

## **AUTHOR'S DECLARATION**

**UNIVERSITI TEKNOLOGI MARA**

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the results of my own work, unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any degree or qualification.

**FABRICATION AND  
CHARACTERIZATION OF  
NANOSTRUCTURED TITANIUM  
DIOXIDE (TiO<sub>2</sub>) FOR OPTICAL  
SENSOR APPLICATION**

I, hereby, acknowledge that I have been supplied with the Academic Rules and Regulations for Post Graduate, Universiti Teknologi MARA, regulating the conduct of my study and research.

**SITI FARHANIZA BINTI  
ABD SAMAT**

Name of Student : Siti Farhaniza Binti Abd Samat  
Student I.D. No. : 2014974785  
Programme : Master of Science (Electrical Engineering) – EE750  
Faculty : College of Engineering  
Thesis : Fabrication and Characterization of Nanostructured of  
Titanium Dioxide (TiO<sub>2</sub>) for Optical Sensor  
Application

**MSc**

Signature of Student :  .....  
Date : August 2021

**August 2021**

## ABSTRACT

Titanium dioxide, TiO<sub>2</sub> or titania is one of metal oxide which is most abundant and well-known semiconductors used in developing the optoelectronics applications technologies. The method used in this research study is sol-gel dip coating technique where it is easy to handle. The usage of high technologies is rapidly growth in sensing where the fast response and low cost effective are currently need. However, there are many factors effected the thin film to obtain a nanocrystalline phase that can achieve a good sensing performance. So that, the TiO<sub>2</sub> thin film has to undergo a few parameters during solution preparation and dip coating process. The deposition parameters involved are precursor molar concentration, number of dipping cycle, withdrawal speed, number of layers, and annealing temperature to determine the optimized sensing membrane for crystalline phases and fast response time. Based on the result, the crystalline phase state was obtained in anatase and rutile in one layer deposition and annealed at 450°C. However, the UV light response needs more energy to perform fast response and also short recovery time. Therefore, the doping process of aluminum (Al) with TiO<sub>2</sub> thin film is needed. According to the results, TiO<sub>2</sub>/Al bilayer configuration shows superior sensing performance as opposed to TiO<sub>2</sub> thin film itself. It was found that TiO<sub>2</sub>/Al bilayer films possess response time and recover time at 4.8ms and 6.6s upon illumination at (365 nm) with 10V respectively. Besides, the TiO<sub>2</sub> sensing membrane was tested in sampling with a different number of used fried cooking oil. The response of TiO<sub>2</sub> thin film as a sensing membrane at a narrow wavelength under UV light photo response showed that the transmittance degradation related to the highly used cooking oil. All of these results demonstrate that this high-quality photosensor can be a promising candidate as a low-cost UV photodetector for commercially recycled cooking oil sensor applications.

## ACKNOWLEDGEMENT

Firstly, I wish to thank God for giving me the opportunity to embark on my MSc. and for completing this long and challenging journey successfully. My gratitude and thanks go to my supervisor, Ts Dr Puteri Sarah bt Mohamad Saad and my Co-supervisor, Ts Dr Mohd Faizul bin Mohd Idrus for the guide and assist me in this project research.

My appreciation goes to the staff in Nanotechnology laboratory in level 4 and 5 who are Ir. Ts. Dr Hafiz, Mr. Azwan, Mr. Suhaimi, and Mr. Asrul who provided the facilities and assistance during sampling. Special thanks to my colleagues and friends for helping me with this project. They are Mr. Alhadi Zulkefli, Rohanieza Abd Rahman, Najwa Ezira, Dr Nurbaya, Dr Aimi Baziliah Rosli, Dr Khairul Aimi, Dr Marmizi and Dr Syakirin.

Finally this thesis is dedicated to the loving memory of my dear father and mother, Mr. Abd Samat bin Abd Rahman and Mdm. NurShakirah bt Othman for the vision and determination to educate me. This piece of victory is dedicated to both of you. Alhamdulillah. And also my siblings. They are so helping me in all kind of vision through this journey. My husband, Mr. Mohd Naquiddin bin Ismail, my father and mother in laws, Mr. Ismail bin Jusoh and Mdm Marmi bt Abd Rahman for their support internal and external. Lastly, my daughter Nurul Fatihah bt Mohd Naquiddin and Muhammad Naufal bin Mohd Naquiddin for being more special to me during this upside down journey.

## TABLE OF CONTENT

	Page
CONFIRMATION BY PANEL OF EXAMINERS	ii
AUTHOR'S DECLARATION	iii
ABSTRACT	iv
ACKNOWLEDGEMENT	v
TABLE OF CONTENT	vi
LIST OF TABLES	ix
LIST OF FIGURES	x
LIST OF SYMBOLS	xiv
LIST OF ABBREVIATIONS	xv
LIST OF NOMENCLATURE	xvi
<b>CHAPTER ONE INTRODUCTION</b>	<b>1</b>
1.1 Research Background	1
1.2 Problem Statement	3
1.2.1 Instability of crystalline phases in sensing detection	3
1.2.2 Improvement of sensing detection with fast response time as an optical sensor.	3
1.3 Objective of the Research	4
1.4 Scope and Limitation of the Studies	4
1.5 Significance of Study	4
1.6 Thesis Outline	5
<b>CHAPTER TWO LITERATURE REVIEW</b>	<b>6</b>
2.1 Introduction	6
2.2 Properties of TiO <sub>2</sub>	7
2.3 TiO <sub>2</sub> Thin Film Deposition Method	9
2.4 Introduction of UV Light Photocurrent for Optical Sensor Application	13
2.5 Chapter Summary	15