CHAPTER VI

SUMMARY AND CONCLUSIONS

Pure (ZnO, ZnS and CdS) and multi shells coated ZnO/CdS/ZnS and ZnS/ZnO/CdS nanoparticles were successfully synthesized by chemical precipitation method in room temperature at an air atmosphere. Effects of shell thickness on the structural, optical and thermal properties were studied. Structural analysis was done using XRD, SEM and TEM, while optical properties were explored using UV-Visible spectrophotometer and Photoluminescence spectroscopy. Thermal properties were studied through TGA-DTA. On the basis of the results obtained during the course of this study key conclusions are summarized as follows:

The XRD results of pure ZnO have hexagonal crystal structure and the CdS and ZnS nanoparticles were cubic in structure. SEM and TEM studies are in well agreement with the X-ray diffraction results. Using UV-Visible spectra, the calculated optical bandgap values are 3.6, 2.7 and 4.1 eV for ZnO, CdS and ZnS nanoparticles. A single emission peak is appeared at 560 nm and 445 nm for CdS and ZnS nanoparticles respectively. But ZnO have two emission peaks such as 371 nm and 470 nm.

The XRD results of ZnO/CdS/ZnS nanocomposites confirmed the formation of the CdS and ZnS shell on the ZnO core. TEM images revealed that the nanocomposites have a mean size of 4 nm. The TEM studies of ZnO/CdS/ZnS nanocomposites stabilized in deionized water for two week showed ball like structure.

The UV-Visible absorption spectra of ZnO/CdS/ZnS nanocomposites reveal that the absorption values are significantly blue shifted compared with their parent (ZnO, ZnS and CdS) compound. Hence, the optical band gap of the ZnO/CdS/ZnS nanocomposites was also increased.
The PL studies of ZnO/CdS/ZnS nanocomposites show a strong blue emission around 450-490 nm and sharp yellow emission around 570-590 nm. Some of the researchers attempted the PL study of ZnO-CdS nanocomposites which reveals two emission bands such as UV-emission band at 365 nm and a broad green emission band at 510 nm. By comparing these two, ZnO/CdS/ZnS gave strong blue emission and sharp yellow emission. It obviously shows that the addition of the ZnS shell improved the photoluminescence property of nanocomposites.

Moreover, in ZnO/CdS/ZnS nanocomposites, the emission from the ZnS and CdS shells resulted in the appearance of the strong blue and yellow emission. This is clearly showed that the CdS and ZnS are perfectly coated on ZnO. For the higher concentration (0.5M) the yellow emission was quenched. At the same time, enhanced blue emission was observed. Thus, the PL emission of ideal ZnO and core-shell ZnO/CdS was dramatically shifted and improved their intensity in ZnO/CdS/ZnS multi shell nanocomposites by varying their thickness. The PL improvement shows the elimination of surface defect and increasing of crystallinity of particles.

The thermal stability of the nanocomposites was estimated as 650°C. Up to this temperature no structural changes take place. After this temperature, the cubic structure of shell materials (ZnS and CdS) is completely converted to some other structure.

The as obtained ZnS/ZnO/CdS nanocomposites are highly crystalline and nearly monodisperse with an average particle size of 4.3-5.6 nm. The TEM image of this nanocomposites are seen to be nearly spherical with very narrow size distribution. The TEM studies of ZnS/ZnO/CdS nanocomposites stabilized in deionized water for two week showed ball like structure.

The UV-Visible absorption spectra of ZnS/ZnO/CdS nanocomposites indicated that the absorption values are blue shifted compared with their parent (ZnO, ZnS and CdS) compound. Thus, the
optical band gap of the ZnS/ZnO/CdS nanocomposites was also increased. For core ZnS, the strong PL emission was observed at 445 nm, which is in good agreement with the previous literature values. In addition, few researchers have attempted to tune the optical emission of ZnS by passivating the ZnO. However, they observed only five nanometer shift from 445 to 450 nm. Also, they observed very weak peaks correspond to shell ZnO for the ZnS/ZnO nanocomposites.

However in the present work, ZnS/ZnO/CdS multi shell nanocomposites showed not only the PL emission of the ideal (core) ZnS was tailored more than 100 nm in the higher wavelength side (visible region) but also that the PL emission of core shell ZnS/ZnO was also successfully tailored into the visible region with a single peak. Further, that the obtained emission peak was improved by varying the shell thickness.

The DTA curve of ZnS/ZnO/CdS nanocomposites revealed the decomposition of Zn-S and Cd-S at 280°C. Moreover, the above 700°C, oxidation and phase transition of nanocomposites were take place. In TGA study, a major weight loss occurred at 370°C. At higher temperature (700°C) a weight gain is observed for ZnS/ZnO/CdS nanocomposites.

Thus, the role of the multi shells on the single compound is not only reducing the particles size and also reduces the surface defect. The observed results show enhanced optical absorption and emission in the visible region. Hence the present study provided a good indication of tuning the visible emission of the nanocomposites, which had possible applications in the fields of luminescence, electronics, and sensors.
FUTURE PLAN

The goal of the future work is to continue the research on this kind of multi shell nanocomposite materials. It is also planned to carry out the multi shell nanocomposites for optoelectronic applications.