Heterojunction of SnO_2 nanosheet/arrayed ZnO nanorods for humidity sensing

ABSTRACT

For the first time, a rutile phased tin oxide (SnO_2) nanosheet was assembled onto a zinc oxide (ZnO) nanorod array to form SnO_2 nanosheet/ZnO nanorod array heterostructure films (TSZR) using a two-step solution immersion method. This study offers a facile and effective path to grow a SnO2 nanosheet assembled layer on ZnO nanorod arrays with a varied density using a tin (II) chloride dihydrate precursor to achieve an optimum humidity sensing response through the SnO_2 growth time from 1 to 5 h. The structural characteristics, electrical properties, and humidity sensing response of the heterostructure films were investigated using various characterization techniques, such as field emission scanning electron microscopy, energy dispersive X-ray spectroscopy, high-resolution transmission electron microscopy, X-ray diffraction, atomic force microscopy, Raman spectroscopy, a two-probe current-voltage measurement, and a humidity sensing response measurement system. The synthesized ZnO nanorods have an average diameter of 90 nm, while the grown SnO_2 nanosheets have an average width of 20 nm. The humidity response performance of the films demonstrates a remarkable dependence on the SnO_2 nanosheet assembled layer on the ZnO nanorod array film with the best humidity sensitivity of 754.4 at room temperature obtained for the 2 h-grown SnO_2 nanosheet-based 2TSZR heterostructure sample. The 2TSZR sample also exhibited good stability over a four-cycle measurement and magnified current value of the humidity sensing response at a high operating temperature up to 60 °C. These investigations reveal that the TSZR heterostructure films are promising for humidity sensing devices with high sensitivity.