Synthesis, Characterization and Sensing Properties of TGA-capped CdTe Quantum Dots

Isis C. Prado[1,2] (PG), Célia M. Ronconi[1] (PQ), Salvatore De-Simone[2] (PQ), Ricardo J. Cassella[1](PQ)[*]

[1]*Universidade Federal Fluminense, Instituto de Química, Niterói-RJ*

[2]*CDTS-FIOCRUZ/INCT-IDN/Laboratório de Bioquímica de Proteínas e Peptídeos, IOC - FIOCRUZ, Rio de Janeiro-RJ*

Corresponding author: isis.prado@ioc.fiocruz.br

Keywords: *quantum dots, quenching sensor, paraquat*

Background

Quantum dots (QDs) are semiconductor crystals with diameters in the range of 1 to 10 nm. In applications of fluorescent dyes, the frequency of the emitted light increases by reducing the size of the quantum dots. Because the quantum dot size can be adjusted during the synthesis, the conductive properties can be carefully controlled. The fluorescence of the QDs can be affected by modifying their surface. Several ligands (molecules and ions) can act as electron donors or acceptors interacting with the surface states influencing the electron-hole recombination process of QDs, thus interfering in their quantum yields.[1] Therefore, these materials can be used as quenching sensors and fluorescence resonance energy transfer (QD-FRET) sensors for the detection of diseases or identification of infectious pathogens.[1] In this work we evaluated two synthetic procedures to obtain of CdTe QDs modified with thioglycolic acid (TGA).[2,3] TGA confers to the CdTe QDs a negatively charged surface that can interact with positively charged molecules or ions.[4] Sensing properties of TGA-capped CdTe QDs was investigated in solution towards a paraquat ($C_{12}H_{14}N_2^{+}Cl_2^{-}$) herbicide.

Results and Discussion

TGA-capped CdTe QDs was prepared using a reported method with some modifications.[2,3] Briefly, the synthesis was carried out under reflux in water, using an argon or ambient atmosphere. Both conditions yielded the desired material, but a better control of the particle size was obtained under ambient atmosphere.

Figure 1 shows the emission spectra of TGA-capped CdTe QDs suspensions in borate buffer solution (pH = 10) in the presence of different concentrations of paraquat – an herbicide positively charged ($C_{12}H_{14}N_2^{+}$). TGA-capped CdTe QDs suspensions exhibited emission at λ = 511 nm when excited at λ = 490 nm.[2] The emission intensity of TGA-capped CdTe QDs was successfully depressed with increasing concentration of paraquat herbicide in the solution. When the concentration of paraquat in solution was 20 ppm, the emission intensity was reduced approximately 40% of that in the absence of paraquat. The quenching of luminescence of the TGA-capped CdTe QDs may be related to the electrostatic interaction between thioglycolic acid and paraquat molecules. Thus, these results suggest that TGA-capped CdTe QDs can be used as a sensor for paraquat herbicide. Further investigations will be carried out at different pHs and paraquat concentrations.

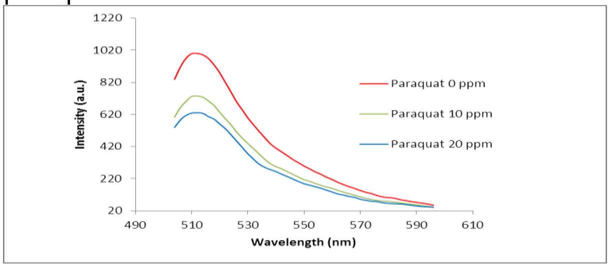

Figure 1. Emission spectra of TGA-capped CdTe QDs in the presence of different concentrations of paraquat.

Conclusions

In conclusion, TGA-capped CdTe QDs (CdTe-TGA) was successfully prepared using different reaction conditions. TGA-capped CdTe QDs displays emission at λ = 511 nm when excited at λ = 490 nm. Efficient quenching of the excited state of aqueous solution of TGA-capped CdTe QDs in the presence of paraquat herbicide indicates that this material can be used as quenching sensor for non-fluorescent compounds.

Acknowledgements

Brazilian Ministry of Science and Technology - CNPq, FAPERJ, CAPES, Chemical Institute-UFF.

[1] V. Durón-Toro, A. Gran-Scheuch, N. Órdenes-Aenishanslins, J.P. Monrás, L.A. Saona, F.A. Venegas, T.G. Chasteen, D. Bravo, J.M. Pérez-Donoso "Quantum-dot-based assay for Cu^{2+} quantification in bacterial cell culture" *Anal. Biochem.*, **2014**, *450*, 30-36.

[2] F.S. Cabrini. "Desenvolvimento de métodos baseados na eletroforese capilar com diferentes abordagens de detecção para determinação de organoestanhos, estrobilurinas e aminoglicosídeos". Tese de Doutorado. PUC-Rio, 2013.

[3] Z. Sheng, H. Han, X. Hu, C. Chi "One-step growth of high luminescence CdTe quantum dots with low cytotoxicity in ambeint atmospheric conditions" *Dalton Trans.*, **2010**, *39*, 7017-7020.

[4] Y.-S. Xia, C.-Q. Zhu "Use of surface-modified CdTe quantum dots as fluorescent probes in sensing mercury (II)" *Talanta*, **2008**, *75*, 215-221.