Abstract

This thesis mainly focuses on two major issues: (a) the growth of CuO nanoflowers and nanorods on Cu foil and on Cu films deposited on glass slides by an inexpensive wet chemical method and their characterization and (b) the possible applications of the synthesized nanostructures in sensing toxic gases and their field emission characteristics. The preliminary growth experiments were performed by varying NaOH and $(NH_4)_2S_2O_8$ concentrations for different dipping times to optimize the growth of nanostructures on Cu foil. The effect of temperature on the growth of nanostructures was also studied. Comparative studies were performed by using KOH and CH_4N_2O instead of NaOH and $(NH_4)_2S_2O_8$ chemical solutions. Finally, the optimum growth conditions for CuO nanoflowers on Cu foil and on Cu films deposited on glass slides was determined to be (3M) NaOH and (0.15M) $(NH_4)_2S_2O_8$ concentration for 3 hours. On the other hand, the optimum growth conditions for CuO nanorods on Cu foil and on Cu films deposited on glass slides was (4M) NaOH and (0.15M) $(NH_4)_2S_2O_8$ concentration for 3 hours.

Stable hydrophobic surfaces were fabricated by treating the CuO nanoflowers with fatty acids. Copper is hydrophilic with a contact angle (68º). After chemical treatment of the Cu foil, due to the formation of nanoflowers, the roughness of the surface increases and the contact angle increased to 124º. It was observed that the contact angle value increased to 130º when the fatty acids were treated on synthesized CuO nanoflowers. A p-type sensing device was fabricated using the synthesized CuO nanoflowers on glass slides and its response was tested with various VOCs at a fixed temperature (240ºC). The device showed stable sensing response for acetone vapors within the concentration range 250-2250 ppm.

A heterostructure was formed by depositing ZnO on synthesized CuO nanostructures and its electrical characteristics were measured using *J-V* measurements. The threshold voltage was determined to be 1.2 V. The junction effect of this device was used for detection of toluene gas with a good response at 250ºC within the concentration range 88-890 ppm. Brass foil, which is an alloy of copper and zinc, was also used as a substrate to form a hybrid CuO/ZnO structure for the detection of chloroform gas with a good response at 250ºC within the concentration range 54-563 ppm. The field emission characteristics of vertically aligned CuO nanorods were measured. The field enhancement factor was also calculated. The turn-on electric field was about 0.64 and 0.013 V/μm at inter electrode distances (d) of 500 and 1000μm, respectively. When the electrode distance was increased from 500 to 1000μm, respectively, the field emission performance became better. Based on the two-region field emission (TRFE) model, it was found that the experimental data could be almost fitted to a straight line.

Keywords: CuO, ZnO, Nanoflowers, Nanorods, Hydrophobicity, Heterostructure, Field emission