Optical Properties and Nanotoxicity of Fluorescent CdS Quantum Dots

[1]Chaparro-Barriera, Eduardo A. and [2]Bailon-Ruiz, Sonia J.

[1]Department of Biology, University of Puerto Rico in Ponce

[2]Department of Chemistry and Physics, University of Puerto Rico in Ponce

LINC UPR-PONCE

Laboratory of Investigation in Nanotechnology and Characterization

PUERTO RICO LOUIS STOKES

ALLIANCE FOR MINORITY PARTICIPATION

Introduction

- The applications of the luminescent quantum dots (2 to 12 nm in size) have been incrementing during the last years due to their size-dependent optical properties.
- Quantum dots (QDs) are used as component of solar cells, emitting diodes, in electronics, medicine, bio-imaging, as probe for disease diagnosis and catalysis.
- However, as the more benefits by nanoparticles also have newly-identified health risks. Thus, quantum dots in aquatic ecosystem could suffer dissolution processes and release toxic ions to aqueous matrices.
- The current work focus on the release of nanoparticles (i.e. quantum dots) in marine environments and the evaluation of their effects on aquatic organisms (i.e. marine crustaceans) posing a risk to humans.

Objectives

i. Generate water-stable QDs (i.e CdS) in presence of biocompatible molecules.

ii. Characterize QDs optically, structurally and morphologically.

iii. Evaluate the interaction between the quantum dot and the organic cover.

iv. Study the toxicity of QDs (i.e CdS) in marine crustaceans

Methodology

H_2O Deionized + $CdSO_4$

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Organic Compounds

(N-acetyl-L-cysteine)

(Glutathione)

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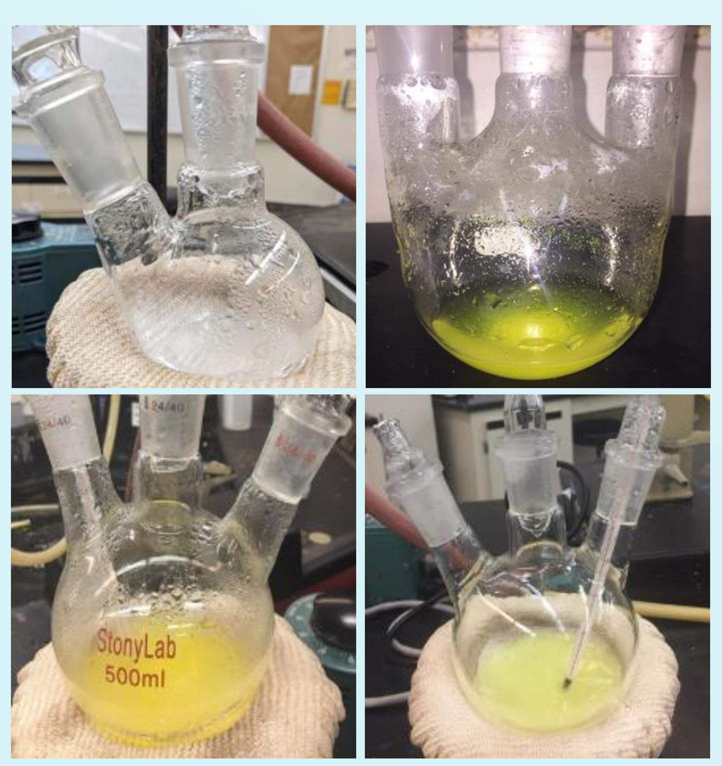
Na_2S



