Synthesis of CdSe and Au Nanoparticles Assemblies to Study the Optical Properties of New Hybrid Nanomaterials

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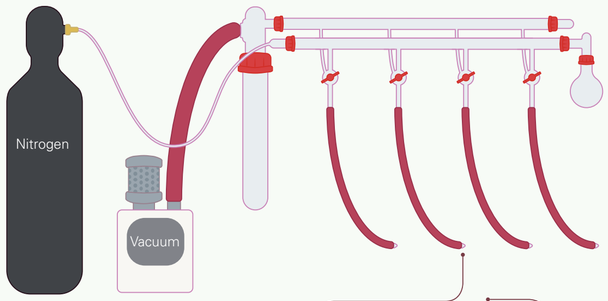
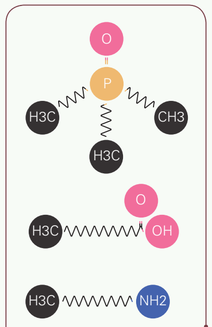
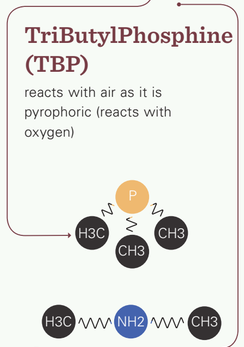
Synthesis of CdSe Quantum Dots

Nitrogen Vacuum Pump contains inert gas (Nitrogen) for carrying out reactions





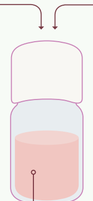
TriButylPhosphine (TBP)
reacts with air as it is pyrophoric (reacts with oxygen)



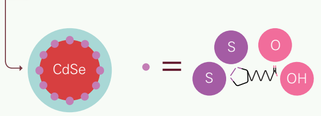
Cadmium Oxide (CdO)
naturally occurs either as an amorphous white powder or as red-black crystals

\+

Selenium Powder (Se)
is a gray powder



Cadmium Selenide Quantum Dots (CdSe)
is a dark red solid with the property of fluorescing under UV light. A ZnS shell is added for stability



Background

The coupling of cadmium selenide quantum dots and gold nanorods is predicted to produce a system that has qualitatively different properties from the isolated particles. These properties can be controlled by exciting the system with a short laser pulse. We hope that the resulting nanoparticle assemblies can serve as a key enabling technology for future optical information processing at high speeds and low power, including quantum-mechanical information processing at the single-photon level (i.e., quantum computers). There are also potential applications to more efficient conversion of sunlight into electricity and in the development of highly efficient displays and ultra-small lasers.

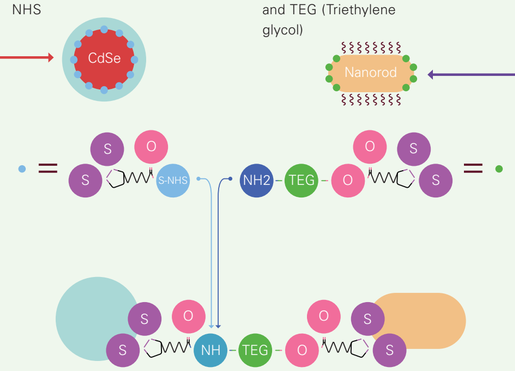
Abstract

The goal of this project is to couple cadmium selenide quantum dots to gold nanorods in order to study the optical properties of this new type of hybrid nanomaterial. We have synthesized both the core shell CdSe/ZnS quantum dots and gold nanorods, which have been characterized using UV-Vis spectrophotometry, fluorometry, and transmission electron microscopy (TEM). The next step is to covalently link the quantum dots with the gold nanorods. These constructs will then be characterized with TEM and will be ready for optical studies.

Linkage of Quantum Dots and Gold Nanorods

Activated
with EDC and Sulfo-NHS

Activated
with TA(Thioctic acid) and TEG (Triethylene glycol)



Synthesis of Gold Nanorods

Seed Solution
is added to growth solution to create nanorods

Hexadecyl Trimethyl-Ammonium Bromide

AuCl4
Gold Chloride
light-sensitive

Sodium Borohydride powder

H2O
water

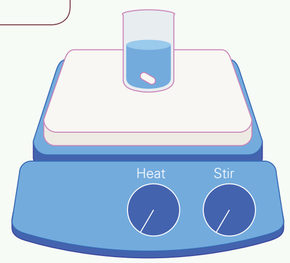
Growth Solution

Hexadecyl Trimethyl-Ammonium Bromide

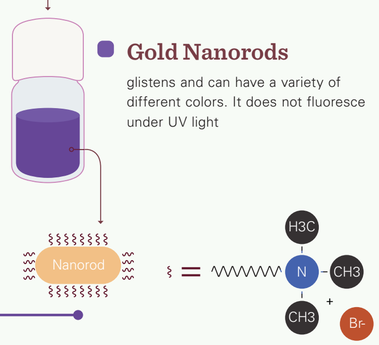
AuCl4
Gold Chloride
light-sensitive

L-Ascorbic acid

Silver Nitrate



Stir Plate
uses magnetic stirrers to mix solution at 40°C

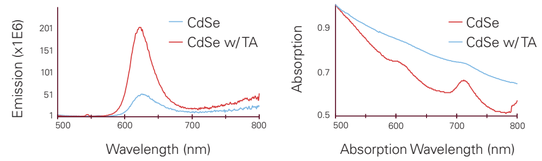


Gold Nanorods
glistens and can have a variety of different colors. It does not fluoresce under UV light

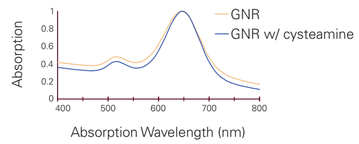
Results

- Synthesized Cadmium Selenide (CdSe) Quantum Dots with emission wave length of 610 nanometers
- Put Zinc Sulfide (ZnS) shells on Quantum Dots for more stability
- Synthesized nanorods with absorption wavelength 600 nanometers
- Activated both nanorods and quantum dots
- Attempted linkage…

Quantum Dots Approximately 4.8 nm in diameter calculated from wavelength of peak absorption



Gold Nanorods Approximately 18.2±3.0 x 39.3±5.2 nm



Future Goals

- Synthesize coupled quantum dots and gold nanorods
- Measure optical properties
- Make different configurations of coupled quantum dots to gold nanorods

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