MSA CAPPED ZnSe QUANTUM DOTS: SYNTHESIS AND PHOTOACTIVATION STUDY

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Abstract

In this work, we synthesized ZnSe QDs and improved their photoluminescence properties using a photoactivation process.

Introduction

Quantum dots (QDs) are fluorescent semiconductor nanocrystals that have unique optical properties, such as broad absorption spectra, fluorescence tuned with their size and a high resistance to photobleaching. Due to these advantages, QDs have been applied in optic-electronic devices and mainly in biological science[1]. Actually, the most used QDs are that containing cadmium in their composition, though Cd^{2+} is considerable toxic for biological systems[2]. To overcome this concern, recently it has been a growing interest in the development of QDs cadmium-free, such as the QDs based on Zinc ions, due to its lower toxic effect. However, QDs based on Zn^{2+} usually have low fluorescence intensity, being necessary modifications in QDs' surface to improve it. In this context, the aim of this work was to synthesize ZnSe QDs and perform a photoactivation (PA) study to improve their photoluminescence properties.

Results and Discussion

ZnSe QDs functionalized/stabilized with mercaptosuccinic acid (MSA) were synthesized, in aqueous solution, using methods developed previously by some of us[3]. After the synthesis procedure, we performed PA process, which consists in controlled UV exposure (300-400 nm) for 30, 60, and 90 minutes.

ZnSe QDs exhibit emission and absorption maxima at 420 nm and 400 nm, respectively (Figure 1A). The emission maximum at 420 nm comes from excitonic recombination of the core and after 450 nm is related to the surface defects. According to TEM analysis, MSA capped ZnSe QDs have around 3 nm.

After the PA process, it was observed a reduction in the Full Width at Half Maximum (FWHM) from 77 to 23 nm. Moreover, we also observed an increase in fluorescence intensity of ZnSe QDs and a reduction of the surface defects emission, as shown in Figure 1B.

Our studies suggest that the PA process improve the passivation layer on the ZnSe surface. Probably it was promoted by the reaction between the zinc unpaired from QDs and the sulfur from MSA in excess, present in the medium, which provides a greater protection of the nanoparticles' core and consequently a decreasing of the QDs surface defects[4].

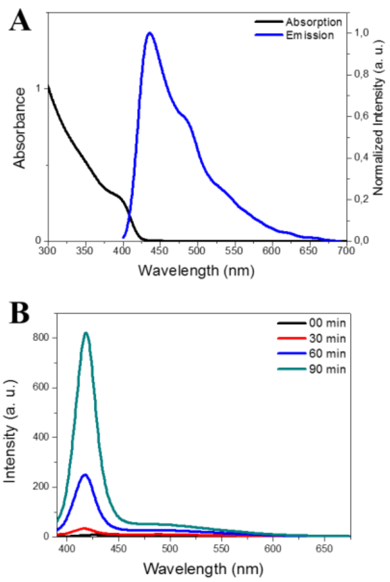

Figure 1. Photoluminescence emission and absorption spectra of MSA capped ZnSe QDs before PA (A) and emission spectra after PA process (B). λ_{exc} = 365 nm.

Conclusion

We synthesized MSA capped ZnSe QDs with high stability in aqueous suspension, and the PA process used allowed the enhancement of their photoluminescence properties, probably due an improvement in the passivation layer. Therefore, we believe that these cadmium-free QDs can be used for biological applications.

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1. Fontes, A.; Lira, R. B. d.; Seabra, M. A. B. L.; Silva, T. G. d.; Neto, A. G. d. C.; Santos, B. S., Quantum Dots in Biomedical Research. In *Biomedical Engineering - Technical Applications in Medicine*, Hudak, R., Ed. InTech: 2012.
2. Chen, N.; He, Y.; Su, Y.; Li, X.; Huang, Q.; Wang, H.; Zhang, X.; Tai, R.; Fan, C., *Biomaterials* **2012,** *33*, 1238-1244.
3. Andrade, J. J.; Brasil Jr, A. G.; Farias, P. M. A.; Fontes, A.; Santos, B. S., *Microelectronics Journal* **2009,** *40*, 641-643.
4. G.-Y. Lan, Y.-W. Lin, Y.-F. Huang, H.-T. Chang, *Journal of Materials Chemistry* **2007**, *17*, 2661-2666.