Results

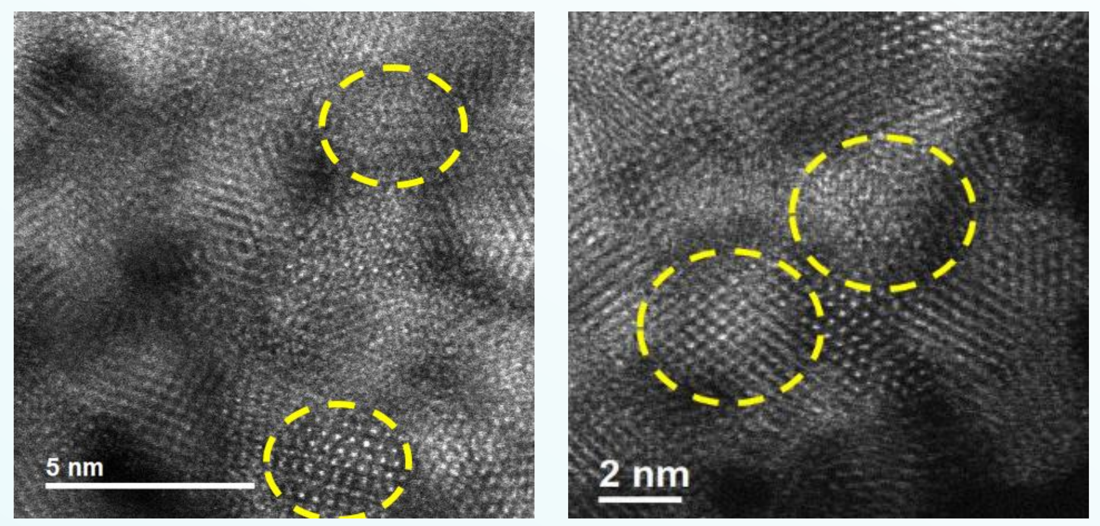


Figure 1 High Resolution Transmission Electron Microscopy (HRTEM) image

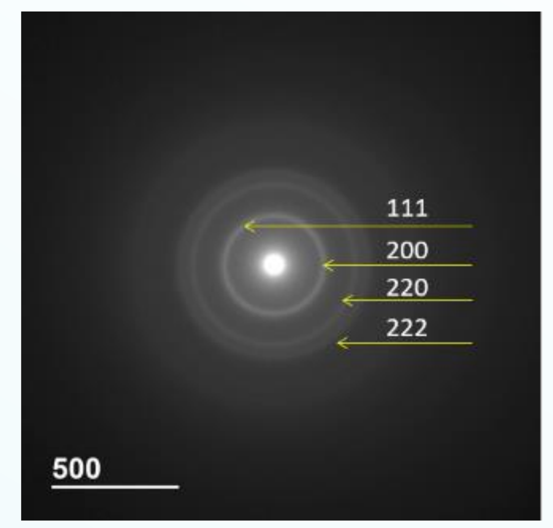


Figure 2 Electron Diffraction spectrum

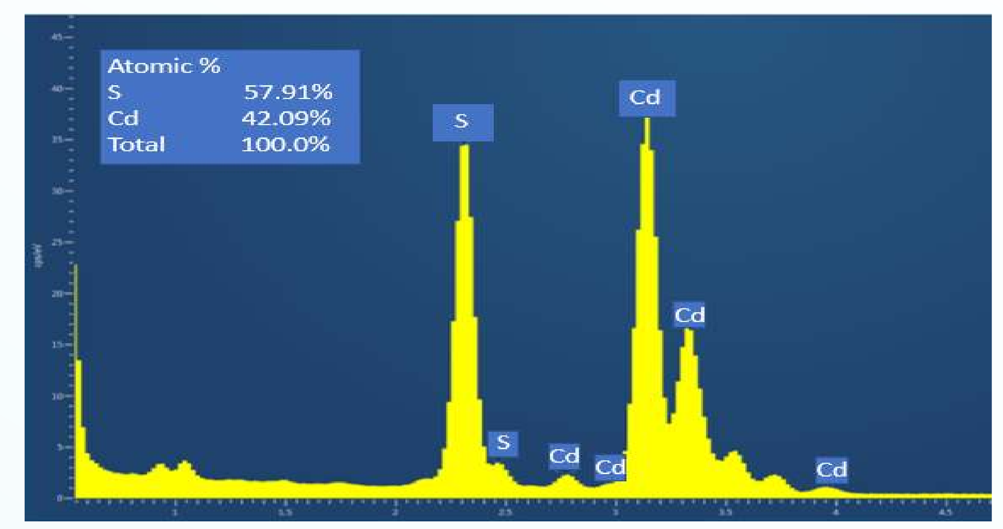


Figure 3 Energy Dispersive X-Ray spectroscopy (EDX) pattern confirmed the presence of CdS in the quantum dots.

