

Synthesis and Optical Properties of Aqueous Soluble ZnSe(S) Quantum Dots

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Luminescent semiconductor nanocrystals or colloidal quantum dots (QDs) of zinc selenide (ZnSe) were the subject of intensive research in the past two decades due to their known optical properties such as narrow and intensive emission spectra, continuous absorption bands, high photoluminescence quantum yield (QY) and good resistance to photo and chemical degradation. [1, 2] ZnSe nanocrystals are non-toxic compared with QDs based on cadmium and its emission is in the UV-blue spectral region, making them useful for biological and technological applications. Although they have been investigated widely over the past decade, it is still a challenge to prepare water-soluble ZnSe nanocrystals with high quality photoluminescence (PL). In addition, the effects of pH, heating and metals adsorption on the spectroscopic properties of ZnSe QDs have not been totally understood. In this work, ZnSe semiconductor colloidal nanocrystals have been synthesized in aqueous media using NaHSe solution as Se precursor. The synthesis conditions were systematically investigated including the use of different kinds of ligands, such as thioglycolic acid (TGA), glutathione (GSH), thioglycerol (TG), 3-mercaptopropionic acid (MPA), 2-mercaptoethanol (2-ME), dodecanethiol (DT) and mercaptosuccinic acid (MSA); pH variable and different precursors concentration. The doped systems ZnSe:Cu and ZnSe:Mn have also been synthesized. Under the optimal conditions, the photostability and heat-stability of the colloidal QDs prepared were also determined. The synthesis evolution and the final ZnSe nanocrystals were characterized by ultraviolet-visible (UV-Vis), infrared (FTIR), photoluminescence (PL) and X-ray photoelectron (XPS) spectroscopies and also by transmission electron microscopy (TEM) and by X-ray diffraction (XRD). The results showed that ligands play an important role in both water-phase preparation and optical properties of ZnSe QDs. MPA and TGA ligands, in higher pH, were more effective to obtain nanocrystals with higher quality and whitening blue luminescence. In addition, XRD diffraction showed the characteristics of the cubic zinc blend in accordance with the results obtained by TEM analysis, that revealed also that the morphology of the particles are nearly spherical and with coherent crystallinity of these QDs, which average size was about 5 nm.

Keywords: quantum dots, semiconductors, ZnSe, doped nanocrystals.

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