PREFACE

The progress in solid state physics from single crystals to thin films is rapid and spectacular. In the case of thin films the miniaturization reaches the level of nanometric dimension. A thin film is a thin layer of material whose one dimension is negligibly small compared to the other two dimensions and is created by the condensation process of molecules or atoms. The properties of materials are entirely different when it is converted into thin film state. Amorphous thin films have applications in superconductivity, solar cells, microelectronics, optical memory devices, metallurgical coatings, integrated optics and energy efficient window coatings.

In the present work, studies have been made on the electrical, optical and thermal characteristics of electrochromic materials namely, molybdenum trioxide (MoO_3), vanadium pentoxide (V_2O_5), and titanium dioxide (TiO_2) films. Their application for developing as energy efficient optical shutters are also investigated. Thin films of these materials have been grown by using resistive heating and electron beam gun (EBG) evaporation in a vacuum coating unit.

Optical shutters are those windows whose transmittance as well as reflectance can be controlled electrically and optically. These types of shutters are coloured by the application of DC voltage or light radiation. Those materials which show colour change due to the application of electricity are known as electrochromic materials and those which produce colour change due to photon irradiation are called photochromic materials. An ideal optical shutter is one that responds automatically to a changing ambient environment to provide comfort visual needs and energy savings. Such devices may be connected to a building energy management system that adjusts heating, cooling, and even lighting to work space needs. An electrochromic device (ECD) is one which can change its optical properties in a reversible and persistent manner under the action of voltage.

Chapter I is the review of electrical conduction and optical studies in electrochromic and photochromic materials. Electrochromism and photochromism, are briefly discussed in this chapter. Electrochromic devices are also described here. The theory of DC conduction through a metal-insulator-metal is included in this chapter.

Chapter II deals with apparatus and experimental techniques used in the present study. Methods of film preparation, by resistive heating evaporation and electron beam evaporation are given in this chapter. Vacuum coating system with pumps are discussed. Thickness measurement made in the present study is dəscribed here. The electrical, optical, and thermal characterization instruments such as Keithley electrometer, fabricated conductivity cell, UV-visible spectrophotometer, infrared spectrophotometer, X-ray diffractometer, optical microscope, and thermogravimetry-differential thermal analyser (TG-DTA) are described in this chapter.

Chapter III describes the electrical studies in MoO_3, V_2O_5, and TiO_2 films. DC electrical conductivity in coplanar geometry and sandwich geometry are studied in this chapter. The activation energy in each case is found out. Field dependent electrical conduction in sandwich form is studied. The variation of capacitance with temperature and biasing voltages for Al-MoO_3-Al, Al-V_2O_5-Al, and Al-TiO_2-Al are studied.

Studies of optical properties of MoO_3, V_2O_5, and TiO_2 films are presented in Chapter IV. Optical band gap of these materials are obtained. Infrared spectra of these materials are shown. X-ray analysis reveals that the films are amorphous. But MoO_3 film shows crystalline nature after annealing. Morphology of MoO_3 film is studied for different annealing temperatures.

Chapter V describes thermal studies on MoO_3 and V_2O_5 films. Thermogravimetry studies of MoO_3 films are done. Thermal activation energy is found out. Thermo-emf of Al-V_2O_5 thermocouple are investigated.

Chapter VI deals with the electrical and optical studies of mixed oxide systems of MoO_3 and V_2O_5 films. Films of different molar concentration of MoO_3

and V_2O_5 mixed oxide systems are prepared. The conductivity and optical band gap variation with different molar concentration of MoO_3-V_2O_5 are studied in this chapter.

The fabrication of electrochromic devices is described in Chapter VII. All-solid-type windows using MoO_3 and lamination type windows of MoO_3 and V_2O_5 are given here. By applying different bias voltages through the conducting electrode layers, UV-visible spectra are taken.

Most of the work reported in the thesis are either published, presented in conferences or in the process of publication.

1. "Electrical and Optical Properties of Molybdenum trioxide thin films",
   S. Krishnakumar and C.S. Menon, Bull. Mater. Sci. 16 (1993) 187.

2. "Electrical and Optical Properties of Ultraviolet irradiated Vanadium pentoxide thin films",
   S. Krishnakumar and C.S. Menon, DAE Symposium on Radiation and Photochemistry, Jan. 27-31 ,1992, BARC Bombay.

3. "Optical Properties of Molybdenum trioxide thin films"
   S. Krishnakumar and C.S. Menon, Indian Science Congress, January 3-10, 1993 Goa.

4. "Electrical Properties of UV irradiated Molybdenum trioxide thin films",
   S. Krishnakumar and C.S. Menon, Fifth Kerala Science Congress, Kottayam 28-30, Jan. 1993.

5. "Effect of UV irradiation on Molybdenum trioxide thin films"

   S. Krishnakumar and C.S. Menon, DAE Trombay Symposium on Radiation and Photochemistry , Jan. 17-21, 1994. (Accepted)

6. "Current-Voltage Characteristics of Al-MoO_3-Al thin film sandwich systems" (Communicated).

   S. Krishnakumar and C.S. Menon

7. "Optical and Electrical Properties of Titanium dioxide thin films "(Communicated).

   S. Krishnakumar and C.S. Menon

8. "Infrared and Field dependent electrical conductivity studies of Vanadium pentoxide thin films"(Communicated).

   C.S. Menon, S. Krishnakumar, and V.S. Pankajakshan

9. "Thermogravimetry and Electrical studies of Molybdenum trioxide thin films" (Communicated).

   S. Krishnakumar and C.S. Menon

10. "Electrical and Optical Properties of Vanadium pentoxide thin films" (Communicated).

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