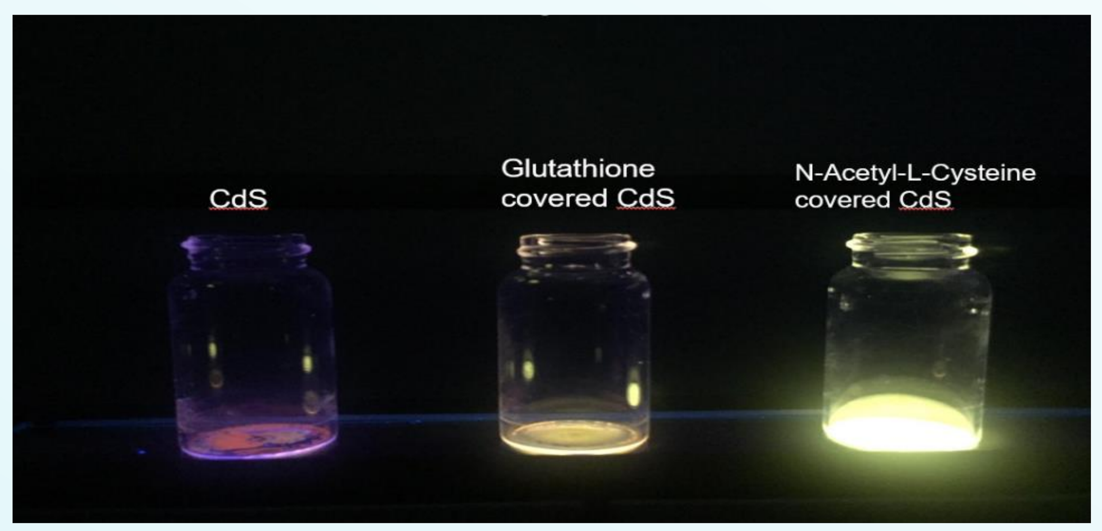


Figure 4 Differences between intensities of Cds quantum dots at 302 nm

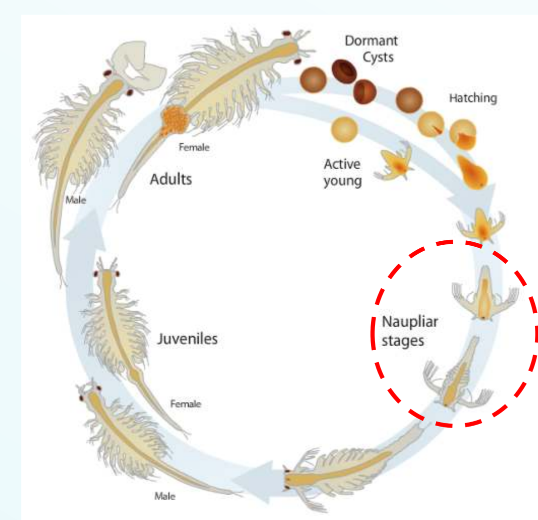


Figure 5 Brine Shrimp Life Cycle

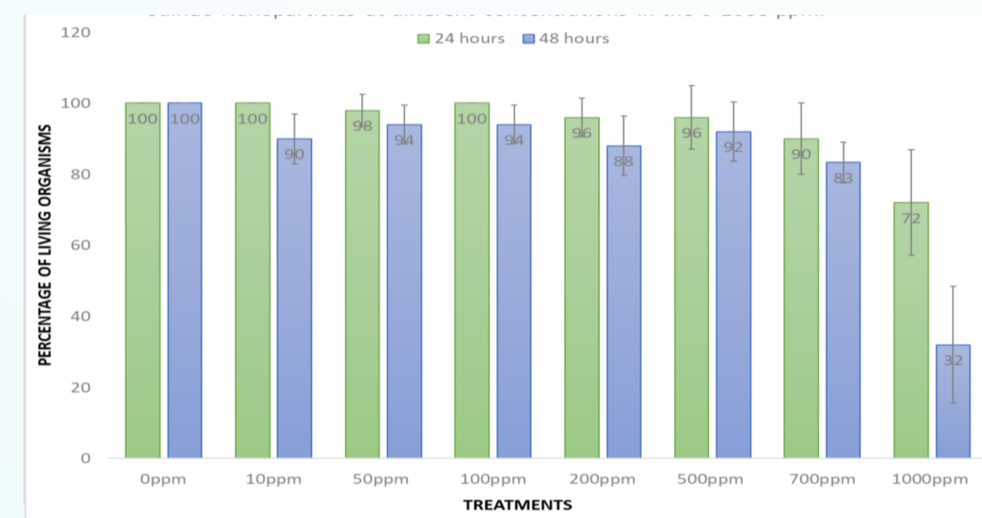


