Preface

The worldwide requirement of small and cost-effective technology for optoelectronics and spintronic devices insists the scientific fraternity to develop new material functionalities and improve the properties of the diluted magnetic semiconductor in low dimensional state. The study on transition metal and rare earth doped diluted magnetic semiconductor (DMS) have been carried out to improve the performance of solar cell, photodetector, sensors, light emitting diodes etc. Among all DMS, ZnO exhibits distinguished identity due to exceptional physical, optical, magnetic and electric properties as well as diverse application in several industries. Zinc oxide is an *n*-type semiconductor, which has wide band gap (3.3eV), large free exciton binding energy (60meV), biocompatibility, high thermal and chemical stability in harsh environments.

In the present thesis, transition metal and rare earth doped ZnO have been investigated in low dimensional states. It embodies the results of structural, morphological, optical and magnetic studies on the doped, co-doped systems. The research work presented in this thesis has been divided into **eight** chapters.

The **first chapter** contains general introduction of semiconductor and the importance of zinc oxide with brief overview of its unique structural, optical and magnetic properties. Moreover, some promising applications of ZnO such as solar cell, UV detector, sensors, have been discussed in detail. Towards the end of this chapter, the aim of the thesis is presented.

The **second chapter** deals with probed experimental and analysis techniques that have been used for sample synthesis and studying the various structural, optical and magnetic properties of the prepared compositions.

The **third chapter** describes the consequences of cobalt (Co) incorporation with different doping concentrations (0, 2, 4 and 6%) on structural, optical and magnetic

properties of ZnO nanoparticles. The structural analysis has been carried out to authenticate the substitution of cobalt and hexagonal crystal structure without any secondary phase formation of all the samples under investigation. The optical analysis shows interesting results such as improved visible absorption, bang gap change, shift in intense luminescent peak. The magnetic analysis confirms the presence of room temperature ferromagnetism (RTFM) in all prepared samples.

The **fourth chapter** presents the study of Mn doped ZnO nanoparticles with different doping concentrations (0, 2, 4 and 6 %) synthesized by sol-gel method. The XRD characterisation, change in structural parameter and Raman study confirms the substitution of Mn at Zn site of ZnO structure. Optical and magnetic measurements have been employed to check the influence of Mn on zinc oxide.

The **fifth chapter** demonstrates the effect of different lithium concentrations (0.25-1.0%) on Eu (1%) doped zinc oxide nanoparticles synthesized by sol gel method. In addition of structural study, XPS and X-ray absorption spectroscopy analysis have been carried out to get exact information about the local structure, bond angle, bond length, lattice distortion and oxidation state of all elements in the composition. The position of Li plays an important role in defect mediated ferromagnetism of zinc oxide. The photoluminescence study demonstrates the enhancement in europium related peak for small lithium concentration. Li substitutions contribute to the ferromagnetic property of zinc oxide by stabilizing Zn vacancy and other magnetic defects. The existence of enhanced luminescence coupled with RTFM makes this material suitable for optoelectronic devices.

Chapter six describes the detailed structural, optical and magnetic properties of Tb doped ZnO nanoparticles co-doped with different Li concentrations (0.25-1.0%). The systemic change in co-doping concentration is similar to chapter 5. The

photoluminescence analysis demonstrates the enhancement in Tb related peak with Li (0.5%) co-doping concentration. The non-magnetic lithium ions stabilize the cation vacancies and support the magnetic nature of terbium.

Chapter seven contains the study of Dy doped ZnO thin film and Co doped ZnO thin film. In the present work, Dy doped ZnO thin film deposited by spin coating method has been studied for its potential application in ZnO based UV detector. The Dy doped ZnO thin film exhibit the significant enhancement in UV region absorption as compared to pure ZnO thin film, which suggests that Dy doped ZnO can be used as a UV detector. Under UV irradiation of wavelength 325nm, the photocurrent value and responsivity is found to increase significantly (31 times) due to the incorporation of Dy in the ZnO lattice. Moreover, Co (4%) doped ZnO thin film has been analysed by HR-XRD and AFM to confirm the phase formation and surface morphology of thin film. The defect generated absorption in the visible region is present due to the incorporation of cobalt in ZnO thin film. Photoluminescence study shows the broad emission in the visible region in all samples. The Co doping causes an increase in broad emission in the visible region.

Conclusions of overall studies have been summarised in the last **chapter eight**. This Chapter also comprises further future research plans on this topic.

Keywords: Zinc oxide nanomaterials, Thin film, Doped ZnO, Structural property, Optical property, Magnetic property, UV detector.