UNIVERSITI TEKNOLOGI MARA

SYNTHESIS AND CHARACTERIZATION OF Ag ION DOPED ZnO NANOSTRUCTURES DEPOSITED ON GOLD SEEDED SUBSTRATE

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

Faculty of Applied Sciences

April 2017

ABSTRACT

High quality of (002) *c*-axis preferential growth of ZnO is vital as the properties of devices is enhanced. In this work, ZnO nanorods were grown on ZnO seed layer. The preparation towards the optimization of ZnO nanorods was studied. This work consists of two major parts, which are the preparation of ZnO seed layer and the preparation of ZnO nanorods on the ZnO seed layer. Firstly, ZnO seed layer was prepared by vapor method; mist-atomization at ambient condition. To increase the adhesion of ZnO seed layer towards glass substrate, gold layer was coated onto the glass substrate by sputtering method. FESEM and UV-vis results gave evidence that 6 nm thickness of gold layer on glass substrate provided the best nucleation site for the growth of ZnO seed layer with high uniformity and enhanced absorbance properties. The effect of substrate temperature to the growth of ZnO seed layer was studied. It was found that ZnO seed layer deposited at 300 °C substrate temperature showed better surface morphology and absorbance properties. From the studies of the effect of precursor concentration, PL spectra showed that the ZnO seed layer prepared at 0.40 M has high crystallinity. The absorbance properties shown by UV-vis confirmed that 0.40 M has the highest absorbance properties with denser morphology was observed through FESEM. Next, ZnO nanorods were grown on the ZnO seed layer through facile solution-immersion method. Through FESEM and Raman studies, it was found that ZnO nanorod prepared by 0.40 M also gave the best crystal quality. To enhance the electrical properties of ZnO, *p*-type Ag^+ dopant was introduced by adding $AgNO_3$ to the base material. From XRD result, 1 at. % Ag^+ doped ZnO (A_1ZO) showed the highest crystal quality with (002) *c*-axis preferential growth. The surface morphology obtained by FESEM showed nanorods can still be obtained with the presence of small concentration of Ag^+ dopant. The I-V measurement showed A_1ZO has the highest conductivity. The effect of annealing temperature was studied and it was found that ZnO nanorods annealed at 500 °C has high crystal quality, well-aligned morphology and highly conductive with a significant improvement of 83.2 %. From the results obtained, high crystal quality of (002) c-axis preferential growth ZnO nanorods were successfully grown by solution-immersion method on ZnO seed with gold seed layer.

ACKNOWLEDGEMENT

First and foremost, I would like to thank Allah SWT the Almighty for giving me the strength, health and blessing to finish this study. It has been a long and tough journey for me and everyone around me. Without Your blessing, none of this is possible. Alhamdulillah.

I wish to express my sincere thanks to my inspiring supervisor, Dr Zuraida Khusaimi for her advice, encouragement and guidance throughout the research. Her constant encouragement has helped me a lot in this journey. Your mentoring technique is special and one of a kind. It is my honor to be your student and I am really proud of it. I really hope we will continue to collaborate in future. A million thanks also to my co-supervisor Prof. Dr. Engr. Mohamad Rusop Mahmood for his selfless support and advice as well as his permission to use his laboratories and equipments.

I would like to thank all of my laboratory mates such as, Nur Amierah Mohd Asib, Noor Aadila Abd Aziz, Kevin Alvin Eswar, Che Rosmani Che Hasan, Ain Zubaidah Maslihan, Azlinda Aziz, Muhammad Salleh Samsudin, Ruziana Mohamed and many more. Not to forget Mr. Azlan Jaafar, Mrs. Nurul Wahida Aziz and Mr. Salifairus Jafar for their continuous support and help. Thank you to Dr Mohamad Husairi Fadzilah Suhaimi and Dr Asnida Asli for their guidance throughout my Master journey.

Special thanks for Mr. Hayub from Faculty of Applied Sciences, Mr. Danial and Mr. Azwan from Faculty of Electrical Engineering for assisting in the FESEM equipment and Mr. Abul Khamis from Faculty of Applied Sciences for his help in the XRD equipment. I also would like to thank Universiti Teknologi MARA and Ministry of Higher Education of Malaysia for the scholarship and financial support.

Last but not least, I want to thank my loving and supportive parents, Abdullah Ab Rahman and and also all my siblings including in-laws, Afla, Norizan, Afzanee, Aziani, Irham, Amira and Amirul for their continuous support, encouragement and understanding. Thank you to my beautiful nephews and nieces, Danish, Aisy, Qaisara, Humaid, Thaqif and Humaira for their love and joy which make me stronger every day. They are my great support and strength. All the hard work and sacrifices has finally paid off. Next, a new journey shall begin.

Nurul Afaah binti Abdullah
April 2017

"Human beings and semiconductors are interesting because of their imperfections..."

TABLE OF CONTENTS

CHAPTER ONE
INTRODUCTION

1.1 INTRODUCTION

An overview of nanotechnology and ZnO is provided in this chapter. It details the problem statement, objectives, scope and limitations, and significance of study.

1.2 NANOTECHNOLOGY

The prefix 'nano' is derived from the Greek word 'nanos' which means dwarf but in science, nano means one billionth. One nanometer means one billionth of a meter. The prefix is denoted by a factor of 10^{-9} with unit of nanometer (nm) is generally ranged less than hundred. Materials with structure components less than 100 nm size is referred as nanomaterials. The term of nano is extensively defined as the control, manipulation and restructuring of matter in order of nanometer. Nanotechnology is regarded as one of the key technologies in the future.

Nobel Laurette Richard Phillips Feynman of California Institute of Technology (Caltech) was the first person to introduce the idea of nanotechnology in year 1959. His talk entitled "There's Plenty of Room at the Bottom" delivered to the American Physical Society's West Coast section has become inspiration for nanotechnology research development. In the lecture, he used physics to demonstrate the physical possibilities for manipulating, visualizing and controlling matter on small scale. He envisioned "we could arrange atoms one by one, just as we want them". From that day, many countries have invested in research and development (R&D) of nanotechnology. It is believed that nanotechnology will be vital in the future and give advantages in devices applications [1], health and medical application [2] and military defense.

There are two approaches to nanotechnology synthesizations; top-down and bottom-up approaches. Top-down approach is where the bulk size starting materials were reduced into required size and shape. On the other hand, bottom-up approach is where the structures were built up of atom by atom or molecule by molecule, through