Photoluminescence and magnetic properties of Mn^{2+} doped CdS nanoparticles synthesized by hot injection method

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Semiconductor nanoparticles doped with magnetic impurities have attracted great deal of attention due to its interesting optical properties [1, 2]. Cadmium sulfide is one of the most important semiconductors with the band gap of 2.42 eV, which has interesting applications in light emitting diodes, solar cell and other electronic devices [3]. The magnetic ion doping of nanoparticles semiconductors gives rise to new optical, luminescence and magnetic properties. The present investigation is based on study of effect of Mn doping on optical and magnetic properties of CdS nanoparticles.

Mn^{2+} doped CdS NPs are interesting because of the fact that Mn^{2+} ions provide good traps for the excited electrons, the d electronic states of Mn ions interacting strongly with the s and p electronic states of the host nanocrystal. Mn^{2+} ions d states and s-p states of the host generates intermediate energy states in the system through which the host generated exciton relaxes ($^4T_1 \rightarrow ^6A_1$) resulting in a new emission centered at ~ 620 nm (shown in Figure 1) [4]. Electron paramagnetic resonance (EPR) provides a simple and accurate way to analyze concentration and distribution of doped paramagnetic ions within the host crystals.

Figure 1: Transmission electron micrograph of CdS nanoparticles

Mn doped CdS nanoparticles are synthesized by hot injection method as it gives high quality products. The structure of Mn doped CdS

nanoparticles have been studied by X-ray diffraction (XRD) and Transmission electron microscopy (TEM). Figure 1 shows Transmission electron micrograph of CdS nanoparticles. The optical properties of Mn doped CdS nanoparticles have been studied by UV-visible (UV-vis) absorption spectroscopy, photoluminescence (Figure 2). The magnetic properties of Mn doped CdS nanoparticles have been studied by Electron paramagnetic resonance (EPR) measurement (shown in Figure 3).

Figure 2: UV Visible absorption and photoluminescence spectra of 2% Mn doped CdS

Figure 3: EPR spectra of undoped and 2 % Mn doped CdS nanocrystals

References

1. C. B. Murray et. Al., Annu. Rev. Mater. Sci. 30(2000) 545
2. A. Nag et al, J. Phys. Chem. C111(2007) 13641
3. A. Cao et.al. Adv. Mater. 22(2010)103
4. H. Liu et al, J. Phys. Chem. C 119 (2015)14797