Preface

Physical properties of nanomaterials have been a subject of intense research over the past two decades because of the scientific and technological interest on the grain size dependence of these properties. Synthesis of nanostructured films is an important area of nanoscience and nanotechnology due to the wide ranging technological applications of such films. Nanostructured films with morphological features in the nanometer range and structured assemblies of nanometer sized particles are remarkable sets of nanomaterials with enormous technological potential. The characteristics of films such as their crystal structure, phase purity, state of aggregation and effective surface area are important to assess the usefulness of such films for applications and to relate these film parameters to the end use for device fabrication. Nanoparticles and nanostructured films of oxides of copper (Cu$_2$O and CuO) have been the subject of investigation by researchers. Cu$_2$O layers on semiconductor and insulator substrates have interesting properties in photovoltaic devices and as photoelectrodes in high-efficiency photo-electrochemical cells. CuO is widely used in applications such as gas sensors, solar energy transformation, varistors and catalysis. TiO$_2$ is another important metal oxide semiconductor that finds extensive potential applications. Its enhanced photosensitivity to UV radiation and excellent chemical stability in acidic and aqueous media point to its enormous potential for use in a variety of applications such as dye sensitized solar cells, chemical sensors and photocatalysts.

The thesis entitled "Preparation of nanostructured semiconductor films and study of their properties" is a detailed account of the deposition of nanostructured copper oxide (Cu$_2$O and CuO) and titanium dioxide thin films and the study of their properties using different experimental techniques.

The thesis is divided into seven chapters. Chapter 1 gives a general introduction to the field of nanostructured materials. A brief review of reported studies on the preparation, characterization, properties and applications of nanostructured copper oxide and titanium dioxide films are included in this chapter.

The 2nd chapter details the deposition of nanostructured copper oxide (Cu$_2$O and CuO) films. The films were prepared by deposition of grainy copper films by vacuum
evaporation followed by careful thermal oxidation in air at different temperatures. Structural and morphological features of the samples and the influence of oxidation temperature on these features are explored using characterization techniques like Grazing incidence X-ray diffraction (GIXRD), High resolution Transmission Electron Microscopy (HRTEM) and Atomic Force Microscopy (AFM). Fractal analysis of the AFM images is also explained in this chapter.

Chapter 3 contains the details of the study of micro-Raman spectra and UV-Visible transmission spectra of nanostructured copper oxide (Cu$_2$O and CuO) films. Raman spectra were recorded for two different excitation wavelengths and the spectra were analysed in detail. The band gap energy values obtained from UV-Visible transmission spectra were used to study the resonance effects exhibited by the Raman spectra.

In the 4$^{th}$ chapter, a systematic study of the process of structural evolution and film orientation of RF magnetron sputtered amorphous and crystalline TiO$_2$ films is presented. TiO$_2$ thin films were deposited on quartz substrates by RF magnetron sputtering technique and the as-deposited amorphous films were subjected to thermal treatment for getting nanocrystalline TiO$_2$ films of anatase phase. Structural and morphological features of the samples and influence of annealing temperature on these features were explored using GIXRD, HRTEM and AFM. This chapter contains discussions on the agglomeration mechanism on the surface of the films investigated by fractal analysis of the AFM images.

Chapter 5 contains the details of the study of micro-Raman spectra and UV-Visible transmission spectra of nanostructured TiO$_2$ film samples annealed at different temperatures. The intensity and broadness characteristics of Raman band of anatase phase of TiO$_2$ around 141 cm$^{-1}$ is discussed in detail in this chapter. UV-Visible spectra of the samples as-deposited and annealed at different temperatures are discussed and the dependence of band gap energy on annealing temperature is analyzed.

Chapter 6 describes the UV-Visible and photoluminescence spectroscopic studies of ZnO doped nanostructured TiO$_2$ film samples. The observed blue luminescence is discussed in detail based on the recombination process of excitons. Effects of doping on
the emission characteristics and Stokes shift in the luminescence maximum are investigated.

Chapter 7 gives a summary of the results and conclusions drawn from different experimental analyses conducted in the present study. Also, scope for future studies is highlighted.

The major part of this research work had been published /communicated in scientific journals and presented in national/international conferences. The list of journal and conference publications is given below.

**Published/Communicated Articles**


2. “Nanoscale fine-structure evaluation of RF magnetron sputtered anatase films using HRTEM, AFM, micro-Raman spectroscopy and fractal analysis”, M. Abdul Khadar and N. A. Mohemmed Shanid, Surface and Coatings Technology (under revision)

**International/National Conferences**


