ELECTRICAL PROPERTIES OF NIOBIUM DOPED TITANIUM DIOXIDE THIN FILMS BY SPIN COATING TECHNIQUE

Thesis is presented in partial fulfilment for the award of the
Bachelor of Engineering (Hons.) Electronic
Universiti Teknologi Mara

NURUL NADIA BINTI ASHARI

FACULTY OF ELECTRICAL ENGINEERING

UNIVERSITI TEKNOLOGI MARA

40450 SHAH ALAM

SELANGOR, MALAYSIA

JANUARY 2014

ACKNOWLEDGEMENT

I would like to express my gratitude to my lovely supervisor, Mrs. Norulhuda Abd. Rasheid for her guidance, encouragement and support throughout the completion of my final year project. This thesis would not have been possible without her helpful supervision. I would like also to express my sincere appreciation to my research co-supervisor, Mr. Saurdi Bin Ishak for their knowledge sharing and great encouragement in this project.

My thanks also go to Faculty of Electrical Engineering, UiTM for providing the laboratory facilities especially NET laboratory and thanks to all the NET's staffs who have involved directly or indirectly during development of this project.

Finally, I would like to express my deepest gratitude to my parents and siblings for their love, encouragement, understanding and support during my entire final year project period.

ABSTRACT

In this research, undoped TiO_2 and Niobium (Nb)-doped TiO_2 thin films have been successfully prepared and deposited on glass substrate by spin coating technique. The effect of annealing temperature on electrical properties using I-V measurement of Titanium Dioxide thin films was studied. TiO_2 thin films were annealed at 300°C to 550°C. The results indicated that the conductivity increased with the increasing of annealing temperatures. Using 450°C as an optimum annealing temperature, the effect of Nb doping concentrations on electrical properties was investigated. As the doping concentration of Nb was increased, conductivity was increased. Optical properties of TiO_2 thin films were investigated using UV-vis-NIR spectrophotometer and indicated that the optical band gap increased with increasing Nb doping concentration. The FESEM investigation showed that the thin films consist of nanometer-sized grain particles.

TABLE OF CONTENTS

CHAPTER 1

INTRODUCTION

1.1 PROJECT BACKGROUND

TiO_2 is well known as a metal oxide semiconductor, has been extensively studied in many applications and for example, it is used for dye-sensitized solar cells (DSSC), photo-electrodes and photocatalysts, and applications with high performance due to its fine physical, chemical and optical properties [1]. TiO_2 presents three crystalline structures: brookite, anatase, and rutile [2]. Titanium dioxide (rutile) has an extensive range of applications due to its interesting electrical and photo-electrical properties determined by nonstoichiometry and related point defect structure. Metal ion doping (by both acceptor- or donor-type elements) can significantly modify these properties. High-temperature semiconducting properties of undoped, acceptor- or donor- doped TiO_2 have been the subject of numerous reports [3].

TiO_2 is used widely as a gas sensing material due to its change in electrical conductivity under analyte gas exposure. Sensing capability has been improved with the addition of foreign atoms such as W, Pt and Cr, Mo and Nb, Fe, and Cu and La [4]. Many researchers have studied, and found that the properties of transition metal oxides can be enhanced by doping, which widens their potential applications. Nb doping modifies the microstructure of TiO_2, introduces electronic defects at the surface or in the bulk of grains, so modifies TiO_2 conductivity and gas sensing [4].

There are several techniques that are used to deposit undoped Nanostructured Titanium Dioxide thin film (UN) and Niobium doped nanostructured (NbDN) TiO_2 thin film such as RF-magnetron sputtering, pulsed laser deposition (PLD), metal-organic chemical vapor deposition (MOCVD), sol-gel process and spin coating method.