Figure 6 Brine Shrimp Viability after 24 and 48 hours of contact with CdS at 0-1000 pmm

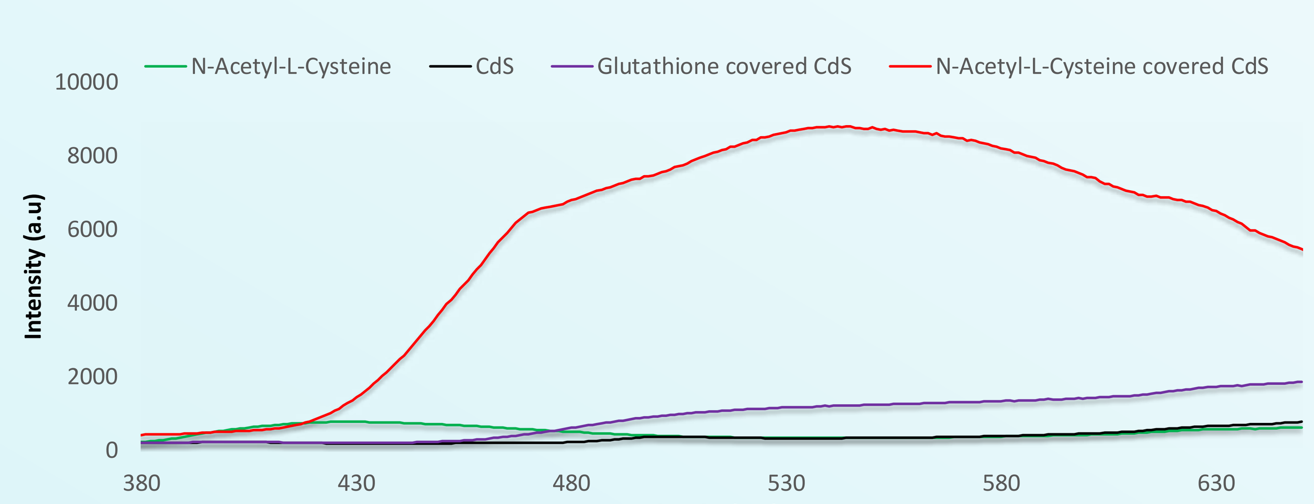


Figure 7 Shows the photoluminescence spectra, comparing different intensities of the synthesized quantum dots.

