Thick Film of Carbon Nanotube Composite for Ethanol Sensor

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ABSTRACT

One interesting application of carbon nanotubes is their use as a gas sensor. In this work, a thick film carbon nanotube composite was prepared by mixing carbon nanotube powder with iso-butyl methyl ketone and painted onto alumina substrates. Then, the composite's gas-sensing properties for ethanol vapor were tested by measuring the resistance change of the composite at ethanol concentrations of 50, 100, 500, and 1,000 ppm at room temperature. An increase in resistance of 2–5 ohm has been observed with a responsiveness of about 0.01, a sensitivity of about 1 and a response time (τ_{90}) of about 10 sec. The sensing mechanism of the composite could be explained on the basis of volume expansion and polar interaction of various vapors on the carbon nanotube surface.

Key words: Carbon nanotube, Thick film, Composite, Gas sensor

INTRODUCTION

Carbon nanotubes (CNTs) have a wide variety of potential applications including field emission devices, electronic switches, biological sensors, flow sensors and gas storage (Govindaraj and Rao, 2002; Ghosh et al., 2003; Kruger et al., 2003; Philip et al., 2003; Stetter et al., 2003). One potential important application of CNTs is as a gas sensor. Gas sensing properties depend on the surface area and the huge surface area of the nanotubes, because of their hollow cores and outside walls, make them an exceptional candidate material for such applications. (Dai et al., 2002; Ong et al., 2002; Choopun et al., 2004; Lizznersk et al., 2004; Tan, 2004). Several methods such as arc-discharge, laser vaporization, chemical vapor deposition (CVD), pyrolysis and electrolysis (Singjai, 2005) can be used to fabricate CNTs. For gas sensor application, CNT composites have been typically used. The gas sensors based on CNT/polymer, ceramic and metal oxide composites such as epoxy, polyimide, PMMA, BaTiO3 and SnO_2 (Dai et al., 2002; Ong et al., 2002; Philip et al., 2003) have been demonstrated. The gas sensing properties of CNT composites toward various gasses such as dichloromethane, chloroform, acetone, methanol, oxygen, carbon dioxide and ammonia have been reported. For example, Philip and co-workers reported CNT/PMMA composite thin films for gas-sensing application (Philip et al., 2003). They observed an increase of resistance in the order of 10^2–10^3 toward dichloromethane, chloroform and acetone due to surface modification and explained the gas sensing mechanism on the basis of volume expansion and polar interaction of various vapors on the CNTs surface.

In the present paper, we report on the gas-sensing properties of CNTs/iso-butyl methyl ketone composite thick film toward ethanol vapor.