ABSTRACT

The magnetic semiconductors have received much attention due to their potential combination of semiconducting and magnetic behavior in a single material. Such combinations make possible integration of magnetic properties into existing semiconducting materials. As the consequence, Diluted Magnetic Semiconductors (DMS) are viewed as capable materials for the emerging field of magneto-electronic devices and technology. In addition to their potential technological interest, the study of magnetic semiconductors is disclosing new and fascinating physical phenomena including persistent spin coherence, novel ferromagnetism and spin-polarized photoluminescence. The semiconducting materials have been synthesized as polycrystals, single crystals and in many other forms dictated by their end use, including fine powders, thin films and composites. They are also frequently integrated with other materials in advanced structures and devices. Therefore, the magnetic semiconducting materials have now become the cornerstone of such advanced technologies such as memory devices, electro-optic, magneto-optic applications. Based on the above perspective and significance, the present work focused on synthesis and characterization of strontium based wide bandgap semiconducting oxides.

This dissertation comprises an epigrammatic summary of dilute magnetic semiconducting materials and their peculiar properties along with recent trends in spin based electronic devices and need for basic research on magnetic semiconducting materials. Various preparation and characterization methods of semiconducting materials and their basic principles and working aspects also presented.

A detailed study on structural, optical and magnetic properties of pure and Cr doped $SrTiO_3$ compounds synthesized by glycol assisted sol-gel method was carried out. Powder X-ray diffraction (XRD) studies reveal the simple cubic perovskite structure of all the prepared compounds. The presence of metal oxide vibrations such as (Sr-O, Ti-O, Cr-O and Sr-Ti-O) and local order disorder parameters were examined by FTIR and Raman spectroscopic studies. The agglomerated spherical particles transformed into rod like shape while increasing Cr concentration in host material was examined by Scanning Electron Microscope (SEM) and Energy Dispersive X ray analysis (EDX) spectra confirm the presence (Sr, Cr, Ti and O) element in the prepared compounds. Transmission Electron Microscopy (TEM) images evident mixed morphology in Cr doped samples. In addition, Selected Area Electron Diffraction (SAED) pattern confirms the poly crystalline nature. The presence of oxygen vacancy and reduction in Ti^{4+} to Ti^{3+} states was identified by X-ray Photoelectron Spectroscopy (XPS). The UV-Vis absorption spectra evidence the distinctive shift of absorption edges exclusively for Cr doped $SrTiO_3$ compounds. Photoluminescence spectra (PL) of the compounds reveal defective states and decrease in PL intensity due to the influence of Cr in $SrTiO_3$ system. Electron Paramagnetic Resonance (EPR) analysis of Cr doped compounds reveals the paramagnetic nature of the dopants. The magnetization studies of all the prepared compounds emphasis the diamagnetic to ferromagnetic phase transition due to the presence of excess charge carriers induced by Cr ions into $SrTiO_3$ lattice. It was also evident that the Cr^{3+}–Cr^{3+} interaction leads to reversal ferromagnetism in 20% Cr doped $SrTiO_3$ compounds. The ferromagnetic behaviour of the Cr doped $SrTiO_3$ compounds may be understood in terms of carrier mediated ferromagnetism.

The effect of Cr doping on surface morphology, optical and magnetic properties of orthorhombic $SrSnO_3$ perovskite compounds was studied. The pure and Cr doped $SrSnO_3$ compounds were prepared by

chemical precipitation technique. From the XRD pattern, it was revealed that the Cr^{3+} ion was incorporated into the $SrSnO_3$lattice. The presence of Metal oxide vibrations (Sr, Sn, O and Cr) and active Raman modes in pure and Cr doped compounds were found and interpreted by FTIR and Raman spectroscopy analysis. The high resolution scanning electron microscope (HRSEM) and Transmission Electron Microscopy (TEM) images confirm the formation of nanorods in Cr doped $SrSnO_3$ compounds. The increase in level of Cr^{3+} ions leads to decreasing the particle size and enhances blue-shift in optical absorption spectra. Pure $SrSnO_3$ compounds exhibits EPR resonance signal due to the free electrons trapped in oxygen vacancy, further all the Cr doped compounds also shows resonance EPR signal, this is because of the presences of paramagnetic ions (Cr) in $SrSnO_3$ lattice. The magnetic study demonstrates that the pure compound exhibits dia magnetic nature, whereas all the Cr doped compounds reveals the ferromagnetic behaviour.

The preparation and characterization of pure Cr doped $SrMoO_4$ compounds synthesized by chemical precipitation method has been studied. Powder XRD patterns confirm that the compounds were crystallized in scheelite type tetragonal system. Metal oxide vibrations (Sr, Mo, O and Cr) and presence of local order and disorders of the prepared compounds were identified with FTIR and Raman spectra. Oxidation states, Chemical composition and oxygen vacancy in pure and Cr doped compounds were examined by XPS analysis. Electron microscopy analysis authenticates the presence of irregular and agglomerated particles in pure $SrMoO_4$ compounds, whereas all the Cr doped compounds exhibit nuts like shape. Optical absorption spectra reveal the distinctive shift in absorption peak of pure and Cr doped compounds. The presence of paramagnetic Cr^{3+} ion in the host lattice was verified by EPR analysis. The magnetic study demonstrates that the paramagnetic nature of pure $SrMoO_4$ compound whereas all the Cr doped compounds exhibit saturated ferromagnetic behaviour.

Studies on structural, optical and magnetic properties of nano crystalline pure and Cr doped $SrWO_4$ compounds synthesized by chemical precipitation method have been carried out. Powder XRD analysis reveals the scheelite type tetragonal structure of all the compounds. Metal oxide vibrations (Sr, W, O and Cr) and crystal symmetry and local structure of the compounds were examined by FTIR and Raman spectroscopic studies. The micro sphere and poly-dispersed surface morphology of all the compounds were examined by Scanning Electron Microscopy and Transmission Electron Microscopy analysis. Further, oxygen vacancy and oxidation states of elements present in the compounds were analyzed by X-ray photoelectron spectroscopy (XPS). The optical absorption spectra explicitly describe the distinctive shift in absorption edge and linear decrease in band gap values while increasing Cr concentrations in $SrWO_4$ system. The presence of defective states and oxygen vacancy in Cr doped $SrWO_4$ compounds was confirmed with multicolor PL emission spectra. Electron Paramagnetic Resonance (EPR) spectra authenticates the inducement of paramagnetic center (Cr^{3+}) on increasing the dopant concentration. The magnetization analysis demonstrates enhanced ferromagnetic behaviour of all the Cr doped compounds, whereas the pure $SrWO_4$ compound exhibits frustrated ferromagnetic behaviour.

In summary, the effect of Cr doping on optical and magnetic properties of Perovskite and Scheelite structured compounds was investigated. The dopant Cr induces morphological difference in all the compounds. Cr may tune the optical band of the prepared materials by changing the electronic structure. The enhanced magnetic behaviour is observed in all Cr doped compounds. Hence, the physical nature of dopant Cr, preparation technique and morphological change play an important role on optical and magnetic properties of the prepared compounds.