ABSTRACT

The present work deals with the studies on electrochromic properties of RF sputtered transition metal oxide thin films. The systematic study on the influence of deposition power and substrate temperature over the characteristics of V$_2$O$_5$ thin films prepared are discussed and are compared with their respective annealed thin films. Also the structural, morphological, optical, photoacoustic and impedance studies are performed on V-Ce mixed oxide thin films prepared in different molar ratios so as to understand their role as working electrodes in ECDs.

V$_2$O$_5$, a low mobility n-type transition metal oxide semiconductor is analyzed widely due to their high charge capacity (30-40mCcm$^{-2}$) and unique optical properties when it is used as working electrode in ECDs. V$_2$O$_5$ thin films exhibits a mixed coloration behavior suffering anodic coloration in UV region and cathodic coloration in NIR range. CeO$_2$ can be used as a passive electrode but it exhibits slow reaction kinetics and low charge capacity. To achieve high quality working electrodes in ECDs, mixed oxides of these materials in different molar ratios have been prepared by using the non reactive RF magnetron sputtering technique.

The main objective of the present work can be summarized in to three points as below.

- Deposition of high quality V$_2$O$_5$ and V-Ce mixed oxide thin films by RF magnetron sputtering; Annealing the prepared V$_2$O$_5$ thin films.
- Systematic analyzing on the structural, morphological, optical, photoacoustic and impedance properties of the prepared thin films to understand their characters thoroughly.
- Fabrication and characterization of electrochromic devices by using the prepared V-Ce mixed oxide thin films as working electrodes.

The whole study is dealt in six chapters.

Chapter one starts with the importance of thin films and their applications in the present world. It follows with the significance of V$_2$O$_5$ and V-Ce mixed oxides and their electrochromic properties are described thoroughly. The structural, morphological, optical and impedance properties and the applications of these materials in the form of thin films in scientific and technological fields are also elaborately explained. The existing literature review of the materials selected for the current work has been given for reference.
Chapter two deals with the different types of deposition techniques employed to prepare thin films and the importance of using RF magnetron sputtering technique. The details regarding the preparation of targets and thin films including the conditions followed during deposition in the deposition parameters and during annealing process are given with care. The characterization techniques adopted in this work to study the properties of the prepared thin films are explained in detail along with their theoretical background.

Chapter three describes the structural, morphological, optical, photoacoustic and ac impedance properties of the prepared V$_2$O$_5$ thin films. The characteristics of the corresponding annealed thin films are also studied in detail for comparison. Thickness data obtained by a stylus profilometer for all prepared thin films is given for reference. The XRD patterns are used to calculate the grain size and other structural parameters. The morphological studies are discussed with the help of AFM and FESEM images of the prepared thin films. The optical properties are investigated by analyzing the transmission, photoluminescence, Raman and Fourier transform infrared spectra of the thin films. Thermal properties of the samples are discussed by undertaking photoacoustic measurements and the bulk conductivity and the bulk resistivity of the prepared high resistivity thin films are calculated by analysing the ac impedance measurements.

Chapter four deals with the characteristics of V-Ce mixed oxide thin films prepared in 2:1, 1:1 and 1:2 molar ratios. The x-ray diffraction patterns and the AFM and FESEM images help to compare the structural morphological properties of mixed oxide thin films developed in different molar ratios. The variations in the transmittance spectra and thereby a change in the energy bandgap value of the deposited thin films are studied elaborately. The emission and absorption peaks observed in the photoluminescence spectra, Raman peaks due to the stretching modes of orthovanadates in the Laser Raman spectra and the absorption bands recorded in the FT-IR spectra are further compared for the mixed oxide thin films prepared in different molar ratios. The photoacoustic optical absorption spectra are investigated for knowing the thermal properties of the prepared samples. The ac impedance measurements help to calculate the impedance parameters of the mixed oxide thin films.

Chapter five discusses the fabrication of an electrochromic device with deposited V-Ce mixed oxide thin films in different molar ratios as working electrodes and the electrochemical characteristics of the thin films are studied by recording the cyclic voltammograms by using an electrochemical analyser/Workstation. Also the variation in colour is analyzed by recording the transmittance spectra of the thin films simultaneously. The diffusion co-efficient
value of the H\(^+\) ions during intercalation and de-intercalation process which is an essential parameter in a redox process is calculated by using Randles-Sevcik equation.

**Chapter six** presents the overall summary and conclusion of the current work precisely. In addition to that, the scope of the present work in the field of electrochromic device fabrication is also discussed.