Synthesis, characterization, and ligand exchange of Cadmium-Selenide quantum dots.

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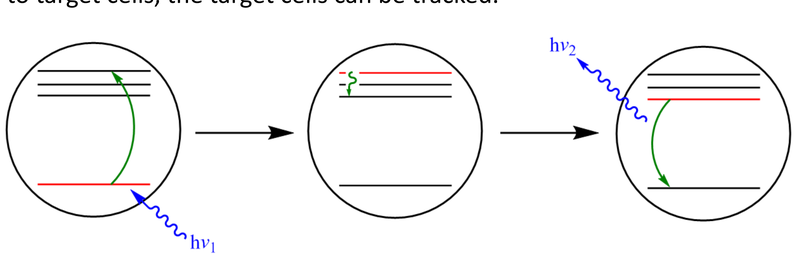
Abstract

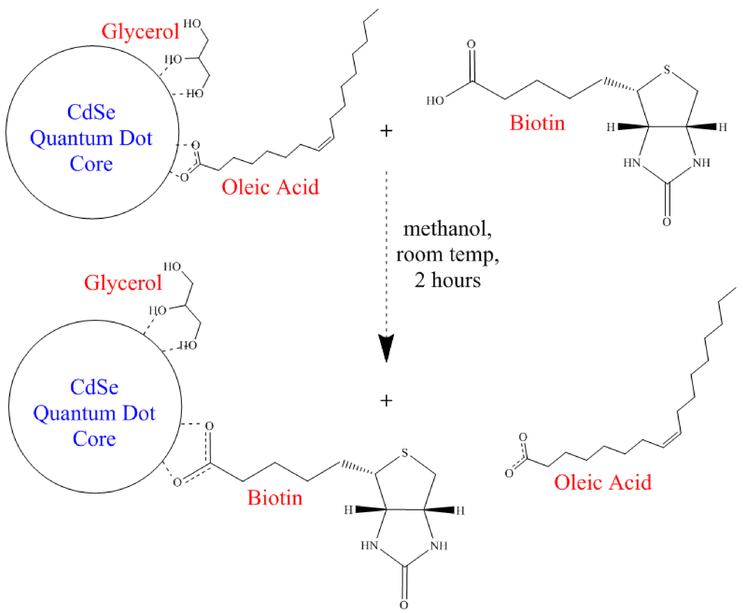
Herein the investigation and synthesis of cadmium-selenide quantum dots is reported. The synthesized series of organic quantum dots yielded absorption values at 500 and 525 nm, and emission values at 490 and 525 nm. In addition, the organic quantum dots are currently being utilized in a ligand exchange for the purpose of cell-tagging.

Background

Quantum dots are nanoparticles that display quantum confinement, which allows them to be used as semiconductors in solar cells, fluorescing components in LEDs, and cell markers. By manipulating quantum dots to fluoresce at a specific wavelength and attaching them to target cells, the target cells can be tracked.



Scheme 1. The electrochemical process which triggers quantum dot fluorescence.



Scheme 2. Proposed ligand exchange on the surface of a cadmium-selenide quantum dot. Biotin exchanges with the oleic acid on the surface of the nanoparticle.

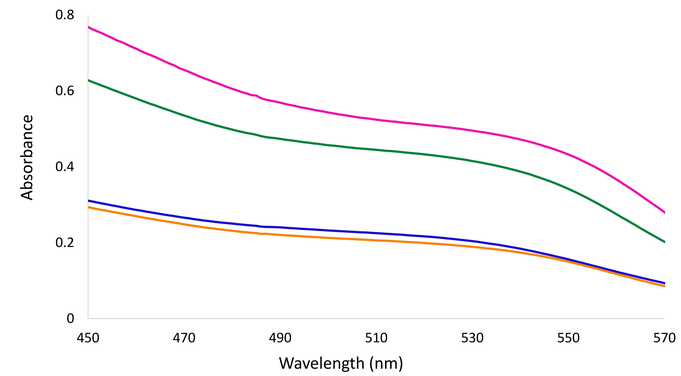


Figure 1. Absorption spectra of the organic quantum dots. The first two of eight total quantum dots, (blue, orange), were observed at 500 nm, while the quantum dots three (green) through eight (pink) were observed at 525 nm.

