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Depiction of ZnS /CdS nanoparticles and their composites

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Abstract: *Herewith we discuss about the characterization of Zinc and Cadmium divalent nano particles and composite materials as sand witch model by SEM and Tem by spectroscopic methods.* ***CdS-ZnS*** *sandwich type nanocomposites were synthesized using chemical precipitation method under ambient conditions. TEM images of the ZnS NP and its NC showing spherical quantum dots with particle sizes less than 10nm. The TEM image for* ***ZnS*** *revealed the formation of spherical, 2-3nm sized pure ZnS quantum dots. SEM images of the synthesized ZnS nanoparticles and its nanocomposites with CdS at 5500 times magnification*

Key Words: *ZnS, CdS* **,** *Nanocomposites, SEM, TEM.*

1. INTRODUCTION:

ZnS NP doped with transition metals may possess improved magnetic properties owing to partially filled d or f valence electronic states of transition metals, as they contain unpaired electrons, in accordance with their spin which may display a magnetic phenomenon. Thus metal doped ZnS can have promising applications in spin-valve transistors, electroluminescent devices, spin light-emitting diodes, multidimensional sensor devices, non-volatile memory and may possess a range of luminescent properties excited by X-ray, electrical currents, ultraviolet or cathode ray[1-4].

The optical properties of various semiconductor QDs may also be improved by coating them with a shell of a second higher band gap semiconductor, consequential in core-shell type-I systems[5-6]. CdS is an effective photo catalyst in visible region but faces a major negative aspect of poor quantum efficiency due low stability in solution as a result of Cd^{2+} ions leaching. In spite of the drawbacks associated to CdS, considerable efforts are still being made to improve the photocatalytic stability taking into account its relatively high photoactivity[7]. Various attempts have been made to improve the photocatalytic efficiency of CdS like changing the surface structure of CdS NP by controlling morphology[8], doping of transition metal ions into CdS[9], depositing CdS to Nafion membranes, grapheme sheets or carbon nano tubes to get unvarying, homogeneously disseminated CdS QDs[10-11] and coupling of CdS with another semiconductor[12-13]. Among these, the combination of different band gap semiconductor forming solid solutions is an effective way to control the potential of conduction and valence bands by successive changes in the composition. The ZnS, due to its optoelectronic and structural properties, can be a significant semiconductor material to combine with the CdS forming a continuous series of solid solutions ($Cd_{1-x}Zn_xS$), where metal atoms are reciprocally replaced in the crystal structure[14-15].

2. MATERIALS AND METHODS:

ZnS nanoparticles and its composites with CdS were grown by simple chemical precipitation method in aqueous medium at room temperature and pressure. 50mL methanol (24.44M) 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 brisk stirring, continued for additional 2 hours. The solution turned from transparent to milky white. In another reaction vessel 100mL $Cd(NO_3)_2$ (0.085M) was taken and 50mL methanol (24.44M) was added drop wise with continuous stirring. The reaction was then conceded 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 mixed together with vigorous stirring which was continued for 2 hours. The resulting solution was yellow in color. Microscopic studies were carried out using Scanning Electron Microscopy (SEM) and Transmission Electron Microscopy (TEM)

3. RESULTS AND DISCUSSION:

Scanning Electron Microscopy (SEM)

The SEM micrographs showed amorphous structure with awfully fine particle size. But definite particle size and shape was not discernible due to presence of very fine amorphous powder. **Figure 1** shows the SEM images of the synthesized ZnS nanoparticles and its nanocomposites with CdS at 5500 times magnification (5.5kx).

