UNIVERSITI TEKNOLOGI MARA

SYNTHESIS AND CHARACTERIZATION OF SILVER-DOPED ZINC OXIDE NANORODS ON TITANIUM DIOXIDE SEEDED SUBSTRATE: POTENTIAL APPLICATION AS UV SENSOR

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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 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

Zinc Oxide (ZnO)-based UV Sensor has been investigated widely and it is realized that the performance of this device depends on the dimension, morphology and the structure of ZnO. One of the efforts that lead to the surface modification of ZnO is by introducing dopant in ZnO which is expected to improve certain properties of ZnO and hence enhancing the performance of UV Sensor. In this work, metal-doped ZnO were grown on titanium dioxide (TiO_2) seed layer by using a spin-coating technique for the deposition of TiO_2 seed layer and the solution-immersion method for the growth of metal-doped ZnO. The effectiveness of TiO_2 as a seed layer was investigated and it proved that the presence of TiO_2 as a seed layer revealed a smaller diameter size of nanorods (392nm) with high absorption properties of ZnO compared with pure ZnO (1226nm). Then, the preparation towards the optimization of metal-doped ZnO nanorods on TiO_2 seed layer was also studied. The properties of ZnO nanorods on TiO_2 as a seed layer (ZTO) was successfully improved by introducing different types of metal dopants (Ag, Al, Mg and Cu). All metal dopants showed a good potential to be used as dopants due to the size reduction of nanorods which contribute to high absorption properties of ZnO compared to non-doped samples. But, because Ag dopant produces the highest absorption with a smallest size of nanorods, Ag is the best metal dopant to produce a good optical property in the UV region. The detailed study on the optimized Ag-doped ZnO thin films on the TiO_2 seed layer (AgZTO) was successfully carried out by varying the parameters. It was found that 1.5 at.% of Ag, 0.08M Zn precursor concentration and 500°C thermal annealing temperature were the optimum growth conditions for AgZTO nanorods. On the other hand, the optimized AgZTO was further utilised for the preparation of highly conducting thin films in order to estimate the feasibility of Ag dopant in enhancing the performance of UV sensors. The comparative studies between ZTO and AgZTO under controlled parameters were successfully investigated. The results showed an excellent optical property of $Ag_{1.5}ZTO_{0.08}$ compared with $ZTO_{0.08}$. The presence of Ag dopant in ZnO leads to the improvement of light absorption properties and high value of I_{UV}/I_{Vis} (4.70) which is 90.4% higher than $ZTO_{0.08}$ (0.50). These samples were also tested using the I-V measurement system and the result proved that the conductivity of $Ag_{1.5}ZTO_{0.08}$ ($14.493 Scm^{-1}$) was increased about 90.6% compared with $ZTO_{0.08}$ ($1.502 Scm^{-1}$). As Ag dopant was introduced to ZnO, the intensity of UV emission and conductivity of the sample increased and hence demonstrated as suitable high performance of UV sensor. It is generally accepted that smaller diameter size of AgZTO contributes to more surface area available in nanorods. The surface area facilitates a faster surface reaction process, as the photogenerated hole discharge the negatively charged adsorbed oxygen ions (O_2^-) on the nanorod surface, which generates free electrons in the conduction band. Afterward, these free electrons move to the outer circuit and hence contributes to increase in the conductivity.

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