

**Synthesis and Properties of Mn Doped CdS/ZnS  
Core/Shell Quantum Dots  
for Yellow-Emitting Phosphors**

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Over the past few years, semiconductor quantum dots as a luminescent material have been intensively investigated. The band gap as a function of a crystal size due to the quantum size effect can be tailored, which allows tunability of band-edge emission and excitation wavelengths. Since the surface of nanocrystals may act as luminescent quenching and photobleaching centers, effective passivation of the nanocrystal surface is important for the practical applications such as optoelectronic and biochemical applications.

Yellow-emitting ZnS-passivated CdS:Mn (CdS:Mn/ZnS core/shell) nanocrystals were synthesized via reverse micelle chemistry. The water-to-surfactant molar ratio [W] in the reverse micelle method controls the crystal size. X-ray diffraction (XRD) patterns and photoluminescence (PL) excitation spectra of nanocrystals with different sizes obtained by varying [W] value are shown in figure 1 and 2, respectively. As the [W] value decreases, the size of nanocrystals decreases, as shown by broader peaks in XRD patterns and by larger shifts to higher energy in PL excitation spectra. Synthesized CdS:Mn/ZnS core/shell quantum dots exhibit a core diameter of 1.5 – 2.3 nm and a shell thickness of 0.4 nm (which corresponds to 1.5 monolayers of ZnS), based on high resolution transmission electron microscopy (HRTEM) observations and Debye-Scherer analysis of XRD. PL emission spectra as a function of passivation and doping are compared in figure 3. While *n*-dodecanethiol-passivated CdS:Mn nanocrystals show a distinct surface defect-related peak at ~ 450 nm, as well as a broad Mn<sup>2+</sup>-related peak at ~ 600 nm, ZnS-passivated CdS:Mn core/shell nanocrystals exhibit much sharper Mn<sup>2+</sup> emission which is not related to surface defects. These observations indicate the successful passivation of the CdS:Mn core surface by the ZnS shell. Undoped CdS core/ZnS shell nanocrystals show relatively broad and weak defect-related emissions.

The core/shell nanocrystals showed increased PL emission intensity during UV irradiation. After enhancement of the PL emission by UV irradiation for 10 – 20 min, the emission intensity remains almost constant for longer UV irradiation, indicative of photostability. The enhanced PL emission is attributed to the photooxidation between the oxygen in the air and ZnS shell surface.

We also have measured a high PL quantum yield of 18 - 28 % from CdS:Mn/ZnS quantum dots, and Mn<sup>2+</sup>- and defect-related luminescence decay behaviors based on the time-resolved measurements.

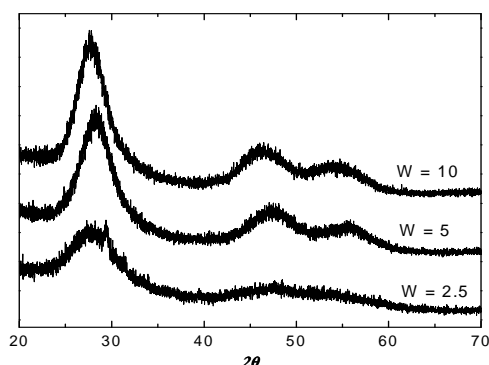


Figure 1. X-ray diffraction patterns from CdS:Mn/ZnS core/shell nanocrystals synthesized with different values of [W].

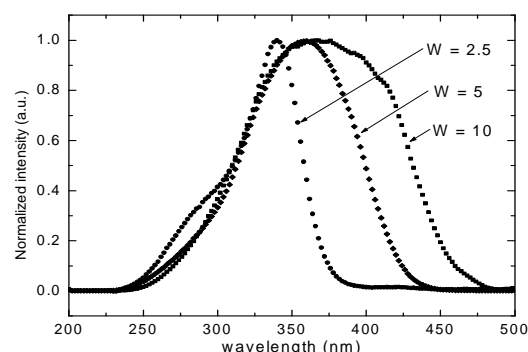


Figure 2. PL excitation spectra of core/shell nanocrystals synthesized with different values of [W]. The detected wavelength is 585 nm.

Figure 3. PL emission spectra of (a) *n*-dodecanethiol-, (b) ZnS-passivated CdS:Mn nanocrystals, and (c) ZnS-passivated undoped CdS nanocrystals. The 325 nm laser excitation was used.

