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Title :
Fabrication and Performance of Nanostructured ZnO/SnO_2 Based Humidity Sensor

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Humidity sensors were fabricated using zinc oxide/tin oxide (ZnO/SnO_2) composite nanorods and novel structures of ZnO/SnO_2 nanoblock arrays and ZnO/SnO_2 composite nanocubes. The ZnO/SnO_2 composite nanorods and ZnO/SnO_2 nanoblock arrays were successfully synthesised using thermal chemical vapour deposition (CVD). The ZnO/SnO_2 composite nanocubes were prepared using a novel sol-gel immersion method. First, ZnO thin films were synthesised to prepare the ZnO/SnO_2 composite nanorods and the ZnO/SnO_2 composite nanocubes. These ZnO thin films acted as template layers, which were deposited using a radio frequency (RF) magnetron sputtering system. To obtain a conductive template layer, parametric studies were conducted by varying the RF power and the temperature of the substrate. This template was optimised using a RF power of 200 watts and a substrate temperature of 500°C to obtain the ZnO template with the highest conductivity of 73.1 S cm^{-1}. The ZnO/SnO_2 composite nanorods were studied by varying different parameters including the ZnO/SnO_2 composition, the type of tin precursor (i.e., dibutyltin diacetate, tin powder and tin chloride pentahydrate), the substrate temperature (between 200 and 600°C) and the oxygen flow rate (5, 10 and 15 sccm). The sensitivity of the humidity sensor and the response and recovery times were studied in each experiment. The experimental results were used to relate the sensor performance to the surface conditions in terms of the dimension of the active layer. The humidity sensor was fabricated using a novel sensor configuration consisting of ZnO/SnO_2 composite nanorods, ZnO/SnO_2 nanoblock arrays and ZnO/SnO_2 composite nanocubes. The humidity sensor made of ZnO/SnO_2 composite nanorods had a sensitivity of 265. Remarkably, the highest sensitivity of 371 was obtained for a humidity sensor based on a ZnO/SnO2 nanoblock array for which the porous surface structure was enhanced using a tin chloride pentahydrate precursor at a substrate temperature of 500°C and an oxygen flow rate of 10 sccm. The humidity sensor based on ZnO/SnO_2 composite nanocubes was successfully grown on a ZnO template by controlling two parameters: the Zn:Sn molar ratio (1 to 10:10) and the immersion time (0.5 to 6 h). Notably, the highest sensitivity of 101 was found for the humidity sensor based on ZnO/SnO_2 composite nanocubes, which were deposited using a Zn:Sn molar ratio of 5:10 and an immersion time of 2 h. In this study, high sensitivities were observed for the fabricated humidity sensor based on ZnO/SnO_2 composite nanorods, the humidity sensor based on ZnO/SnO_2 nanoblock arrays and the humidity sensor based on ZnO/SnO_2 composites.