Synthesis of Colloidal Quantum Dots and Selection of Ligand Chemistry

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Background

Efficient lighting is needed to lower our energy consumption to fuel growth of developed and undeveloped countries. In addition, the development of lightweight, flexible, efficient lighting is crucial for space exploration and colonization, as well as in residential and commercial lighting. This project is only a small part of creating such lighting by optimizing the interface in Inorganic-Organic light emitting devices using Quantum Dots. Quantum Dots also have applications in solar cells as well as other renewable devices.

Purpose

The purpose of the research is to synthesis quantum dots and to modify its surface chemistry to better suit our application. Although quantum dots can be purchased, this can prove expensive and increase the amount of steps to change the surface chemistry. Also, development of novel quantum dots is necessary to reach goals of efficiency and cost reduction. It is believed that manipulating the surface chemistry of the quantum dots and the polymer used in the device can increase the efficiency of the device. Therefore, by changing the ligands on the quantum dots, the efficiency of the device can be tested systematically to document any change of performance based on the surface properties of the ligands.

Design/Method

A cadmium aqueous solution and a selenium aqueous solution are created and combined under an inert atmosphere to synthesis the quantum dots. The quantum dots are then isolated and dispersed in a tri-n-octylphosphine to be injected into hot hexadecylamine for capping of the quantum dots. The quantum dots are isolated and dispersed in toluene.

To alter the surface chemistry of the quantum dots to better suit the polymer of the device, 1 mL of quantum dot solution produced is diluted with 50 mL of distilled water and ultrasonicated for 1 hour to breakup any conglomeration. 4-Mercapto-benzoic Acid is added to the solution and after 2 hours, the acid has attached to the quantum dot. 1,4-benzenedithiol (BDT) will also be used as a ligand on the quantum dots to test organically soluble quantum dots. Each type of ligand will be tested on the polymer PEDOT and the 4-mercapto-benzoic acid will be tested on polypyrrole as well.

Results

This process creates roughly 10 mg of CdSe organically soluble Quantum Dots.

Conclusions

This research is in the early stages of development, we are still in the process of refining our synthetic process. It has been found that the cadmium solution must be added to a nearly boiling selenium solution for creation of the quantum dots. Otherwise, large CdSe particles are fo rmed on the scale of microns. We anticipate having the synthetic process worked out and some early results by March.