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Silica Capped $CdS/Cd(OH)_2$ Quantum Dots for Biological Applications

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Abstract – In the last few years, quantum confinement effects in semiconductor nanocrystals (quantum dots) have attracted a significant amount of interest due to their new optical properties and also because of their potential applications in biological systems. In this work, cadmium sulphide (CdS) nanoparticles were synthesized in aqueous solution and passivated with $Cd(OH)_2$. Particle aggregation was avoied by polyphosphate ions. The resulting core-shell $CdS/Cd(OH)_2$ quantum dots were coated with silica. Their optical properties were studied by absorption, excitation and emission spectroscopies and their morphological characterization was carried out with transmission electron microscopy.

Semiconductor colloidal quantum dots (QDs) have become, for the past two decades, an important tool for biological imaging mostly due to their physical and chemical properties. Even though they have several advantages over the conventional biolabels, the presence of elements such as cadmium, tellurium and selenium actually represents a challenge in order to avoid their release in biological media. Several authors [1,2,3] have pointed to the coating of QDs´ surface with silica (SiO_2) layers, in order to overcome such kind of processes. Silica is an extremely stable and resistant material, providing a good isolation between the quantum dot and the media. Coating the QDs with silica is not a simple task due to the fact that the QD surface generally does not have chemical affinity with silica. Then, QDs´ surface must be modified in order to become vitreophilic.

In this work we report the production of silica coated water-soluble core/shell $CdS/Cd(OH)_2$ QDs for biological applications. This was achieved by a two step synthesis. The first task was the production of the nanoparticle itself using a previously known method[4]. The second step is the silanization which was achieved by a synthetic route we developed, which presents significant novelty and advantages when compared to other methods already mentioned in the literature. In the quantum dot formation step a cadmium hydroxide shell is formed and this layer, besides been a passivation to the core also acts as a surface priming, enabling the silanization process directly in the quantum dot without the need of any further surface preparation.

The optical properties were studied by absorption, excitation and emission spectroscopies. The morphological characterization (Figure 1) was carried out with transmission electron microscopy.

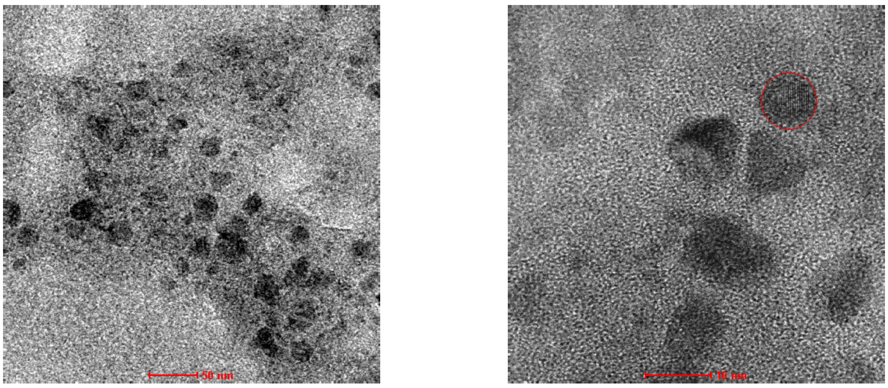

Figure 1: TEM image of $CdS/Cd(OH)_2$ nanoparticles coating with SiO_2. Scale barr = 50 and 10nm.

References

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