], microemulsion[10], and micellar solutions[11]. Most of these methods involve, high temperature, sophisticated instruments, and large reaction time, but chemical precipitation method on other hand is nearly a very simple and cost effective method, as it does not require sophisticated instrumentation, high temperature or pressure and long reaction time but may sometimes require some stabilizing/capping agents to prevent crystal growth[12]. One-dimensional ZnS nanostructure can be synthesized as nanowires, nanofilms and nanocombs[13-14]. Compared with conventional bulk materials, ZnSNP exhibit many promising characteristics as strength, thermal stability, electronic and magnetic properties, especial surface features and energy band structure which dramatically differ from that observed in bulk, *viz*; ZnS nanoparticles exhibit wider energy gap, high thermal stability, surface effect, quantum confinement effect etc. Due to its excellent properties of optical, electrical, luminescence photochemistry [15], solar cells[16], field emitters[17], photocatalysts[18].

MATERIALS AND METHODS

Synthesis of CdS-ZnS Sandwich Nanocomposites

24.44M of 50mL methanol was added into 100mL $ZnCl_2$ (0.15M) drop wise with continuous stirring. The reaction was then carried out in H_2S atmosphere for 1 minute with vigorous stirring, continued for additional 2 hours. The solution turned from transparent to milky white. In another reaction vessel 0.085M of 100mL $Cd(NO_3)_2$ was taken and 50mL methanol (24.44M) was added drop wise with continuous stirring. The reaction was then carried out in H_2S atmosphere for 1 minute with vigorous

stirring, which was continued for 2 hours. The solution turned transparent to light yellow. The two solutions were added together with vigorous stirring which was continued for 2 hours. The resulting solution was yellow in color.

RESULTS AND DISCUSSION

Structural, elemental and Morphological properties were analyzed by Fourier Transform Infrared (FTIR) Spectroscopy. **Figure.1** shows the synthesized ZnS nanoparticles and its nanocomposites with CdS. The white colored samples indicated the formation of pure **ZnS** nanoparticles. While the yellow colored samples indicated the formation of ZnS nanocomposites with CdS.

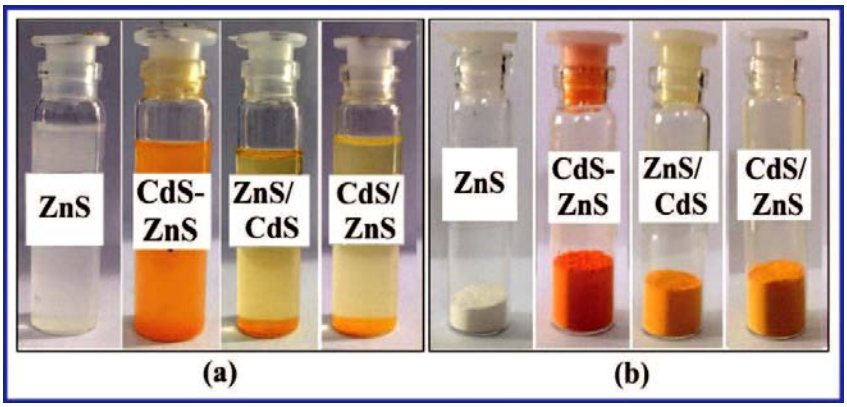

Figure.1: The synthesized **ZnS** nanoparticles and its nanocomposites with CdS (a) obtained as such in suspension form and (b) obtained after washing and drying. Sample **CdS-ZnS** were expected to be Sandwich-type colloidal nanocomposites with smaller ZnS nanoparticle attached as a satellite over larger CdS nanoparticle. **Figure.2** shows the FTIR spectra of the synthesized ZnS nanoparticles and its nanocomposites with CdS. The FTIR spectra confirmed the purity and composition of the samples. The FTIR spectra could be explained by the various peaks obtained by the samples. The absorption peak in the range from 3600 to 3200cm^{-1} corresponded to the –OH group of water adsorbed by the samples. The weak absorption band at 1635cm^{-1} was accredited to CO_2 adsorbed on the surface of the particles, which is quite common for nanosized powder with high surface area. Small peak ear 400-650cm^{-1} indicated the formation of Zn -S and Cd-S bonds as this region is assigned to Metal-Sulphur bond. The characteristic peak of CdS at 405cm^{-1} was observed in all CdS and ZnS nanocomposites. For ZnS, the stretching frequencies were observed at 510-520cm^{-1}. **Table.1** reveals the enlightenment of the peaks obtained by ZnS nanoparticles and its nanocomposites with CdS.

