UNIVERSITI TEKNOLOGI MARA

STRUCTURAL AND OPTICAL PROPERTIES OF DEPOSITED ZINC OXIDE ON INTEGRATED PULSED ELECTROCHEMICAL POROUS SILICON

NURUL HANIDA BINTI ABD WAHAB

MSc

April 2020

AUTHOR'S DECLARATION

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.

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.

Name of Student	:	Nurul Hanida Binti Abd Wahab
Student I.D. No.	:	2014264688
Programme	:	Master of Science (Electrical Engineering) - EE7750
Faculty	:	Electrical Engineering
Thesis Title	:	Structural and Optical Properties of Deposited Zinc Oxide on Integrated Pulsed Electrochemical Porous Silicon
Signature of Student	:	……..
Date	:	April 2020

ABSTRACT

This thesis focuses on the study of the structural and optical properties of deposited zinc oxide on porous silicon substrate which has been prepared by using two different etching method. This work has been divided into two parts where the first part was the fabrication of porous silicon with two different methods used known as direct current (DC) electrochemical etching and pulse current (PC) electrochemical etching. During the pulse current etching process, the introduction of delay time has been introduced to each samples with variation of 0 minutes, 2 minutes and 4 minutes delay. This time delay was applied during the etching process before applying the current source to the cell. During this time delay, the silicon wafer was left to react with the chemical solution mixture which acts as an electrolyte for the etching process. The different range of time delay has resulted in the different pattern in terms of their surface morphology, surface roughness, elemental composition, as well as optical properties of the porous silicon structure. The structural analysis showed that all the porous silicon samples which has been fabricated using pulse current etching exhibited uniform circular shape and the surface roughness has also increased as compared to the as grown silicon sample. The sample with introduction of time delay for 2 minutes has been identified to have the most homogeneous pore structure as compared to other samples. Furthermore, stronger Raman peak obtained from the sample with 2 minutes delay time as compared to other fabricated samples with slightly left shifted from the infrared (IR) region. The quantum confinement effect for this sample has been observed by the increase in band gap value of 1.60eV. The second part of these research work was the deposition of zinc oxide (ZnO) inside the porous silicon structures in order to synthesize the ZnO nanostructures in terms of structural and optical properties. The deposited process has been done to all porous silicon samples by using thermal evaporation method. During the thermal evaporation method, the zinc (Zn) plate with 99.9% purity was placed in the tungsten boat which later being attached in the bell jar. The Zn plate was melted hence evaporated as ZnO on the surface of porous silicon substrate. This deposited structure has formed different morphology on the surface where flower petals like structure were obtained in all samples. The Atomic Force Microscopy (AFM) results showed that the sample with 2 minutes delay time has the roughest surface as compared to other samples which similar to previous results before deposited process is performed. The X-Ray Diffraction (XRD) pattern of the deposited porous silicon samples reveals that all of the samples are polycrystalline. The peaks that appeared at 2θ of 31.8°, 34.5°, 36.3°, 47.6°, 56.7°, 63.0°, 68.1° and 69.2° represent the (100), (002), (101), (102), (110), (103) and (112) phases respectively. These phases indicating the hexagonal close-packed crystal structure of the ZnO according to JCPDS no. 36-1451. Sample with 2 minutes delay time has constantly showed better optical properties as compared to other samples for having highest intensity in the PL spectra and blueshift has been identified. By comparing the PL results between the PSi samples and the deposited ZnO/PSi samples of 2 minutes delay time, it can be concluded that the PL peak has been experienced blue shift with broader peak at 630nm which falls in the red region for deposited sample ZnO/PSi as compared to the PSi samples where the peak was located at 766nm.

ACKNOWLEDGEMENT

Alhamdulillah, with the blessed of Allah S.W.T , God of the entire world, the gracious, the merciful for the blessings He had given me, the opportunity, strength and the greatest experience to complete this research work successfully. Even there are lots of difficulties that I have to face in order to balance between this research and my work as a Vocational Training Officer, but with the strength given by Allah, I had overcome all the problems. All the difficulties that I have faces make me realize that it was not an easy task to be a part time student who are doing Master Degree in research mode. Without the helps and supports from other individuals, it would be almost impossible for me to complete this research successfully.

I would like to express my sincere gratitude to my supervisor Dr. Alhan Farhanah Binti Abd Rahim from Faculty of Electrical Engineering at Universiti Teknologi MARA, Pulau Pinang for the chance she had given me to be her Master Degree student, the continuous support, motivation, knowledge, guidance and her patience throughout the research. She never gives up on guiding me to do this research work despite the ups and downs of my performance. A very special thanks dedicated to Dr. Ainorkhilah Binti Mahmood from Applied Science Department at Universiti Teknologi MARA, Pulau Pinang for her ideas and effort in assisting me to complete this research work and had given me full access to use the facilities in the laboratory. Her continuous motivation and endless supports towards me to accomplish this journey will always be remembered.

Beside my supervisor, I also would like to express my gratitude to the staff of the INOR Lab, Universiti Sains Malaysia, especially Mr. Yushamdan bin Yusof, Ms. Ee Bee Choo and Mr. Abd Jamil bin Yusuf for providing the facilities, knowledge and assistance during the completion of the characterization work. Their wonderful assistance along this journey are very much appreciated. Other than that, I would like to thank Jabatan Perkhidmatan Awam for funding my studies through Hadiah Latihan Separa Biasiswa (HLPSB) and MOHE under Fundamental Research Grant Scheme (FRGS) who sponsored this research. I would also like to acknowledge my employer Japan Malaysia Technical Institute for allowing me to pursue this research, to my colleagues Ms. Azlina Abd Rahim and Ms. Najwa Abd Rahim who were being empathetic towards my situation as a part time student.

Finally, I must express my very profound gratitude to my much beloved, supportive and understanding husband, Hussaini Aras Bin Agus Salim, my parents Abd Wahab Bin Hj. Abd Majid and Norkamaliah Binti Othman as well as my siblings, Guntor Putra Bin Abd Wahab, Mohd Hazril Bin Abd Wahab and Nazatul Izwa Binti Abd Wahab for providing me with unfailing support and continuous encouragement throughout my years of study, the process of researching and writing this thesis. This accomplishment would not have been within the realms of possibilty without all of them. Thank you.

TABLE OF CONTENTS