Biomolecule-Quantum Dot systems for biological applications: Size-controlled aqueous synthesis of CdS Quantum Dots in homogeneous phase with BSA as capping ligand.

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The literature contains few works reporting on the *in situ* generation of a reagent for the obtaining of nanocrystals with quantum characteristics. Yang and Xiang[1] have described the aqueous synthesis of nanocrystals of CdS using $CdSO_4$ and $Na_2S_2O_3$ as precursors in the presence of thioglycerol as a dispersant. However, in that experimental work the authors failed to study the changes in size of the nanocrystals as a function of different conditions and, additionally, the dispersive behaviour of thioglycerol is small, since colloidal solutions of CdS are obtained and these have low stability. The same precursors and the same dispersant were used by Unni et al. for the synthesis of nanocrystals of CdS spiked with Zn^{2+} or Cu^{2+}, with the above drawback of the low capacity of the dispersant to stabilize the solutions in which the nanocrystals are formed.

Serum albumins have been used as a model protein for many and diverse biophysical, biochemical and physicochemical studies. Due to the high homology between bovine serum albumin (BSA) and Human Serum Albumin (HSA) it is possible to investigate systems aiming at future applications in medicine and biology.

In this work, we reported the bioconjugation of CdS Quantum dots directly with bovine serum albumin (BSA) as capping ligand via an aqueous route. In an earlier work[2] by our team, we performed the synthesis of CdS nanocrystals in aqueous medium starting out from the precursors $CdCl_2$ and Na_2S and using mercaptoacetic acid as the dispersant. We performed an in-depth study of several variables that affect size, surface state, fluorescence and stability of the aqueous solutions containing the CdS nanocrystals.

In the present work we describe a similar set of experiments, but with a fundamental difference in that the S^{2-} ion was generated *in situ* from the precursor thioacetamide $CH_3C(S)NH_2$, which was slowly hydrolyzed in basic aqueous solution. $Cd(ClO_4)_2.6H_2O$ was used as the precursor of Cd^{2+} and bovine serum albumin(BSA) was employed as capping ligand.

We study the variables affecting the hydrolysis rate of $CH_3C(S)NH_2$ (pH, temperature). For these variables we studied the evolution of the size of the nanoparticles (NPs) with the time, the surface characteristics governing their fluorescence properties and their stability. We compared the above characteristics of the NPs of CdS obtained with both methods, deducing the advantages conferred by synthesis in homogeneous phase.

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[1] Y. J. Yang, J. W. Xiang. *Template-free synthesis of CuS nanorods with a simple aqueous reaction at ambient conditions*. Appl. Phys. A: Mater Sci. Proc. 81 (2005) 1351-1353

[2] M. J. Almendral Parra, A. Alonso Mateos, S. Sánchez Paradinas, J. F. Boyero Benito, E. Rodríguez Fernández and J. J. Criado Talavera. *Procedures for controlling the size, structure and optical properties of CdS Quantum Dots during synthesis in aqueous solution.* Journal of Fliorescence 22 (2012) 59-69.