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Review Article

A brief Review on the physical properties of Cadmium selenide nanoparticles and zinc sulfide nanoparticles and applications

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ABSTRACT:

Group 12-16 (II-VI) semiconductor nanoparticles such as ZnSe, CdSe, CdS, ZnS which are called quantum dots (Quantum Dots) have numerous applications in Optoelectronics, photocatalytic activity and solar energy industries. The Cadmium Oxide (CdO) nanoparticles, which are made in various forms, are widely interested in the field of medicinal and pharmaceutical researches, especially the researches about its applications on cancer treatment. A nanometer is a one billionth of a meter i.e. 10-9 m. The nanomaterials exhibit distinctive physical properties as compared to the bulk. The size dependent properties at this scale make nanomaterials capable of enhancing the performance and shelf life of number of products in the industrial sector. Applications: **UV-Sensors:** ZnS makes a promising material for fabricating optoelectronic devices

Chemical Sensors: Mn+2 doped ZnS nanocrystals with amine capping layer have been fabricated and utilized for the fluorescence detection of chemicals like 2,4,6-trnitrotoluene (TNT) by quenching the strong orange Mn+2 photoluminescence.

Biosensors: Recently CdSe/ZnS core-shell QDs conjugated with enzymes is used to sense glucose. The QDs were used as electron donors whereas enzymes were used as acceptors for oxidation/ reductions reactions involved in oxidizing glucose to gluconic acid. The newly developed QD systems possess superior design, high flexibility, low cost and good sensitivity.

Keywords: Cadmium selenide, zinc sulfide, Biosensors, Chemical Sensors, UV-Sensors.

INTRODUCTION:

New demand for manufacture of integrated circuits especially memory circuits including Dynamic random-access memory (DRAM) and Static Random Access Memory (Static RAM or SRAM) with features such as high-speed operation together with reduced power dissipation steadily increased. In evolutionary process, miniaturization of electronic components especially in geometry and submicron scale of less than 0.2 micrometres i.e. design of nano-technology electronic components and manufacture of integrated circuits is complicated. On average, sizes and dimensions of electronic components has been reduced by half per six years. Today, using the advantages of integration of small parts, in particular nano-electronics technologies for structure of such integrated circuits have turned broader and more complex, so that these circuits have developed from tens of millions of transistors, diodes, resistors and capacitors. The width of connecting lines between different parts in 2000 has been 0.18 micrometers which continued to reduce. To progress this technology, in this year total sales of integrated circuits in the world have been estimated at $ 150 billion.

Electrons in quantum dots likewise clumped semi-conductor tend to have transitions near the edges of the energy gap. Energy levels depend on the size and shape of the quantum dots. The smaller quantum dot, the energy levels fall apart and energy levels increase. Semiconductor quantum dots with low dimension due to various applications including solar cells, catalysts, biological labels, laser media and optoelectronic devices have attracted much attention (1,2].

Disadvantage of this nanoparticle is that it is easily exposed to degradation and release of toxic ions+ Pb2 by hydrolysis or oxidation in the biological environment [3,4].

Semiconductor films of Cadmium Oxide (CdO) nanostructures have a direct and wide band gap (4.05 eV) and are of unique applicable characteristics for gas sensors, solar cells, laser, Spintronics and etc. Cadmium Oxide (CdO) is polycrystalline and is of wurtzite structure and is an n–type semiconductor [5-32].

Cadmium Oxide (CdO) films have been produced using different techniques such as magnetron sputtering [33,34], Pulsed Laser Deposition (PLD) [35-43], Spray Pyrolysis Technique [44] and sol–gel [35-59]. Spray Pyrolysis Technique is one of the least expensive and most simple methods for producing Cadmium Oxide (CdO) films. The technique is one of the most industrial methods for deposition of Cadmium Oxide (CdO) films and other transparent conductor oxides [59-91].

On the other hand, Cadmium Oxide (CdO) nanoparticles have opened new horizons to scientists and researchers for the prevention of cancer and its treatment. In this regard, Cadmium Oxide (CdO) nanoparticles–based therapy has emerged as a new branch of nano–based treatments. The Cadmium Oxide (CdO) nanoparticles, which are made in various forms, are widely interested in the field of medicinal and pharmaceutical researches, especially the researches about its applications on cancer treatment. Cadmium Oxide (CdO) nanoparticles are used in various fields such as delivery of drug to the tumor cells, pulling out the cancer of live cells, attacking to cancer cells, improving the sensitivity of cancer cells to imaging and observing them more accurately [92-96].

Zinc sulphide nanoparticles:

A nanometer is a one billionth of a meter i.e. 10-9 m. The nanomaterials exhibit distinctive physical properties as compared to the bulk. The size dependent properties at this scale make nanomaterials capable of enhancing the performance and shelf life of number of products in the industrial sector.

