CHAPTER 6

SUMMARY AND SUGGESTIONS FOR FUTURE WORK

6.1 SUMMARY

Rare-earth-doped ZnO nanostructured materials have attracted much attention for both fundamental and technological reasons. By doping with luminescent centers such as rare-earth metal ions, the emission properties of ZnO can be tailored toward selected wavelengths in the visible region, which is of interest for a variety of applications including multicolor emission in light emitting devices. Rare earth metals like Pr, Sm, Dy doped zinc oxide (ZnO) systems have received much attention due to their application in the luminescence device like field emission displays. The main objectives of the present investigation were to study the effect of rare-earth dopants on the structural and optical properties in ZnO nanorods and thin films.

Effect of Pr doping on the structural and optical properties of ZnO nanorods prepared by low temperature solution synthesis has been studied. The rod like morphology was observed and presence of the dopant has been confirmed by EDS and ICP analysis. X-ray diffraction, Raman and FTIR spectroscopy studies reveal the wurtzite structure of the ZnO nanorods without any secondary phases. The crystallinity of the Pr doped ZnO nanorods has been further examined by HRTEM. UV-visible diffused mode absorbance measurements provide enough evidence to tune the band gap of
ZnO based nanostructures through Pr incorporation, with a typical red shift in the spectrum. Emission spectrum of the Pr doped ZnO shows increase in green emission and yellow emission, which is attributed to excess of oxygen vacancies and interstitial oxygen.

Sm and Dy doped ZnO thin films with different dopant concentrations were prepared by spray pyrolysis. XRD studies reveal the polycrystalline nature of the films with wurtzite structure without any secondary phases. Decrease and increase in lattice parameter values have been observed on doping Sm and Dy. Texture coefficient (TC) has been estimated and the values of TC for (002) plane were found to be higher than unity indicating the textured growth. Raman spectroscopy studies reveal the broadening of the phonon mode for Sm doping, which indicates the presence of a certain amount of intrinsic defects associated with the oxygen atoms. For Dy doped ZnO, the shift in E_2 (high) mode observed in the Raman spectra towards the lower wave numbers was (increase in Dy concentration) correlated with the increase in stress on the ZnO matrix upon Dy substitution. Atomic force microscopy and scanning electron microscopy studies showed that the grain size decreases with increasing Sm and Dy concentration. RBS measurements revealed the stoichiometry of the films and the film compositions are comparable to the precursor stoichiometry.

Spectroscopic ellipsometry studies were performed to determine the thickness and optical constants of the thin films. It was observed that the optical constants of Sm and Dy doped ZnO films are related to the film composition. The refractive indices and extinction coefficients varies with Sm and Dy doping. The observed decrease in band gap upon increasing Sm concentration is attributed to the formation of Sm impurity band into the ZnO energy bands. Optical transmittance studies confirmed that the films are
transparent in the visible region. The NBE emission shifts towards the lower wavelength side upon increasing dysprosium concentration. This behavior could be explained based on the Burnstein-Moss effect.

6.2 SUGGESTIONS FOR FUTURE WORK

In the present investigation, Sm and Dy doped ZnO thin films were prepared by spray pyrolysis. Resistivity of the Sm and Dy doped films was high and hence it is suggested that the preparation and spray conditions can be optimised to reduce the resistivity of the films. Pr doped nanorods have been synthesized by low temperature solution synthesis. Attempts can be made to synthesize different nanostructures of rare earth doped ZnO by changing pH and temperature.

Sm and Dy doped ZnO thin films show good luminescence property. It is suggested that other rare earth metals like La, Ce, etc. can be doped in ZnO to study optical property. Attempts can be made to understand the magnetic property, which has not been studied. Attempts can also be made to study the optical and electrical properties by various techniques like time resolved photoluminescence, hall measurements, etc. Thin films can be also be prepared by different techniques and the properties can be compared. The film parameters are to be optimized suitable for device applications.