ABSTRACT

In this present work we have reported the “Preparation and characterization of RF sputtered oxide thin films for devices”. The systematic and detailed study on transparent conducting oxides (TCOs), namely cadmium tin oxide (Cd$_2$SnO$_4$) and zinc tin oxide (Zn$_2$SnO$_4$) thin films prepared by RF magnetron sputtering technique were studied for their applications as TCOs. This research work was carried out by the author during December 2005 to March 2010.

Among many binary and ternary oxides, Cd$_2$SnO$_4$ and Zn$_2$SnO$_4$ have emerged as promising TCOs, since Cd$_2$SnO$_4$ possesses high carrier mobility compared to most conventional TCOs and Zn$_2$SnO$_4$ has better optical transparency. A detailed investigation has been carried out on the deposition and characterization of these transparent conducting oxides coated on glass substrates. Among various methods adopted to prepare the Cd$_2$SnO$_4$ and Zn$_2$SnO$_4$ films, the RF magnetron sputtering technique seems to be more effective because of its simple process control and superior quality of the deposited films. The main objectives of the present work are:

➢ Prepare the Cd$_2$SnO$_4$ and Zn$_2$SnO$_4$ thin films by RF magnetron sputtering technique by varying the deposition parameters such as the substrate temperature and the RF power.

➢ To carry out systematic characterization studies like structural, compositional, surface morphological, thermal, optical and electrical properties of the films and study the effect of deposition temperatures and RF power on these properties in detail.

➢ To explore the device performance of the Cd$_2$SnO$_4$ and Zn$_2$SnO$_4$ films as a promising TCO.

This thesis comprises eight chapters. The first chapter gives the brief introduction to the metal oxide semiconductors and the transparent conducting oxides. A brief sketch about the structure and a review of the existing literature on Cd$_2$SnO$_4$ and Zn$_2$SnO$_4$ films are presented.

The second chapter gives the principle and complete experimental details of RF magnetron sputtering technique. A detailed method of preparation of the transparent conducting Cd$_2$SnO$_4$ and Zn$_2$SnO$_4$ films is also described in this chapter.
The third chapter deals with the basic principles of the characterization techniques and the analysis methodology, which were adopted in the present study.

The fourth chapter elaborates the preparation of $\text{Cd}_2\text{SnO}_4$ and $\text{Zn}_2\text{SnO}_4$ powders through solid state reactions. The crystal structure of $\text{Cd}_2\text{SnO}_4$ and $\text{Zn}_2\text{SnO}_4$, established via \textit{ab-initio} structure solution from X-ray powder diffraction is also elaborately explained.

The fifth chapter elaborates the structural, surface morphological, compositional, thermal, optical and electrical properties of RF magnetron sputtered $\text{Cd}_2\text{SnO}_4$ thin films. Extra-mural studies are also extended towards various factors such as substrate temperature and RF power, which influence the above characteristic properties of $\text{Cd}_2\text{SnO}_4$ films. Correlation studies among these properties of the material are also discussed.

The sixth chapter outlines the above mentioned properties like structural, compositional, surface morphological and optical properties of $\text{Zn}_2\text{SnO}_4$ films. The results are discussed in a detailed manner.

The seventh chapter elaborates the device performance of the $\text{Cd}_2\text{SnO}_4$ and $\text{Zn}_2\text{SnO}_4$ films. The results of the I-V characterization studies on $n$-$\text{Cd}_2\text{SnO}_4/p$-$\text{Si}$ and $n$-$\text{Zn}_2\text{SnO}_4/p$-$\text{Si}$ heterojunctions are presented. The gas sensing mechanism and the testing procedures are also explained briefly to understand the sensing behavior of the solid state gas sensors. The results of the gas sensor characterizations on $\text{Cd}_2\text{SnO}_4$ and $\text{Zn}_2\text{SnO}_4$ are also presented.

The eighth chapter summarizes the salient features of the present study and plan for the future work.