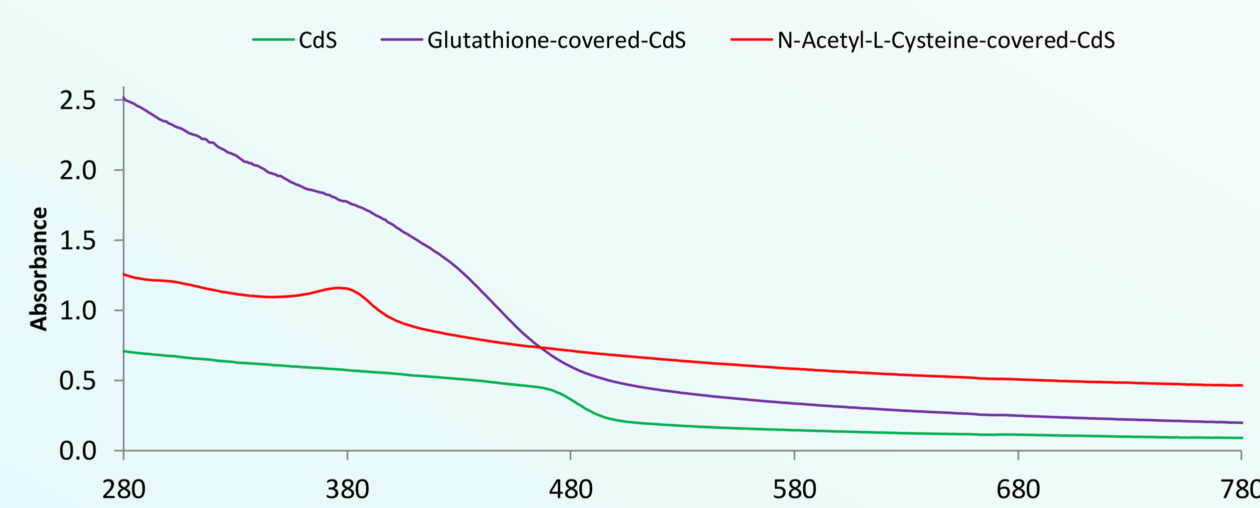


Figure 8 Demonstrates the UV-vis spectra between CdS quantum dots

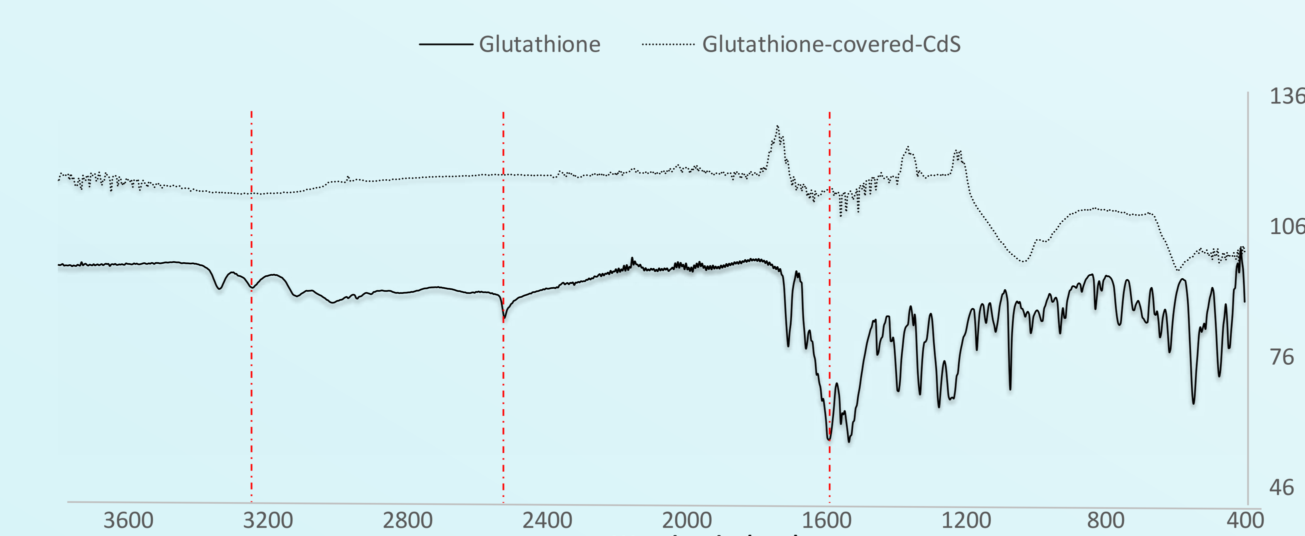


Figure 9 Using FT-IR spectral measurements we determine the presence Glutathione on the CdS quantum dots surface.

