PREFACE

Phthalocyanines are an important class of materials used in the production of inks, plastics, dyes, photocopying materials, chemical sensors and liquid crystal colour display systems. Several features of the metal-substituted Phthalocyanines make them attractive candidates for the use in electronic and optoelectronic devices. Phthalocyanine thin films are particularly interesting because of their chemical and thermal stability, ease of preparation, compatibility with vacuum deposition and light absorbing properties in the visible and infrared regions. Optical studies performed on trivalent and tetravalent metal Phthalocyanines have shown that these materials have reasonable energy conversion efficiencies and the ratio of dark conductivity to photoconductivity is quite small. The electrical sensitivity to adsorbed impurities favours Phthalocyanines for use as chemiresistors and surface acoustic wave microgravimetric devices.

The d.c. electrical conductivity of Phthalocyanine thin films shows ohmic conduction at low voltages and space charge limited conduction at high voltages. Detailed investigations on the electrical properties of the Phthalocyanines depend on the accurate knowledge of their molecular and crystal structures. The electrical conductivity of these films depends on the evaporation rate, substrate temperature and post evaporation annealing. The optical properties are also found to depend on crystal structure, deposition parameters and annealing temperatures. Each of these parameters have to be optimised to get desirable physical properties. There exists difference among different workers regarding the structure of the polymorphic forms of Phthalocyanines.

This thesis deals with the techniques of preparation of the metal substituted Phthalocyanines–Copper Phthalocyanine (CuPc), Cobalt Phthalocyanine (CoPc) and Lead Phthalocyanine (PbPc) thin films and the study on their electrical conductivity, photoconductivity, optical and structural properties. Chapter 1 gives a brief review of the earlier studies on the metal substituted Phthalocyanines and a comparison to metal-free Phthalocyanine. Various theories on the charge conduction mechanism is given in this chapter. The band structure models, thermal

activation energies and crystal structures of these materials are also presented here.

In chapter 2, the apparatus and experimental set up used in the present study are discussed. Methods of film preparation including the thermal evaporation technique are given here. Brief descriptions of the vacuum coating unit, different pumps and gauges used, UV–Vis–NIR spectrophotometer, Keithley electrometer and X–ray diffractometer which are used in the present study are described. Different techniques used for thickness measurement of the deposited films are also discussed.

Chapter 3 deals with the electrical conductivity studies in CuPc, CoPc and PbPc thin films. The measurement of electrical conductivity, determination of the activation energy and the type of carriers are given in this chapter. Variation of the thermal activation energy with substrate temperature and the effect of post deposition annealing are discussed here.

In chapter 4, the optical studies in CuPc, CoPc and PbPc thin films are made. The optical band gaps and their trap energy levels are determined. The variation of the band gap and the trap energy levels

with substrate temperature and post deposition annealing are also studied.

Crystal structure and grain size determination of the evaporated CuPc, CoPc and PbPc thin films is done in chapter 5. Also the effect of post deposition annealing on the structure and grain size is given in this chapter. Lattice parameters and grain size are determined from the X-ray diffractograms using the ASTM data.

Chapter 6 gives the photoconducting properties and photoresponse spectra for CuPc, CoPc and PbPc thin films prepared at room temperature. The effects of applied electric field, temperature, incident photon energy and its intensity on photocurrent are studied.

Chapter 7 is the concluding chapter which gives the summary of the results and discussion. The future scope of this work is also indicated. Most of the work presented in this thesis have either been published in international journals or presented in conferences or are in the process of publication. The list of publications is given below.