INVESTIGATIONS ON THE STRUCTURAL, OPTICAL AND MAGNETIC PROPERTIES OF STANNATE BASED PEROVSKITE SYSTEMS

Stannates have received both industrial and application interest among the research fraternity for the past few decades. In particular, perovskite structured stannates with formula ($MSnO_3$) where M=Ba, Ca, Sr have been explored enormously due to their interesting structural and physical properties such as optical and magnetic characteristics. Tuning their behaviour can pave way for many arenas in material science like spintronics, magnetic memory devices, luminescence, gas sensors and dielectrics etc. It is a well-known phenomenon that structural properties such as crystal structure, crystallite size and strain are greatly influenced by the method of synthesis and have a considerable impact on the application. Added to this, the introduction of dopant ions in the host system tend to unfurl stimulating optical and magnetic properties due to its adaptable crystal structure. The present thesis focuses on two perovskie systems namely, $BaSnO_3$ (BSO) and $CaSnO_3$ (CSO). BSO belongs to cubic perovskite structure and CSO belongs to orthorhombic perovskite structure. The advantage of stannates is that they can be prepared using various synthesis methods. Although many works of literatures are available related to dye-sensitized solar cell (DSSC), gas sensors, thermally stable capacitors and photocatalytic activity etc, a detailed observation on the changes in magnetic and optical behaviour upon the dopant incorporation is least reported. Hence the present work studies the structural, optical and magnetic properties of transition (Cr^{3+}), post-transition (In^{3+}) and rare earth (Pr^{3+}) doped barium and calcium stannate perovskite system. To explore the doping effects, $BaSn_{1-x}Cr_xO_3$, $BaSn_{1-x}In_xO_3$, $BaSn_{1-x}Pr_xO_3$ and $CaSn_{1-x}Pr_xO_3$ are synthesized by chemical co-precipitation method and characterized by various analytical measurements to extensively analyze the physio-chemical characteristics. The thesis introduces with a brief description of the current trends in the electronic industries, and the importance of dilute magnetic semiconductors (DMS). Further, various exchange mechanisms of magnetism and ferromagnetism in oxide materials are dealt with. Detailed literature on the perovskite stannate systems along with the aim and scope of the thesis is also given. The second chapter elaborates the synthesis methods adopted in the thesis, its importance and further explains the analytical characterization measurements that are performed to investigate the physico-chemical properties of the synthesized perovskite materials. The effect of Cr^{3+} (chromium) ions on the structural, optical and magnetic properties of $BaSnO_3$ compounds are discussed in the third chapter. XRD studies delineate the cubic structure and Raman measurements support the role of oxygen vacancies. Morphological changes are observed upon doping. UV-Vis DRS measurements indicate a change in the bandgap. Photoluminescence studies validate the existence of defects. Mössbauer measurements establish tetravalent state of Sn. EPR measurements suggest the existence of oxygen vacancies. VSM measurements reveal a change in diamagnetic to ferromagnetic behaviour upon Cr doping. The observed transition in magnetic characteristics may be due to the *F*-centre exchange interaction. The effect of In^{3+} (indium) ions on the structural, optical and magnetic properties of $BaSnO_3$ compounds are discussed in the fourth chapter. XRD results indicate the cubic crystal structure. Defects such as oxygen vacancies are identified from Raman modes. Changes in morphological shape are witnessed from HR-SEM measurements. Variations in optical band gap and defect states are identified from UV-Vis DRS and photoluminescence studies. Mössbauer results indicate the tetra valent state of Sn. EPR measurements validate the presence of oxygen vacancies. A characteristic

change from diamagnetic to ferromagnetic behaviour is understood from VSM studies. The effect of Pr^{3+} (praseodymium) doping on the structural, optical and magnetic properties of barium and calcium stannate based perovskite systems is discussed in the fifth chapter. The first part of the chapter elucidates the role of Pr ions on the $BaSnO_3$ lattice. The second part of the chapter investigates the role of Pr ions on the CaSnO3 lattice. Interesting structural, optical and magnetic properties of Pr doped $BaSnO_3$ and $CaSnO_3$ compounds are discussed. Finally, the thesis is presented with summary and suggestions for future work.