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# Exciton-Plasmon Interactions between CdS Quantum Dots and Noble Metal Nanospheres in Aqueous Dispersion

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## Extended Abstract

Over the last few years, the materials based in nanostructures have attracted attention due to their unique chemical and physical properties. Semiconductor quantum dots and noble metal nanoparticles show excitations at optical frequencies that can be designed to be resonant with each other. These excitations in semiconductor quantum dots are defined by the electronic levels in the valence and conduction bands; the electronic transitions between these bands allow the formation of bound electron-hole pairs or excitons. Similarly, metal nanoparticles exhibit collective oscillations of conduction electrons, which are called surface plasmons; the origin of these excitations is the dielectric contrast between the metal nanoparticle and the nonconductive environment. Both, exciton and plasmon frequencies can be controlled by shape and size.

Exciton-plasmon interactions occur when semiconductor and metal nanoparticles are in close proximity. These interactions are manifested as a suppression or enhancement of the semiconductor emission. The suppression is attributed to the energy transfer from semiconductor to metal nanoparticles, and the enhancement is caused by the electric field amplified by the plasmon resonance. The predominant mechanism of interaction depends on the nature of the metal and the presence or absence of a spacer material. In aqueous dispersion, the distance among metal and semiconductor nanoparticles is controlled by the Brownian motion. In this work, we report the exciton-plasmon interaction between cadmium sulfide quantum dots, and silver and gold nanospheres. The analysis was carried out at different levels of concentration of noble metal nanoparticles.

The cadmium sulfide quantum dots were synthesized by a microwave-assisted method using citrate ions as stabilizer. The quantum dots show a band-gap energy value of 2.77 eV, which corresponds to 447 nm of wavelength. This value of band-gap energy indicates quantum confinement in the nanostructures. Nanocrystals with diameter around 5 nm were observed by transmission electron microscopy.

Silver and gold nanospheres were synthesized by chemical reduction of silver(I) and tetrachloroaurate(III) ions in water. The silver nanospheres show a single localized surface plasmon resonance band at 400 nm, and have an average diameter of 10 nm with narrow size distribution. On the other hand, gold nanospheres show a single localized surface plasmon resonance band at 520 nm, and have an average diameter of 15 nm with a narrow size distribution.

The luminescence spectra of the cadmium sulfide quantum dots after the addition of silver and gold nanospheres at different concentrations were recorded at 390 nm of excitation wavelength. The emission bands of the quantum dots are located around 600 nm. Silver nanoparticles cause an increase, and gold nanoparticles a decrease, in the intensity of luminescence of the cadmium sulfide quantum dots.