Development of ZnO Thin Films for Gas Sensing Applications

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In recent decades' gas sensing technology has become significant due to its widespread and common applications in the areas of industrial production, automotive industry, medical applications, indoor air quality supervision and environmental studies. Currently, there is an increasing interest in finding nanostructured materials to develop high performance solid-state sensors for in-house and outdoor hazardous gas monitoring. Among the available gas sensing materials, metal oxide semiconductors typically maintain a leading role owing to their high sensitivity, low cost, small dimensions and simple integration. This study, focused on developing ZnO semiconductor thin films *via* the technique of electrodeposition followed by a heat treatment for detecting LP (Liquid Petroleum) and H_2S gases. A three electrode electrolytic cell containing of 0.1 mol L^{-1} $ZnSO_4$ was used to carry out the electrodepositions. A FTO glass substrate (1×3 cm^2) was used as the working electrode against an Ag/AgCl reference electrode while using a high purity carbon rod as the counter electrode. The Zn electrodepositions were carried out in the cathodic deposition potential (CDP) range of 0.70–1.10 V and pH range of 4.0–1.0 at a temperature of 55 °C. Subsequently, samples were heat treated at 400 °C for 1 hour in order to form ZnO thin films and samples were then characterized for their crystalline structure, surface morphology and elemental composition using the techniques of X-ray diffraction spectroscopy, scanning electron microscopy and energy dispersive X-ray spectroscopy respectively. The sample grown at CDP of 0.80 V at pH of 1.5 for 20 minutes was found to have average sensitivity of 6% and 38% while exposing to LP and H_2S gases respectively for 2 minutes at 30 °C. Further, it revealed that, the sensitivity of the ZnO material could be enhanced by controlling the electrodeposition and the heat treatment conditions applied for the formation of ZnO nanomaterials.

Keywords: Gas sensing, ZnO, Electrodeposition, Thin films