The crystalline sizes of the synthesized ZnS nanoparticles were calculated using the Debye–Scherrer formula in Eq. 1 [97]:

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

Zinc Sulphide (ZnS) is a very important II-VI semiconductor that has been researched widely due to its broad spectrum of potential applications. ZnS is chemically much stable as well as technologically much better than its alternative chalcogenides (such as ZnSe), hence is considered as a favourable host material.

Ram Kripal et al., prepared ZnS: Mn+2 by co-precipitation method and conducted their photo luminescent and photoconductivity properties. UV- visible spectra shows blue shift as compared to bulk counterpart. PL spectra show orange emission that varies with Mn+2 concentrations. The XRD studies estimated the size of nanoparticles to be around 2-4 nm. The TEM images overestimates the larger nanoparicle size due to drying step in sample preparation. The time resolved rise and decay of photocurrent indicates the anomalous behaviour during steady state illumination (Figure 1)[98].

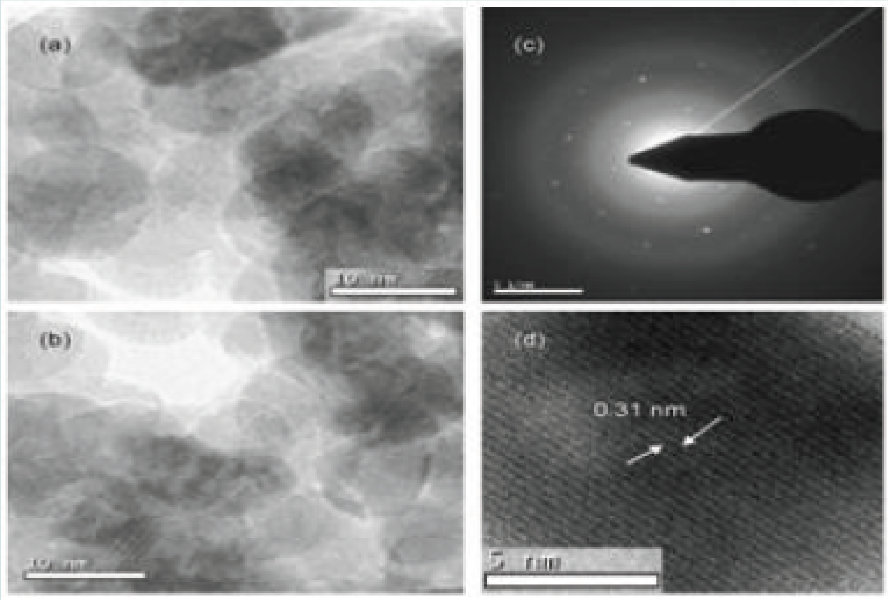

Figure 1: TEM image, SEAD pattern and HRTEM image on ZnS: Mn (1.32%) NPs.

Sarika Pandey et al. prepared Manganese doped ZnS nanoparticles capped with histidine molecule by co-precipitation reaction from the homogenous solution of zinc and manganese salts. The PL spectrum shows the emission peak of doped nanoparticles at around 590 nm. The XRD results calculated the average particle size of ZnS nanophosphor by Debye Scherrer's formula to be of the order of 5-6 nm. A small angle X-ray study shows the maximum uniform particle size distribution of 3.5 nm for the prepared sample (Figure 4) (99).

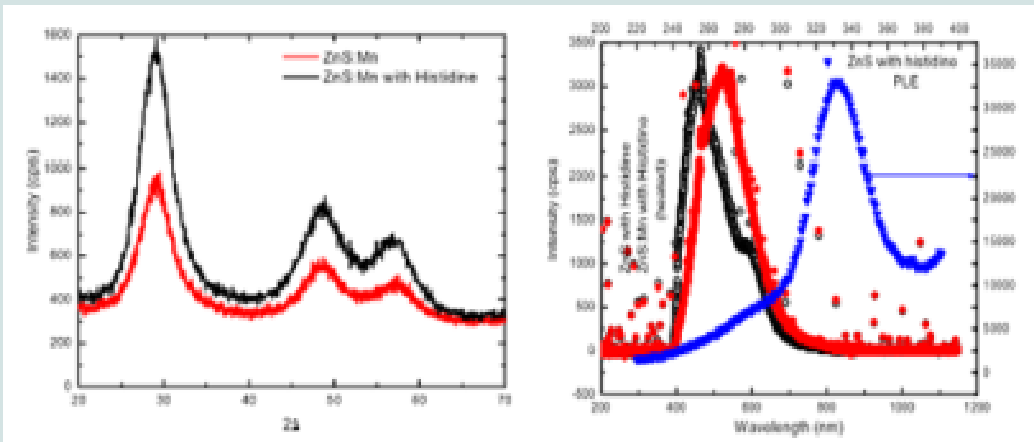

Figure 4: XRD scan and PL spectra of ZnS, ZnS: Mn capped with Histidine respectively.

