Phthalocyanines are stable organic semiconductors having excellent optical and electrical properties. They have potential applications as gas sensors, rectifying devices, electrochromic and photoconductive devices. The intense absorption in the near infrared region of the spectrum finds applications in optical data storage and security printing. Phthalocyanines are also used as photocatalyst and spectral sensitizer in solar energy conversion.

Phthalocyanines and its derivatives exhibit electrical conductivity in the semiconducting range and are stable so that they can be prepared in thin film form by vacuum evaporation technique. Metal phthalocyanines consist of a central metal ion surrounded by a core structure of the phthalocyanine macrocycle. The central metal influences the properties of the film. The electrical conductivity is found to be trap controlled. The ambients are also found to influence the electrical and optical properties of these films. Polymorphism in phthalocyanines is investigated by many workers and there exists differences regarding the structure of various forms. The optical properties are found to depend on the stacking geometry of phthalocyanines. It is observed that the electrical, optical and structural properties of metal phthalocyanines are critically dependent on film morphology which in turn is determined by preparation parameters such as deposition rate, substrate temperature and post-deposition annealing. In order to fabricate films of desired characteristics, an understanding of its properties at various growth conditions is required.
In this thesis, the techniques of preparation of the metal phthalocyanines – Magnesium phthalocyanine (MgPc), Iron phthalocyanine (FePc) and Zinc phthalocyanine (ZnPc) – thin films and study on their electrical, optical and structural properties are presented. A brief review of the earlier work made on metal phthalocyanines is given in Chapter 1. Various theories on the charge conduction mechanisms in phthalocyanines are described here. Band structure models, thermal activation energies and optical band gap studies are also given.

Chapter 2 gives the apparatus and experimental techniques used in the present study. Various methods of film preparation including the vacuum evaporation technique are given here. Brief descriptions of the vacuum coating unit, different pumps and gauges used, Keithley programmable electrometer, UV-Vis-NIR spectrophotometer and X-ray diffractometer are also given. The experimental techniques for thickness measurement of the deposited films are also discussed.

Chapter 3 deals with the electrical characterization of MgPc, FePc and ZnPc thin films. The temperature dependence of the electrical conductivity is studied and the trap levels are discussed. The determination of the activation energy from the electrical conductivity measurements and the type of charge carriers are described here. Effects of substrate temperature and post-deposition annealing on the activation energy are also given.

The investigations on the optical absorption spectra of MgPc, FePc and ZnPc are described in Chapter 4. The optical band gaps and the trap energy levels are determined. Effect of substrate temperature and post-deposition annealing on the band gap and trap levels are also discussed.
Structural studies on MgPc, FePc and ZnPc thin films are given in Chapter 5. The structure of the films, their grain sizes and the substrate temperature dependence and post-deposition annealing are also studied. Lattice parameters and grain size values are estimated.

Chapter 6 gives the summary and conclusion. 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. A list of publications is given below.

List of Publications


