



DEVELOPMENT AND STUDY OF GSH CAPPED CdTe QUANTUM DOTS EMBEDDED POLYMER ELECTROSPUN NANOFIBERS

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ABSTRACT

Quantum Dots (QDs) can be synthesised by chemical method under normal atmosphere. Chemical methods are found to be more economical of all methods, which led to the interest to synthesis QDs through chemical route. The present work focuses the preparation of cadmium Telluride (CdTe) QDs and the formations of CdTe QDs-PVA (poly vinyl alcohol) nanofiber by electrospinning method. The absorption and emission spectra of UV-Visible and Photoluminescence (PL) characterisation confirms the presence of CdTe QDs. The surface morphology and uniformity of CdTe QDs and PVA matrix nanofiber was confirmed through SEM images.

Keywords: Nanofibers, Electrospinning, quantum dots, UV-Visible Spectrum, Photoluminescence, Scanning Electron Microscope.

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INTRODUCTION

Colloidal Semiconductor nanocrystals exhibit unique properties due to quantum confinement effects. Quantum Dots (QDs) have good absorption spectra based on the grain size.¹⁻⁴ QDs can be effectively used in optoelectronic devices, optical transformers, photonic switch devices and other applications.⁵⁻¹⁰ Cadmium Telluride (CdTe) quantum dots are most extensively studying QDs structure which exhibit size tunable optical properties. Photoluminescence properties of the QDs depend on a varying parameters that do not affect the absorption properties.¹¹ The direct band gap of 1.53 eV makes CdTe useful for a wide array of applications.¹² Nanofibers are an interesting nanostructure used for several electronics and Biomedical applications.^{13, 14} The nanofiber properties depends on the applied field, the viscosity of the polymeric solution, nozzle and collector distance. Electrospinning process is a more reliable method to develop Polymeric nanofibers. This process produces well aligned nanofiber structures, compared to other techniques.

In the present paper, we report on excellent photoluminescence properties of CdTe QDs capped with Glutathione (GSH) at various scan rates, which's structural and absorption properties of prepared CdTe QDs and PVA (Poly vinyl alcohol) -CdTe polymeric nanofibers were characterized.

EXPERIMENTAL

Materials and Methods

All the chemicals and reagents of synthesized CdTe QDs were obtained from commercial suppliers and were used without further purification., Glutathione (GSH), cadmium chloride (CdCl₂), Trisodium citrate dehydrate, Potassium tellurate (K₂TeO₃), Sodium Boro hydride (NaBH₄), Millipore water and ethanol.

Preparation of GSH capped CdTe Quantum dots

The colloidal CdTe QDs were synthesized with the capping agent Glutathione (GSH) by colloidal method. Add 0.08M Cadmium chloride in 50ml of Deionised water under stirring for 30 min. Add 0.2 g of Trisodium citrate dehydrate, 0.1g of Glutathione (GSH), 0.02M, 2ml of K₂TeO₃ and 0.1g of NaBH₄

successively while stirring, with 30 minutes interval of time. The mixture was reacted at 95° C oil bath for 72 hours. The obtained QDs were precipitated with ethanol and centrifuged till the pH (7.4) of colloidal solutions.

Preparation of electrospinning solution

PVA of 0.15g was dispersed in 15 ml of cool water for 2 h, Heat the mixture for 30 min at 95° C in order to dissolve the PVA completely. Add 2 g of CdTe colloidal solution under vigorous stirring for 1h. The obtained homogenous polymeric blended solution was used for electrospinning.

Preparation of PVA-CdTe polymeric Nanofiber

As prepared polymeric solution is initially ejected from the tip of a fine nozzle maintained at a potential of 20KV by a DC power supply. The fiber is developed by fixing the nozzle and the collector distance to about (10-15 cm) with various flow rates. The diameter range of the nanofibers depends on flow rate, nozzle collector distance.

Characterization Techniques

The as-prepared semiconductor Quantum dots were characterized by, UV-Visible spectrometer (UV-Vis), Scanning Electron Microscopy (SEM), Photoluminescence (PL).

RESULTS AND DISCUSSIONS

UV-Absorption Spectrum

The as-prepared CdTe Nanoparticles were dispersed in distilled water for UV-absorption analysis. In this analysis water was used for baseline Calibration. The prepared sample was taken in Quartz cuvette and the absorption spectrum was recorded in the range of 200-1200nm as shown in figures- 1 and 2. From the Figure-1, the Maximum absorption range of GSH Capped CdTe nanoparticle was observed from 340nm-590nm respectively. Figure-2 shows UV-Visible absorption spectra of GSH Capped CdTe nanoparticles at various time intervals. By increasing the reflux time, the absorption range increases due to the nucleation of CdTe nanoparticles. Using the energy wave equation, the band gap value of nanoparticles was 3.68eV.

