Synthesis of CdTe Quantum Dots of Different Sizes and their Interactions with Water Soluble Porphyrins

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Abstract. Progress in the synthesis of CdTe quantum dots through controlled colloidal-thermal processing and understanding of the factors that control the luminescence quantum yields of CdTe quantum dots enable us to discover technological applications such as fluorescence probes for chemo sensor development and biological imaging, tunable absorbers and emitters in nanoscale electronics, quantum dot lasers and advanced materials for electrochemical applications. In the present study, CdTe quantum dots of different sizes are synthesized in aqueous solution using both anionic (thioglycolic acid) and cationic (2-amino ethanethiol hydrochloride) as stabilizers. The quantum dots are synthesized in a known pH range and the quantum dots are seen to depend on specific pH values depending on the stabilizer added. Their characterization is made using various spectroscopic techniques. The size of the quantum dots is found to vary with the processing time and temperature. Additionally, interaction of the quantum dots with water soluble porphyrins is investigated using steady-state and time-resolved emission studies. Preliminary results suggest photo induced energy transfer as a mechanism of fluorescence quenching.

1. Introduction

Due to their unique optical properties like strong size dependent emission wavelength, continuous excitation spectrum, excellent emission spectrum, photo stability, and longer photoluminescence decay time, Quantum dots have drawn lots of attention in the past few decades. Due to their unique size dependent optical properties QDs have been exploited in the development of optoelectronic devices, biological labeling, and building blocks of superstructures. Quantum dots synthesized using thioglycolic acid as stabilizer acts as a donor and so their interaction with water soluble porphyrins (acceptor) are investigated using steady state and time resolved studies. In the present study we are concerned on synthesizing CdTe QDs of varying size and their interaction with porphyrins and study the mechanism of energy transfer occurring between the Donor-acceptor systems.

2. Experiment

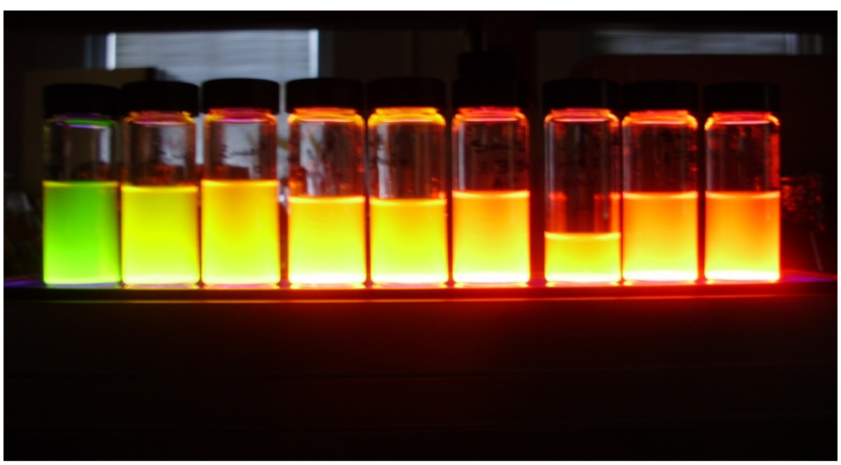

Figure1. CdTe quantum Dots synthesized at different time interval.

Negatively charged CdTe quantum dots were synthesized in an inert atmosphere using one pot synthesis method as shown in figure1 above using thioglycolic acid as the stabilizer. The reaction was carried out in an autoclave at a constant temperature of 130ºC and at a pH value of 11.2 in an aqueous medium.

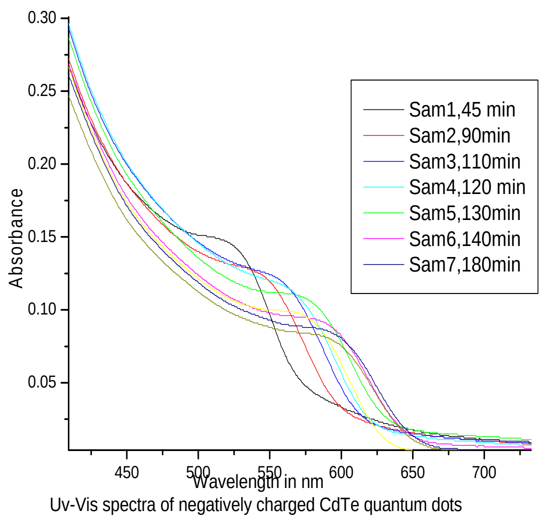

Fig2. UV-Vis Spectra of CdTe QDs.

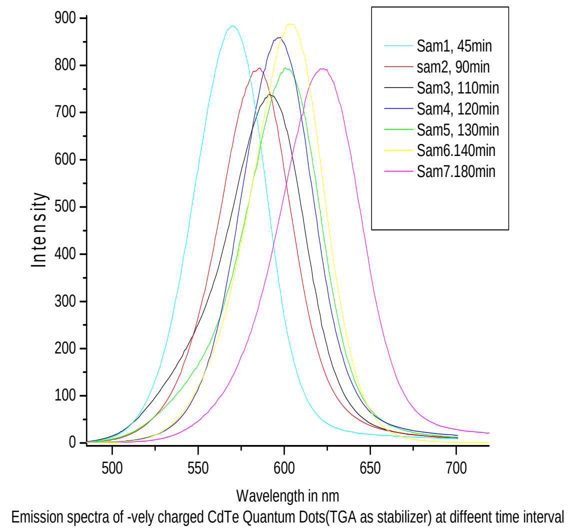

Fig3. Emission spectra of CdTe QDs.

3. Results and Discussion:

CdTe quantum dots can be synthesized as both negatively and positively charged. This depends upon the stabilizer we use for the synthesis in the one pot synthesis method. The quantum dots synthesized were collected at different time interval and the UV-Vis and PL spectra were recorded. Depending upon the time of sample collection we have synthesized different sizes of CdTe QDs as can be seen in the absorption spectra from figure2. It has been observed that the CdTe QDs starts growth at a wavelength of 530nm and with the passing of the reaction synthesis time it shifts towards the red region. This is further confirmed from the emission spectra measurements. From figure3 it can be observed that we have a wide range of the emission spectra showing fluorescence of the QDs. The sizes were calculated and CdTe quantum dots were found to have the sizes of 2.88nm, 3.04nm, 3.19nm, 3.31nm, 3.38nm, 3.43nm, 3.47nm respectively. It has been seen that the quantum dots grow faster as higher temperature. CdTe QDs are purified and stored in dark for further studies. It has been found that the negatively charged CdTe QDs are stable and retain their property for 2-3 months. Lifetime studies of the water soluble CdTe were also done.

4. Further Investigations

The CdTe- Porphyrin system (water soluble) would act as the Donor-Acceptor System. Further studies are taken on photo-induced energy transfer as a mode of fluorescence quenching studies. This promises to be excellent area of energy transfer study that would be a boost in developing solar energy harvesting considering the need of future energy consumption. Biomedical applications of CdTe quantum dots are also being focused in treating diseases such as cancer.

5. Acknowledgement

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