SUMMARY

During the last few decades the development in Semiconductor technology has been based on the miniaturization of already existing devices. This approach will soon reach to its limits since further miniaturization will effectively lead to the observation of Quantum effects even at room temperature. Future technology demands new devices which avail themselves of these effects. A property suitable as control mechanism is the Spin of charge carriers rather than their charge itself since devices based on spin, consumes less energy. The field of research which investigates the controlled manipulation of spins is called Spintronics and has gained much attention during the last few years. Spintronics does not only demand new devices, but also new classes of Materials.

This thesis is devoted to the "***Investigation of the Room Temperature Ferro-Magnetism***" (RTFM) in transition metal doped ZnO and TiO_2. Since a few years researchers have tried to establish Diluted Magnetic Semiconductors (DMS) by doping ZnO with transition metal ions. Initial attempts by various research groups were promising. However, it soon became evident that the results were only poorly reproducible. Furthermore, the mechanisms remain under debate up to now, which should mediate ferromagnetic coupling in transition metal doped ZnO and TiO_2.

In this thesis Co and Mn doped ZnO and TiO_2 polycrystalline samples have been prepared by Solid-state reaction method. Characterization of structural properties was accomplished by X-ray diffraction (XRD), Positron annihilation spectroscopy and Raman spectroscopy. The Mn, Co doped ZnO samples crystallize in a wurtzite structure without any impurity phases in XRD Spectra. The anatase phase structure is confirmed from the XRD measurement on Mn, Co doped TiO_2 samples without any impurity phases. The defect state of Mn, Co doped samples has been investigated by using Positron Annihilation Lifetime (PAL) spectroscopy techniques in which all the relevant lifetime parameters are measured for all the spectra. The results are explained in the direction of doping concentration in these samples in terms of defects structure on Zn lattice site V_{Zn} and oxygen defects V_o. The interplay of dopants with defects and structural properties of the samples is further analyzed by Raman Spectroscopy in terms of broadening and shifting of Raman lines with the incorporation of defects as well as expansion of the

lattice. The Raman Spectroscopic results are explained in terms of the broadening of peaks and small shift of Raman-scattering modes, which may be caused by the generation of defects such as vacancies and interstitials and are due to the microscopic structural disorder of oxygen lattice induced by transition metal incorporation.

Optical properties have been characterized by UV-VIS-NIR spectroscopy. Optical absorption spectra have red shift with Mn and Co concentration increasing in ZnO and TiO_2, which may be due to sp-d exchange interactions. Magnetic properties are characterized by Superconducting Quantum Interference Device (SQUID). Magnetic behaviour of Co doped TiO_2 show the RTFM in these samples, which is purely intrinsic due to the incorporation of defects, impurities and interstitials.

Co doped ZnO nano-crystalline samples also prepared and characterized. Co doped ZnO nano-crystalline powders prepared by Sol-gel technique. Structural, Optical and Magnetic properties of the samples were investigated by XRD, UV-VIS-NIR spectroscopy and SQUID magnetometer. Energy dispersive X-Ray and XRD studies showed that the Co ions were successfully doped at the Zn site in the wurtzite type ZnO lattice. Optical studies showed that Co doping leads to systematic increase in the bandgap with the dopant concentration and a blue shift in the absorption spectrum was observed. Magnetic studies showed that the Co doped nano-crystalline samples display RTFM and the ferromagnetic ordering strengthens with the Co concentration. The observed ferromagnetism in these nano-crystals is due to the formation of defects, such as oxygen vacancy and Zn interstitials.

Finally, this study identified that in transition metal doped ZnO and TiO_2 the RTFM properties are purely intrinsic due to the incorporation of defects, impurities and interstitials. Hence, intrinsic defects or trace impurity alone cannot make the observed magnetic moment in these samples. Several features like bandgap narrowing, shifting, and broadening of some of the Raman modes strongly support the incorporation of Co and Mn in ZnO and TiO_2 lattices. Therefore, Ferromagnetism is expected to arise from the intrinsic exchange interaction of magnetic moments mediated by defects in doped sample.

Hence observation of RTFM in ZnO and TiO_2 is a good achievement for development of microelectronic devices that integrate electrical, optical, and magnetic

properties. The development of spintronic devices by employing such DMS can result in more efficient devices that provide higher information storage densities, higher speeds, and lower power consumption than current technology allows.