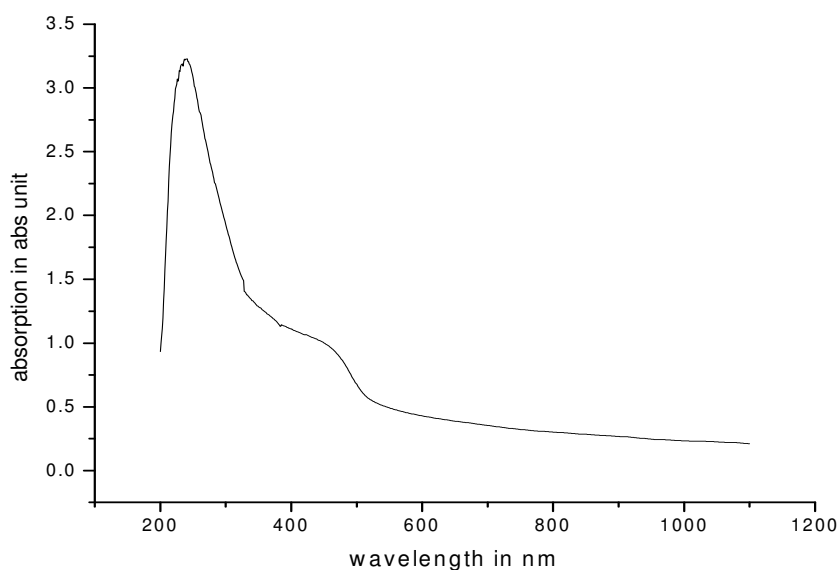


Fig.-1: UV-Absorption spectrum of GSH-CdTe QDs

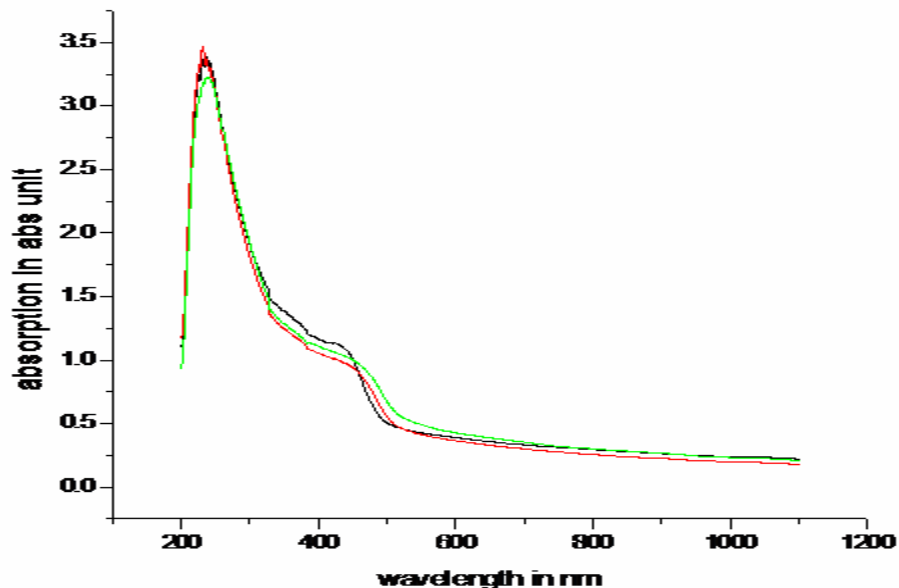


Fig.-2: UV-Absorption spectrum of GSH-CdTe QDs with different refluxing time

Photoluminescence

The Photoluminescence emission of as prepared nanoparticles on the influence of H_2O_2 was studied with different scan rate as shown in figures-3 and 4. The maximum Photoluminescence intensity was observed around 548nm. The Photoluminescence intensity of CdTe capped with GSH nanoparticles decreased with various scan rates due to the quenching effect of H_2O_2 .

