Ethanol Sensing Properties of Zinc Oxide Nanobelts Prepared by RF Sputtering

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ABSTRACT

ZnO nanobelts were prepared on copper tube by radio frequency (RF) sputtering. From Field Emission Scanning Electron Micrograph (FE-SEM), the size of ZnO nanobelts ranged from 10–100 nm. The ethanol sensing properties of ZnO nanobelts were observed from the resistance change under ethanol vapor atmosphere at ethanol concentrations of 50, 500 and 1000 ppm and at temperature of 200–290°C. It was found that the sensitivity and response time of ZnO nanobelt sensor depended on ethanol concentration and temperature. The sensor exhibited high sensitivity and fast response to ethanol vapor at a work temperature of 220°C. These results suggested that ZnO nanobelts could have a potential application as an ethanol nano gas sensor.

Key words: ZnO, nanobelts, RF sputtering, Ethanol sensing

INTRODUCTION

One of the novel properties of semiconducting nanostructures is having a very large surface-to-volume ratio. Since the gas-sensing properties strongly depend on a surface of the materials, the gas sensors based on nanostructures of semiconducting metal oxide are expected to exhibit better sensing properties than bulk or thin film sensors.

ZnO is one of the promising semiconducting metal oxides for gas sensor applications. ZnO ceramic and thin film gas sensors were widely investigated (Cheng et al., 2004; Shishiyanu et al., 2005). Recently, gas sensors of ZnO nanostructures have caught great attention. Wan and coworkers studied gas sensor based on ZnO nanowires prepared by thermal evaporation and fabricated with microelectromechanical system (MEMS) technology. They found that the sensor exhibited high sensitivity and fast response time to ethanol gas at a work temperature of 300°C (Wan et al., 2004). Xue and coworkers studied gas sensors fabricated from $ZnSnO_3$ nanowires and found that they exhibited a very high sensitivity to ethanol gas and up to about 42 against 500 ppm ethanol gas at the operating temperature of 300°C. Both the response and recovery time were about 1 s (Xue et al., 2005). However, ZnO is also sensitive with other gasses as indicated by a few reports of ZnO nanorods sensing with hydrogen-selective. Wang and coworkers studied a sensor of ZnO nanorods synthesized by sputter-deposition. The results showed sensitivity, response and recovery time of ZnO nanorods to hydrogen concentration in N2 of 10-500 ppm and working at room temperature (Wang et al., 2005).

ZnO nanostructures can be synthesized by various growth techniques such as pulsed laser deposition (PLD) (Choopun et al., 2005(b)), chemical vapor deposition (CVD) (Hirate et al., 2005), thermal evaporation (Liu et al., 2005) and sputtering technique (Choopun et al.,