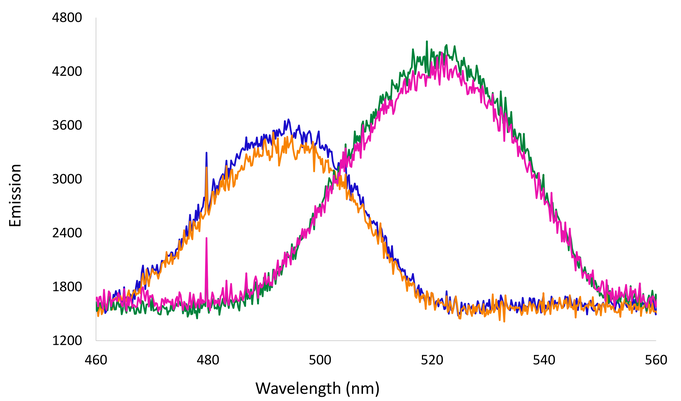


Figure 2. Emission spectra of the organic quantum dots. The first two quantum dots, (blue, orange) emitted light at around 490 nm, while quantum dots three (green) through eight (pink) emitted light at around 525 nm.

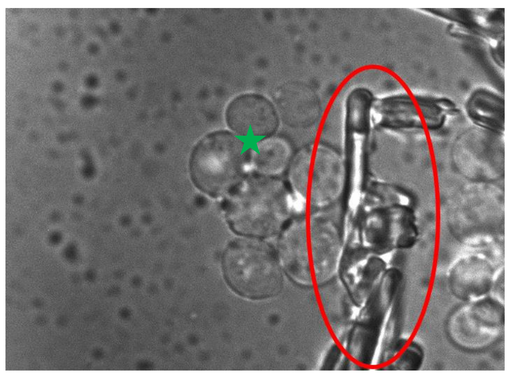
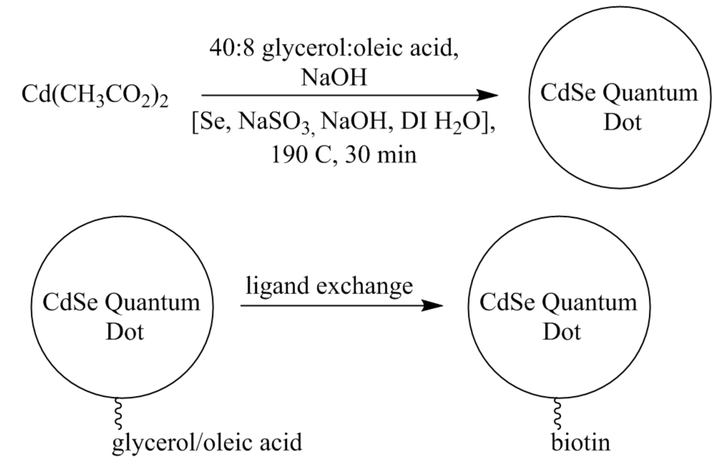


Figure 4. Solution of Baker's yeast, biotin, and organic CdSe quantum dots. The crystalline structure circled in red is suspected to be unbound ligands. The structures denoted by a green star are yeast cells.



Scheme 3. Total proposed synthesis of quantum dots and their use as cell markers.

Looking Forward

- Thorough characterization of both the inorganic and organic quantum dots via absorption and emission spectra
- Run ligand exchange between the ligands on the surface of the quantum dot and biotin
- Confirm ligand exchange via absorption and emission spectra and Transition Electron Microscopy (T.E.M.)
- Quantify the quantum dots' photo-physical properties via a 3D quantum particle-in-a-box model

References

1. Matthew L. Landry, Thomas E. Morrell, Theodore K. Karagounis, Chih-Hao Hsia, and Chia-Ying Wang. Simple Syntheses of CdSe Quantum Dots. *J. Chem. Educ.* **2014**, 91, 274-279
2. Bing Gao, Chao Shen, Bo Zhang, Mengya Zhang, Shuanlong Yuan, Yunxia Yang, and Guorong Chen. Green synthesis of highly efficient CdSe quantum dots for quantum-dots-sensitized solar cells *J. Applied Physics.* **2014**, 115, 193104

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