

UNIVERSITI TEKNOLOGI MARA

**SYNTHESIS AND
CHARACTERIZATION OF ZnO
GROWTH ON PMMA THIN FILM BY
SOLUTION-IMMERSION METHOD
AS A POTENTIAL IN UV RELATED
APPLICATION**

NOOR AADILA BINTI ABD AZIZ

Thesis submitted in fulfillment
of the requirements for the degree of
Master of Science

Faculty of Applied Sciences

April 2017

ABSTRACT

In this study, preparation and characterization of ZnO grown on PMMA thin film was investigated. The procedure was divided into two steps; preparation of PMMA thin film followed by growing ZnO on PMMA thin film. The PMMA thin films were prepared using sol-gel spin-coating method. The AFM image showed that the homogenous thin film is obtained at 6×10^3 wt% of PMMA. It was found that the PMMA thin film gave good UV absorption for 7 layers of deposition on the glass substrate at annealing temperature of 100°C . The ZnO were next grown on PMMA thin film using solution-immersion method with $\text{Zn}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$ as a precursor and $\text{C}_6\text{H}_{12}\text{N}_4$ as a stabilizer. The size of the rods decreased (from $2.430 \mu\text{m}$ to $0.497 \mu\text{m}$) (almost $\sim 79\%$ of size reduction) as the precursor concentration was increased as seen by FESEM analysis. It was found that the precursor concentration of 0.10 M produced the highest intensity of (002) plane compared to the other concentrations (0.01 M , 0.05 M , 0.15 M and 0.20 M) in XRD analysis. In order to protect the properties of PMMA, low annealing temperature ($< 200^\circ\text{C}$) was used to grow ZnO. ZnO annealed at 100°C for 30 minutes exhibit homogenous films with higher absorption of UV. The surface morphology, structural properties and UV absorption of ZnO rods on PMMA was significantly affected by the change of precursor concentration and annealing treatment. To determine the potential sample for UV related applications, a comparison study was carried out. It was found that the ZnO on PMMA thin film produced almost 84% increase in absorption at UV region. The UV absorption of the film almost covers the UV range up to about 400 nm and the visible light transmission was permitted. Thus, the sample was able to prevent the penetration of UV light and maintained transparent which could be applied in transparent UV-protective coating and UV-shielding windows.

ACKNOWLEDGEMENT

All praises and thanks to Allah, without His blessings, I would not be able to complete this thesis, entitled ‘Synthesis and Characterization of ZnO Growth on PMMA Thin Film by Solution-Immersion Method as a Potential in UV Related Application’ in this long and challenging journey.

First, I would like to express my genuine thanks to my lovely supervisor, Dr. Zuraida Khusaimi for her guidance, encouragement and mentorship throughout this research. I thank you very much for the knowledge you have passed on and I will always be grateful for having the opportunity to study under you. Your support was essential to my success here. A million thanks to my co-supervisor, Associate Professor Dr. Mohamad Rusop Mahmood for giving me bundles of guide, support and assist my research. My appreciation also extends to thank all my lab mates at NANO-SciTech Centre especially Nur Amierah Mohd Asib, Nurul Afaah Abdullah, Mrs. Ruziana Mohamed, Dr. Mohd Husairi Fadzillah Suhaimi, Kevin Alvin B Eswar, Hafsa Omar, Che Rosmani Che Hasan, Muhammad Salleh Shamsudin, Ain Zubaidah, Dr. Noor Asnida Asli and many more for their great support during my Master study. Besides that, special thanks to Mr. Salifairus Mohamad Jaafar, Mrs. Nurul Wahida Aziz and Mr. Mohd Azlan Jaafar for helping me handled the instruments during the experiment and sample analysis.

I also would like to thank to NANO-SciTech Centre, Faculty of Applied Sciences and Faculty of Electrical Engineering for the provided equipment, and Universiti Teknologi MARA and Ministry of Higher Education of Malaysia for the financial support.

I would like to dedicate my thesis to my parents, _____ and _____

. A trillion thanks to my husband, Mohamad Shahrol Rusli, my brother, Muhamad Hazwan Abd Aziz, my uncle, Nik Mansur Nik Abd Rahman, my aunt, Roslina Mat Zain, my father-in-law, _____, my mother-in-law, _____

and all families member. Without their love and support over the years none of this would have been possible. They have always been there for me and I am thankful for everything they have helped me achieve.

May all of the person stated here and other person who has in some way involved and helped me during my master study, be blessed and have a peace of mind in running their everyday life until the end of their life, and after life.

Noor Aadila Abd Aziz
April 2017

TABLE OF CONTENTS

	Page
CONFIRMATION BY PANEL OF EXAMINERS	ii
AUTHOR'S DECLARATION	iii
ABSTRACT	iv
ACKNOWLEDGEMENT	v
TABLE OF CONTENTS	vi
LIST OF FIGURES	x
LIST OF TABLES	xiv
LIST OF ABBREVIATIONS	xv
CHAPTER ONE: INTRODUCTION	
1.1 Nanotechnology	1
1.2 Research Background	1
1.3 Problem Statement	3
1.4 Objectives	5
1.5 Significance of Study	6
1.6 Scope and Limitation of Study	6
1.7 Organisation of Thesis	7
CHAPTER TWO: LITERATURE REVIEW	
2.1 Introduction	8
2.2 Poly(Methyl Methacrylate) (PMMA)	8
2.3 Synthesis of PMMA Thin Films	9
2.4 Zinc Oxide (ZnO)	13
2.5 Synthesis of ZnO Nanostructures	14
2.6 Synthesis of ZnO/PMMA	21
2.7 The Potential of ZnO/PMMA Against UV Radiation	22

CHAPTER ONE

INTRODUCTION

1.1 NANOTECHNOLOGY

The term ‘nanotechnology’ was first used in 1974 by late Norio Taniguchi (University of Tokyo) as the ability to engineer materials precisely at the scale of nanometers. It is defined as the field of applied sciences aiming in the production and usage of materials and structures manipulated close to the atomic or molecular scale ranging from 1 to 100 nanometers in dimensions (Zhong Lin Wang, 2004).

Various forms of nanotechnology have significant impact on society. With variety of potential applications such as in medicine, electronic, biomaterials and energy production, nanotechnology is the key technology for the future (Cristina Buzea & Ivan Pacheco, 2007). Nanotechnology is also applied in fields of science such as surface science, organic chemistry, molecular biology, semiconductor physics and microfabrication which include the materials in a form of very thin films used in catalysis and electronics, two dimensional nanotubes and nanowires for optical and magnetic systems, and as nanoparticles used in cosmetics, pharmaceuticals and coatings (Zhong Lin Wang, 2004). Thus, much of fascination with nanotechnology stems from quantum and surface phenomena that matter exhibits at the nanoscale.

1.2 RESEARCH BACKGROUND

Polymer thin films are a novel class of materials that have found their way into a wide range of industrial and biomedical applications which now are an integral part of our everyday livess. Poly(methyl methacrylate) (PMMA) is a transparent thermoplastic polymer that has been extensively studied due to its broad commercial and industrial applications. It possesses desirable properties such as lightweight, high light transmittance, good tensile strength and resistance to weathering corrosion. Therefore PMMA has a wide range of potential application in the field of optical, optoelectronic applications and sensing devices (Gautam A & Khanna PK, 2016; I. Capan & T. Tanrisever, 2007; Mari Napari & Manu Lahtinen, 2015). Extensive work