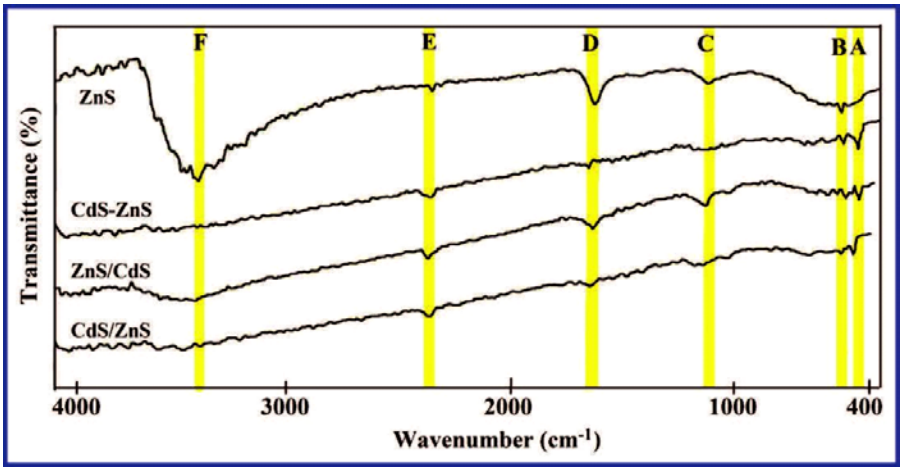

Figure.2: The FTIR Spectra of the synthesized **ZnS** nanoparticles a nd its nanocomposites with CdS (**CdS- ZnS**, **ZnS/CdS** and **CdS/ZnS**).

Table - 1: Table contains the explanation of the peaks obtained by the FTIR spectra of the synthesized **ZnS**, **CdS-Zn S**, **ZnS/CdS** and **CdS/ZnS** nanoparticles.

Peak	Region	Intensity	Significance
A	400-470	Small and weak	Cd-S bond (CdS nanoparticles)
B	430-650	Small and weak	Zn-S bond (ZnS nanoparticles)
C	1060-1120	Small and weak	C-O or S-O (acetone or sulphate)
D	1620-1740	Small and weak	C-H bending of CH_3 (Acetone) or CO_2 bending
E	2340-2360	Weak	S-H bond (Free H_2S)
F	3140-3470	Broad	Intermolecular H-bonds (Lattice water)

CONCLUSION

CdS/ZnS and ZnS/CdS core-shell nanocomposites were synthesized using single pot chemical precipitation method under room temperature and pressure. The presence of both CdS and ZnS was established by FTIR.

REFERENCES

1 Mandal, S. K.; Chaudhuri, S.; Pal, A. K.: Optical Properties of Nanocrystalline ZnS Films Prepared by High Pressure Magnetron Sputtering. *Thin Solid Films* **1999**, *350*, 209-213.

2 Li, Q.; Wang, C.: Fabrication of Wurtzite ZnS Nanobelts Via Simple Thermal Evaporation. *Applied Physics Letters* **2003**, *83*, 359-361.

3 Tian, J.; Chen, L.; Yin, Y.; Wang, X.; Dai, J.; Zhu, Z.; Liu, X.; Wu, P.: Photocatalyst of TiO_2-ZnO Nano Composite Film: Preparation, Characterization and Photodegradation Activity of Methyl Orange. *Surface and Coatings Technology* **2009**, *204*, 205-214.

4 Yang, H.; Huang, C.; Su, X.; Tang, A.: Microwave-Assisted Synthesis and Luminescent Properties of Pure and Doped ZnS Nanoparticles. *Journal of Alloys and Compounds* **2005**, *402*, 274-277.