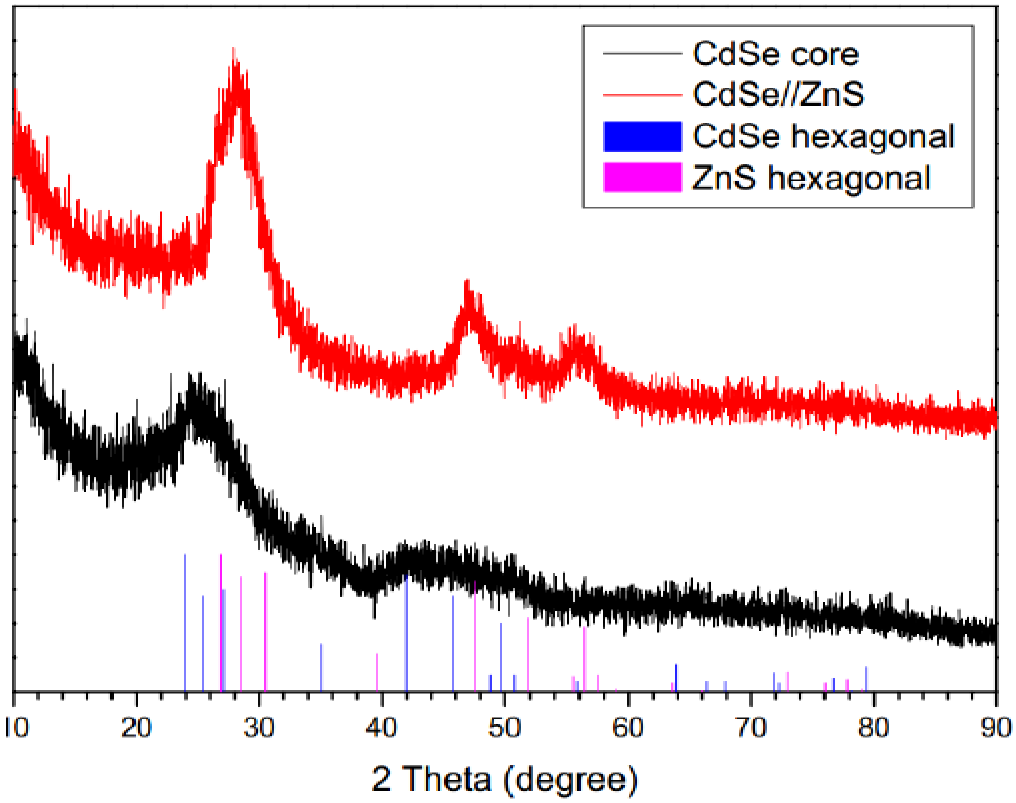

Figure 1. XRD patterns of CdSe QDs & ZnS NPs

Change in absorptionspectrum lies on the interaction between nanoparticles of cadmium selenide and
nanoparticles of ZnS with Copolymer coupling of PEG PCA.

The particle size can be determined via Debye formula. Debye Scherrer equation for calculating the crystallite size is given by $D = K\lambda / \beta cos\theta$ (104) where K is the Scherrer constant, λ is the wavelength of light used for the diffraction, β the "full width at half maximum" of the sharp peaks, and θ the angle measured.

Ultrasonic Test: Ultrasonic test (UT) is one of the non-destructive tests which is grounded on sending high ultrasound into the part to be inspected and examining how the emission occurs in the part.

Applications:

UV-Sensors: ZnS makes a promising material for fabricating optoelectronic devices

Chemical Sensors: Mn^{+2} doped ZnS nanocrystals with amine capping layer have been fabricated and utilized for the fluorescence detection of chemicals like 2,4,6-trnitrotoluene (TNT) by quenching the strong orange Mn^{+2} photoluminescence (100).

Biosensors: Recently CdSe/ZnS core-shell QDs conjugated with enzymes is used to sense glucose. The QDs were used as electron donors whereas enzymes were used as acceptors for oxidation/ reductions reactions involved in oxidizing glucose to gluconic acid. The newly developed QD systems possess superior design, high flexibility, low cost and good sensitivity 101,102).

DISCUSSION AND CONCLUSION

Figure 1 shows the absorption spectrum (CdSe QDs-black curve) and the solution containing quantum dots of cadmium selenide with PEGPCA copolymer at different times (15 min, 30 min, 45 min and 60 min). Absorption spectra are called to the interaction between nanoparticles of cadmium selenide and copolymer PEG-PCA. Due to the opposite charges on the surfaces of nanoparticles of cadmium selenide and copolymer PEG-PCA, this connection will be of electrostatic interaction between the opposite charges.

Electrostatic interaction between nanoparticles of Ag / CdTe with opposite charges has been reported in the article (103).

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