UNIVERSITI TEKNOLOGI MARA

ELECTRICAL PROPERTIES OF Sn DOPED ZnO THIN FILMS DEPOSITED BY SOL GEL SPIN COATING METHOD FOR MSM GAS SENSOR APPLICATIONS

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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 other 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.

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ABSTRACT

This study focused on development of nanostructured ZnO thin films based metal-semiconductor-metal (MSM) gas sensor by sol gel spin coating method. There were three stages that has been studied to fabricate nanostructured ZNO based MSM gas sensor which are: (a) preparation of ZnO thin films by spin coating method (b) preparation of Sn doped ZnO thin films by spin coating method and (c) fabrication of nanostructured ZnO based MSM based sensor. The preparation of ZnO thin films were deposited using spin coating with 10 layers and annealing temperature (350 to 500°C) of ZnO thin film were determined. For preparation on nanostructured n-type doped ZnO thin films by spin coating method, effect of annealing temperature (350 to 500°C) and effect of n-type dopant (Sn concentration 0.2-1.0 at.%) on nanostructured ZnO were studied. X-ray diffraction (XRD), Field emission scanning electron microscope (FESEM), energy dispersive X-ray (EDS) and atomic force microscopy (AFM) were used to characterise the structural properties of nanostructured ZnO thin films. The UV-Vis-NIR spectrometer was employed to study the optical properties determination. The electrical properties were characterized by using current-voltage (I-V) measurement (Keithley 2400) to characterize the resistivity, conductivity and the electrical resistance behaviour of the thin films. Then, gold (Au) was deposited on nanostructured ZnO as an electrode to fabricate nanostructured ZnO based MSM gas sensor. The gas sensor devices have been characterized using current–voltage (I-V) measurement system to measure the sensitivity, response time and the recovery time. The O_2 oxygen gas with flow rate 20 sccm has been used for fabricated nanostructured ZnO thin film based gas sensor testing. The highest sensitivity behaviour of nanostructured Sn doped ZnO thin films with 1.0 at.% were determined to detect 20 sccm of oxygen (O_2) gas at room temperature which found to be 12.56%. Then, the highest conductivity value was 9.17×10^{-4}S/cm at 1.0 at.% of Sn doped ZnO thin films. The transmittance of Sn doped ZnO thin film at 1.0 at.% also showed high transmittance of 92 % and produced the lowest optical band gap energy of 3.521 eV. Therefore, the increment of Sn doping concentration from 0.2 to 1.0 at.% has performed the samples to response faster from 85 to 40 s. In addition, the recovery time of Sn doped ZnO experienced the similar phenomenon which were decreased from 93 to 53 s. Then, the sensitivity of the samples showed the gradually increment from 6.11 to 12.56% as the Sn doping concentration increased. Additionally, temperature at 500°C has been determined as an optimum temperature between the increment of annealing temperature. The nanostructured ZnO thin films based MSM gas sensor was fabricated by spin coating method. In addition, increment of the annealing temperature from as-deposited to 500°C has improved the samples to response faster from 112 to 85 s, as well as recover faster from 120 to 93 s. Meanwhile, the sensitivity of samples increased from 5.27 to 6.12 % as the annealing temperature increased up to 500°C. The 500°C has achieved a remarkably highest sensitivity at 6.12% which comparable with to other studies.

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TABLE OF CONTENTS