Exploring the Cytotoxicity of Silica Coated Water-Soluble CdSe Nanocrystals

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Introduction

Fluorescent quantum dots (QDs) are nanometer-sized semiconductors that have been shown to have numerous photophysical properties ideal for biological applications. They exhibit high resistances to photobleaching and are exceptionally bright (Fig 1).[1] However, many QDs, such as CdSe, tend to be toxic for biological applications, therefore they need to be altered to make them water-soluble and prevent surface photo-oxidation.[2] To make CdSe biologically compatible, we have encapsulated them with silica: a nontoxic, water-soluble coating.

Fig1: Quantum Dot

CdSe Synthesis

Red-emitting, approximately 4.4nm, CdSe was prepared by Standard Pyrolysis of Organometallic Precursors:

1. Nucleation: 10.0g TOPO (Trioctyl-phosphine oxide), 10.0g HDA (hexadecylamine), 0.256g CdO, and 1.00g DDPA (dodecyl- phosphonic acid) were heated to 330˚C and purged with argon
2. Growth: Temperature was reduced to 260˚C and 4mL of 0.2M Selenium:TBP (Tributylphosphine) was injected.
3. Sample cleaned: To remove any excess organic ligands

Fig 2: Experimental Setup for QDs Synthesis

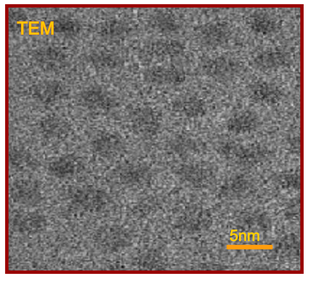


Fig 3: TEM Image of CdSe

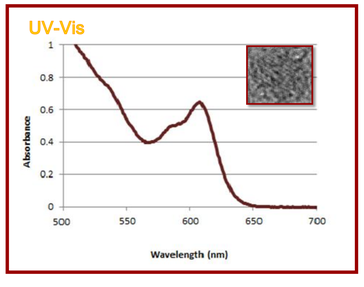


Fig 4: UV-Vis spectra at 607nm

Silica Coating

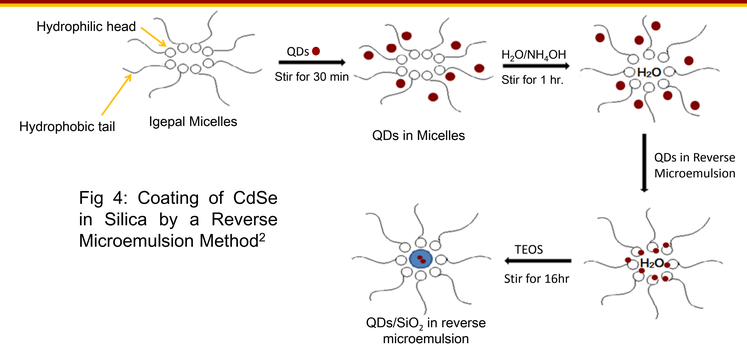


Fig 4: Coating of CdSe in Silica by a Reverse Microemulsion Method[2]

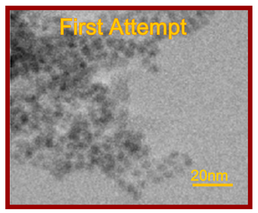


Fig 5: Large amounts of aggregation of both silica and quantum dots

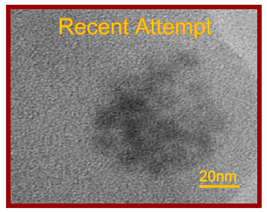


Fig 6: Aggregation of QDs is still present but in smaller proportions

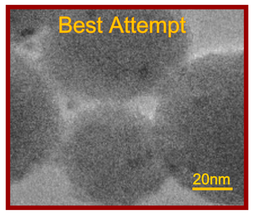


Fig 7: Less aggregation but QDs are not monodispersed in SiO_2 coating

MTT Cytotoxicity Assay

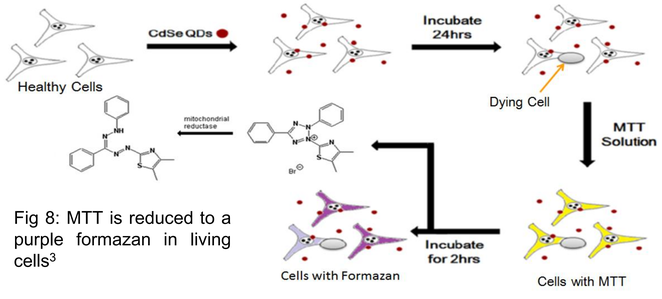


Fig 8: MTT is reduced to a purple formazan in living cells[3]

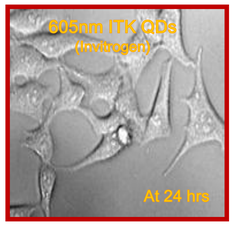


Fig 9: Cells are fairly healthy

Fig 10: Healthy Cells

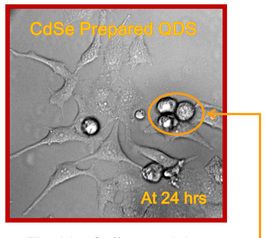
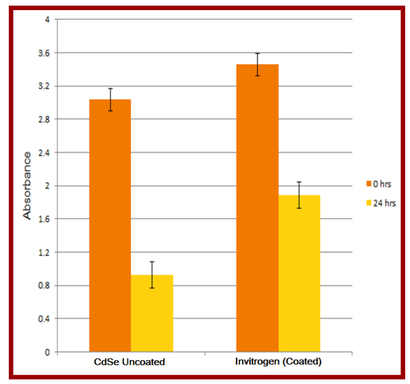


Fig 11: Cells are dying

MTT Cytotoxicity Assay



Results

- Formazan absorption decreased more in cells treated with CdSe uncoated QDs than coated Invitrogen QDs at 0hrs
- Cells viability was then lower in cells treated uncoated CdSe QDs.

Fig 12: Absorption graph of Formazan solution

Future Work

To prepare monodispersed silica coated water-soluble QDs that has little to no aggregation of silica and are able to be tested for cytotoxicity .

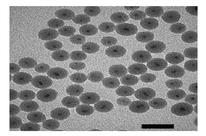


Fig 13: Monodispersed Silica Coated QDs

References

1. Rosenthal, S .J.; Chang, J. C.; Kovtun, O.; McBride, J. R.; Tomlinson, I. D. Biocompatible Quantum Dots for Biological Applications. *Chemistry and Biology*. **2011**, *18*, 10-24.
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Acknowledgements

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