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

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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 SnO_2/ZnO nanocomposite films could magnify the performance of the device. The SnO_2 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.

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