5 Han, J.; Zhang, W.; Chen, W.; Thamizhmani, L.; Azad, A. K.; Zhu, Z.: Far-Infrared Characteristics of ZnS Nanoparticles Measured by Terahertz Time-Domain Spectroscopy. *The Journal of Physical Chemistry B* **2006**, *110*, 1989-1993.

6 J F Xu; Wj Ji; J Y Lin; S H Tang; Y W Du: Preparation of ZnS Nanoparticles by Ultrasonic Radiation Method. *Applied Physics A* **1998**, *66*, 639-641.

7 Lu, H.-Y.; Chu, S.-Y.; Tan, S.-S.: The Characteristics of Low-Temperature-Synthesized ZnS and ZnO Nanoparticles. *Journal of Crystal Growth* **2004**, *269*, 385-391.

8 Loukanov, A. R.; Dushkin, C. D.; Papazova, K. I.; Kirov, A. V.; Abrashev, M. V.; Adachi, E.: Photoluminescence Depending on the ZnS Shell Thickness of CdS/ZnS Core-Shell Semiconductor Nanoparticles. *Colloids and Surfaces A: Physicochemical and Engineering Aspects* **2004**, *245*, 9-14.

9 Calandra, P.; Longo, A.; Liveri, V. T.: Synthesis of Ultra-Small ZnS Nanoparticles by Solid-Solid Reaction in the Confined Space of AOT Reversed Micelles. *The Journal of Physical Chemistry B* **2003**, *107*, 25-30.

10 Oliva, A.; Santiago, P.; Gayou, V.; Salazar, H. B.; Delgado, M. R.; Zavala, G.: Structural Studies of ZnS Nanoparticles by High Resolution Transmission Electron Microscopy. *Journal of Nano Research* **2010**, *9*, 125-132.

11 Ding, Y.; Wang, X. D.; Wang, Z. L.: Phase Controlled Synthesis of ZnS Nanobelts: Zinc Blende vs Wurtzite. *Chemical Physics Letters* **2004**, *398*, 32-36.

12 Ma, C.; Moore, D.; Li, J.; Wang, Z. L.: Nanobelts, Nanocombs, and Nanowindmills of Wurtzite ZnS. *Advanced Materials* **2003**, *15*, 228-231.

13 Nizamoglu, S.; Ozel, T.; Sari, E.; Demir, H.: White Light Generation Using CdSe/ZnS Core–Shell Nanocrystals Hybridized with InGaN/GaN Light Emitting Diodes. *Nanotechnology* **2007**, *18*, 065709-065709-5.

14 Bouhafs, D.; Moussi, A.; Chikouche, A.; Ruiz, J.: Design and Simulation of Antireflection Coating Systems for Optoelectronic Devices: Application to Silicon Solar Cells. *Solar Energy Materials and Solar Cells* **1998**, *52*, 79-93.

15 Oladeji, I. O.; Chow, L.: Synthesis and Processing of CdS/ZnS Multilayer Films for Solar Cell Application. *Thin Solid Films* **2005**, *474*, 77-83.

16 Chen, Z. G.; Cheng, L.; Xu, H. Y.; Liu, J. Z.; Zou, J.; Sekiguchi, T.; Lu, G. Q. M.; Cheng, H. M.: ZnS Branched Architectures as Optoelectronic Devices and Field Emitters. *Advanced Materials* **2010**, *22*, 2376-2380.

17 irov, S.; Fedorov, W.; Graham, K.; Moskalev, I.; Badikov, V.; Panyutin, V.: Erbium Fiber Laser–Pumped Continuous-Wave Microchip Cr^{2+}:ZnS and Cr^{2+}:ZnSe Lasers. *Optics Letters* **2002**, *27*, 909-911.

18 Sorokina, I. T.; Sorokin, E.; Mirov, S.; Fedorov, V.; Badikov, V.; Panyutin, V.; Schaffers, K. I.: Broadly Tunable Compact Continuous-Wave Cr^{2+}: ZnS Laser. *Optics Letters* **2002**, *27*, 1040-1042.