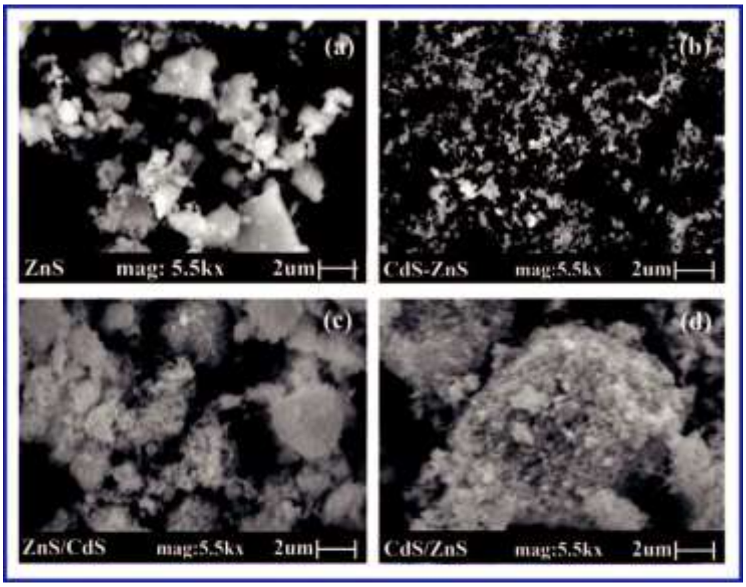

Figure 1. SEM images of the synthesized ZnS nanoparticles and its nanocomposites with CdS, at 5500x magnification showing (a) pure **ZnS**, (b) sandwich **CdS-ZnS** colloid nanoparticles and core-shell (c) **ZnS/CdS** and (d) **CdS/ZnS**.

Transmission Electron Microscopy (TEM)

Figure 2, displays the TEM images of the ZnS NP and its NC (**CdS-ZnS**, **ZnS/CdS** and **CdS/ZnS**) showing spherical quantum dots with particle sizes less than 10nm. The TEM image for **ZnS** (**Figure 2 (a)**) revealed the formation of spherical, 2-3nm sized pure ZnS quantum dots. The TEM images for **CdS-ZnS** (**Figure 2 (b))** showed the presence of two different sized nanoparticles, corresponding to CdS (4-5nm) and ZnS (2-3nm) with close proximity to each other, thus suggesting the formation of sandwich colloidal **CdS-ZnS** nanocomposites. The TEM images for **ZnS/CdS** (**Figure 2 (c)**) showed ~5-6nm sized particles, suggesting the formation of core-shell **ZnS/CdS** nanocomposites, as presence of both CdS and ZnS was confirmed by EDS and XRD. The increase in NCs diameter revealed by TEM is considered to be the most direct proof of successful shell growth.

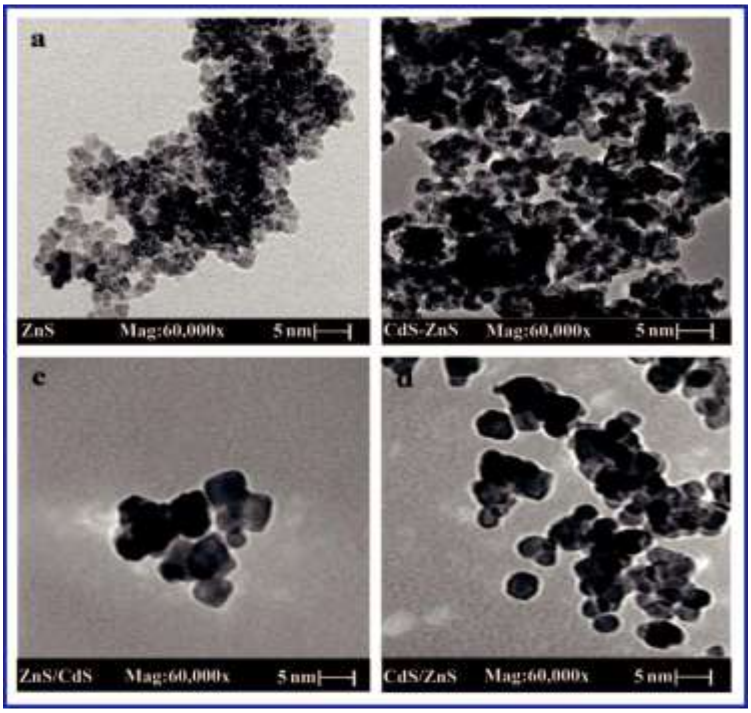

Figure 2.TEM images of synthesized **ZnS** nanoparticles and its nanocomposites with CdS, showing (a) pure ZnS, (b) sandwich **CdS-ZnS** colloid nanoparticles and core-shell (c) **ZnS/CdS** and (d) **CdS/ZnS** .

4. CONCLUSION:

The **CdS-ZnS** sandwich-type nanocomposites showed the formation of both CdS and ZnS nanoparticles with close proximity to each other. These are characterized by SEM and TEM. The TEM images for **CdS/ZnS** displayed ~4-5nm sized particles which were larger than the pure CdS core, suggesting the formation of core-shell **CdS/ZnS** nanocomposites are depicted.

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