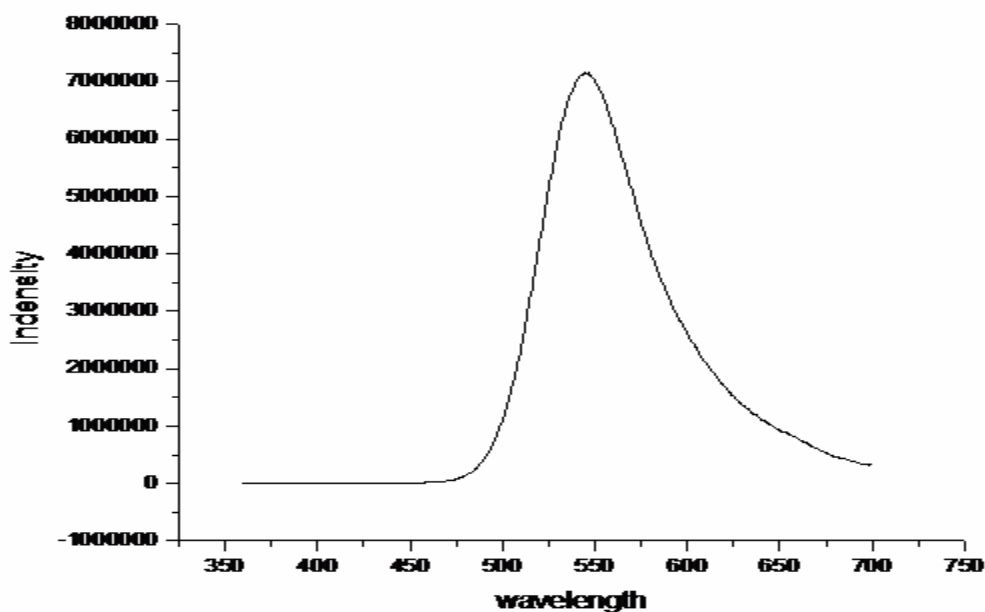


Fig.-3: Photoluminescence Spectrum of GSH-CdTe QDs

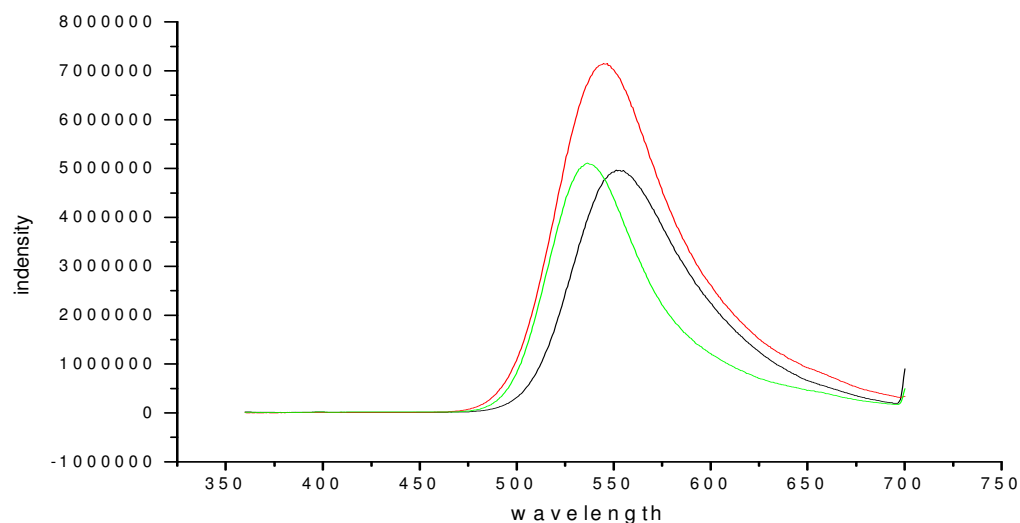


Fig.-4: Photoluminescence spectrum of GSH-CdTe QDs with different Scan rate.

SEM Analysis

Figure-5 shows the surface morphology of GSH capped CdTe nanoparticles. It is observed that the particles are amorphous in nature with different shapes and sizes. The morphology of GSH capped CdTe -PVA nanofibers were characterized by SEM. In this figure-6, due to the high concentration of CdTe nanoparticles, the structure of nanofibers was not homogenous.

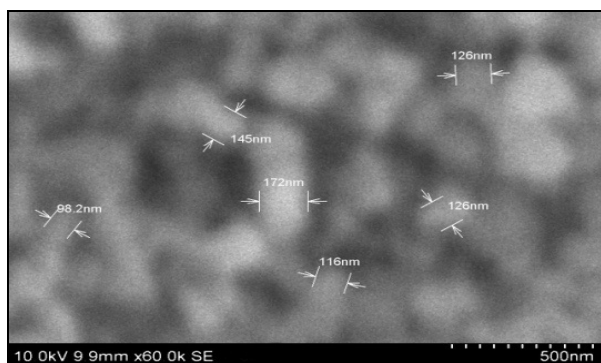


Fig.-5: SEM image of GSH-CdTe QDs

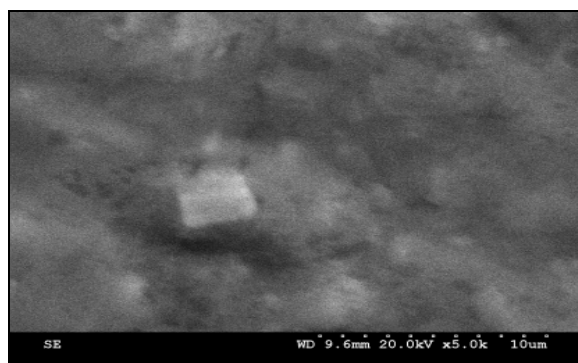


Fig.-6: SEM image of PVA-CdTe QDs composite nanofibers.

CONCLUSION

In this study, a simple and rapid colloidal method was adapted for the preparation of GSH capped CdTe QDs. Using the optical absorption studies, the energy gap values were calculated. The Photoluminescence studies were studied with different scan rate intensity. Electrospinning method was used to incorporate CdTe QDs in PVA nanofibers. In this process the solvents evaporated at a faster rate due to high concentration of CdTe, Thus the nanoparticles structure of nanofibers was not founded to be homogenous.

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