

UNIVERSITI TEKNOLOGI MARA

**HUMIDITY SENSING
PERFORMANCE OF ALIGNED
ASSEMBLY TIN-DOPED ZINC
OXIDE NANOCOMPOSITED FILMS
VIA LOW TEMPERATURE
IMMERSION METHOD**

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Thesis submitted in fulfillment
of the requirements for the degree of
Doctor of Philosophy
(Electrical Engineering)

Faculty of Electrical Engineering

May 2019

ABSTRACT

In this study, resistive humidity sensors were fabricated using ZnO-based nanocomposite films on top of ZnO-seed-layer-coated glass substrates. This study introduced different novel configurations of humidity sensors that were prepared using sol-gel immersion and sputtering method. Several approaches, such as doping and constructing composite films, were applied to improve the ZnO-based humidity sensors. The structural, optical, and electrical properties of the synthesized films were characterized via field-emission scanning electron microscopy, transmission electron microscopy, X-ray diffraction, atomic force microscopy, energy-dispersive X-ray spectroscopy, Raman spectroscopy, ultraviolet–visible–infrared spectrophotometry, and two-probe current-voltage measurement. The humidity sensing performances of the films were measured in a humidity chamber equipped with a measurement system. Results showed that the intrinsic ZnO nanorod arrays (NRAs) exhibited a humidity sensitivity of 1.53. The humidity sensing performance of the fabricated ZnO NRAs could be further enhanced to 3.7 by doping with 1 at.% of tin (Sn). A slight increment of humidity sensitivity of the Sn-doped ZnO (SZO) film was facilitated by the enlargement of surface area. This phenomenon was induced by reducing the average diameter of NRAs and enriching the free carrier concentrations in the ZnO film when Sn dopant occupied the ZnO structure. In addition, the implementations of SnO₂/ZnO nanocomposite films could magnify the performance of the device. The SnO₂ nanosheet (SNS)/SZO configuration substantially improved the humidity sensitivity to 754.41. The humidity sensing performance of the films could be further improved by incorporating conductive materials, namely, graphene (G) and platinum (Pt). The appearances of G and Pt as the additional elements amplified the sensitivity of the humidity sensors up to 1542.51 and 979.34, respectively. The remarkable augmentation of humidity sensing performance of the nanocomposite films may be due to the increase in surface area and superior properties of nanocomposite films. These nanocomposited films offer more surface reaction sites with water molecules, good electron transfer properties across the film, and synergistic effects at the interface of the materials induced by the different work functions of the materials. Thus, the ZnO-based nanocomposite films are very promising to fabricate high-quality humidity sensors. G and Pt coating on these nanocomposited films could enhance the performance of the sensors further.

ACKNOWLEDGEMENT

Firstly, I wish to thank God for giving me the opportunity to embark on my PhD and for completing this long and challenging journey successfully. My gratitude and thanks go to my supervisor, Ir. Ts. Dr. Mohamad Hafiz Mamat, for his extremely helpful guidance, generous support and continuous encouragement with his wisdom, knowledge and experience. My gratitude also goes to my co-supervisor, Dr. Nor Diyana Md. Sin and Prof. Dr. Suriani Abu Bakar for their kind support and meaningful contributions.

I would like to thank Prof. Engr. Dr. Mohamad Rusop Mahmood for his contribution to this research. My special gratitude also to my colleagues of NANO-ElecTronic Centre (NET) and NANO-SciTech Centre (NST), especially Dr Mohd Firdaus Malek, Dr Ruziana Mohamed, Dr Marmeezee Mohd Yusoff, Norfarariyanti Parimon, Muhammad Amir Ridhwan Abdullah, Wan Rosmaria Wan Ahmad, Nur Munirah Safiay, and others for their help, motivation, kindness, and support during my studies. I also would like to thank the Faculty of Electrical Engineering UiTM for the equipment and also IRMI of UiTM for the financial support under GIP grant (600-IRMI/MYRA 5/3/GIP (002/2017)).

Special thanks also go to the technical staffs of NANO-ElecTronic Centre (NET) and NANO-SciTech Centre (NST), especially Mr. Azwan Roseley, Mr. Suhaimi Ahmad, Mr. Asrul Mohamed, Mr. Salifairus Mohammad Jafar, Mrs. Nurul Wahida Aziz, and Mr. Azlan Jaafar, for helping me to accomplish my research. I would also like to send my special thanks to my research group members and friends for their kind assistance.

Finally, this thesis is dedicated to my lovely father, Ismail@Rosdi Adam, my dear late mother, [REDACTED] my step mother, [REDACTED] and my siblings Farihah, Muhammad Subhi, and Muhammad Addha for the vision and determination to support and educate me. This piece of victory is dedicated to you. Alhamdulillah.

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