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Synthesis and Characterization of water-soluble CdTe/CdS core/shell semiconductor nanocrystals

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Abstract – CdTe/CdS core/shell semiconductor nanocrystals have been synthesized in aqueous media using thioglycolic acid as ligand. The core/shell nanocrystals were characterized by UV-Vis, FTIR and photoluminescence spectra. The crystalline phase and size of crystals were determined by XRD. Increasing in the size of the core and shell were confirmed by observation of a red shift in the UV-Vis absorption spectra. CdTe cores were growth for comparison purposes.

Semiconductor nanocrystal quantum dots (QDs) have been the subject of great scientific and technological interest, with promising applications that include display devices, biological tagging materials, photovoltaics and lasers. Such potential applications are due to their unique properties such as high chemical stability, resistance to photodegradation and readily tunable optical properties. [1]

Up to now, the most successful and well-developed method to prepare highly luminescent II-VI semiconductors is the usage of coordinating solvent synthetic approach. However, high temperature is needed in this method and the resulting nanoparticles are insoluble in water, limiting their biological applications. Therefore, methods to directly produce water-soluble semiconductor nanocrystals are important to the development of new applications of semiconductors nanocrystals. [2]

In this work CdTe/CdS core/shell semiconductor nanocrystals have been synthesized in aqueous media using thioglycolic acid as ligand.Thiourea was used as source of sulfur ions, which reacted with the excess of free cadmium ions. The thiourea releases gradually sulfur ions at high temperatures (~100^{o}C), and sucessive additions of this reagent was used to increase the shell thickness. The core/shell nanocrystals were characterized by UV-Vis, FTIR and photoluminescence spectra. The crystalline phase and size of crystals were determined by XRD. Increasing in the size of the core and shell were confirmed by observation of a red shift in the UV-Vis absorption spectra.

The temporal evolution of UV-Vis absorption spectra of the CdTe/CdS nanocrystals the excitonic absorption band shifted systematically to longer wavelength, which demonstrated clearly the growth of nanocrystals. In addition, the PL spectra also displayed such red-shifted in agreement with the UV-Vis results. XRD diffraction showed the characteristics of the cubic zinc blend with diffractive peaks (2 theta) at 23.7^{o}, 39^{o} and 46.6^{o}. In addition, high-resolution transmission electron microscopy (TEM) images showed well organized crystalline planes.

[1] H. Peng, L. Zhang, C. Soeller, J. Travas-Sejdic, J. Lumin. 127 (2007) 721.
[2] Z. Gu, L. Zou, Z. Fang, Z. Zhong, Nanotech. 19 (2008) 135604.