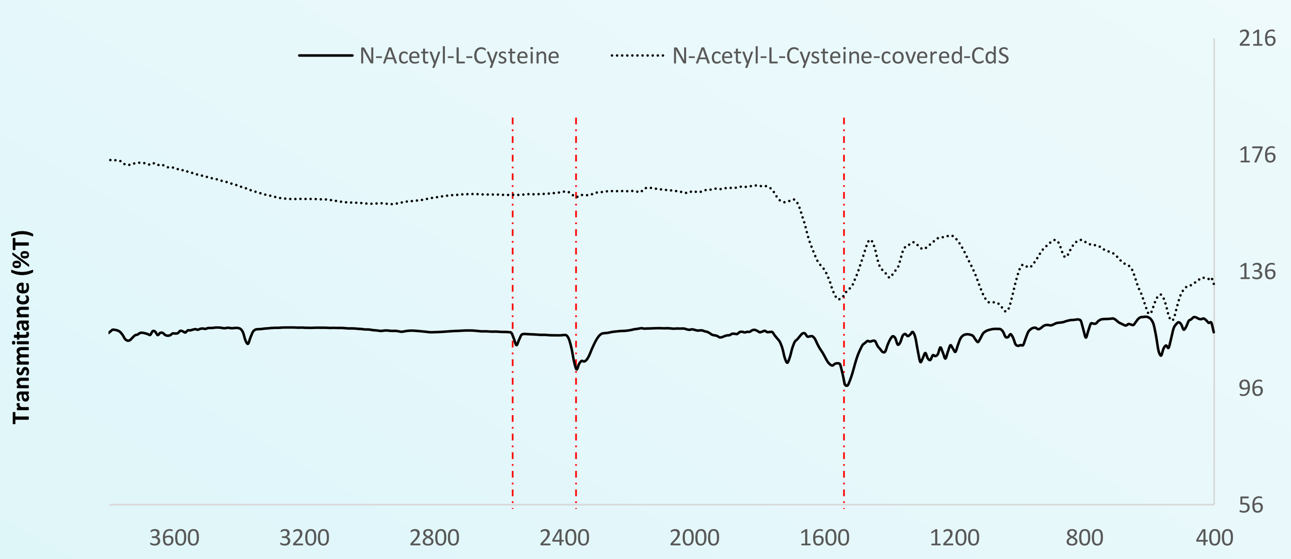


Figure 10 Using FT-IR spectral measurements we determined the presence of N-Acetyl-L-Cysteine on the CdS quantum dots surface.

Results and Discussion

Quantum dots were produced in presence of cadmium precursors, Sulphur precursors and different organic compounds (i.e. N-acetyl-L-cysteine or L-glutathione). They had a size less than 5 nm and a morphology mainly spherical. Crystallographic results of electron diffraction evidenced face-centered cubic structures and EDX reports confirmed the presence of cadmium and sulfur into the crystalline structure. Infrared studies confirmed the presence of N-acetyl-L-cysteine or L-glutathione on the quantum dots surface. Also, FT-IR suggested that the interaction between the nanoparticle and the organic compound occur by covalent bond (i.e. S-H). Interaction analyses evidenced a decrease in the viability of the brine shrimps in the presence of N-Acetyl-L-Cysteine-covered- CdS, which was dependent on the concentration of the nanoparticles and exposure time.

Ongoing Research

- Evaluate the effect of morphology (i.e. rods) of CdS on the toxicity of marine crustaceans.
- Create a core-shell quantum dots (i.e. CdS@ZnS) and evaluate their toxicity.
- Evaluate the photocatalytic capacity of quantum dots, in aqueous matrices contaminated with organic dyes.

References

- Bruneau, A., Fortier, M., Tayabali, A., Fournier, M. (2013). Size distribution effects of cadmium tellurium quantum dots (CdS/CdTe) immunotoxicity on aquatic organisms. *Environmental Science: Processes & Impacts*, *15*(3), 596. doi: 10.1039/c2em30896g
- Hardman, R. (2006). A Toxicologic Review of Quantum Dots: Toxicity Depends on Physicochemical and Environmental Factors. *Environmental Health Perspectives*, *114*(2), 165–172. doi: 10.1289/ehp.8284

Acknowledgements

I thank my mentor, Dr. Sonia Bailon-Ruiz. Also, I thank her Institutional Funds of UPR in Ponce and PR-LSAMP Funds has been able to carry out and support the present research. A part of this research was performed at the National High Magnetic Field Laboratory, which is supported by the National Science Foundation Cooperative Agreement No. DMR-1644779* and the State of Florida.