ST-P012

Hydrogen and Ethanol Gas Sensing Properties of Mesoporous P-Type CuO

Yun-Hyuk Choi, Hyun Soo Han, Sun Shin, Seong Sik Shin, Kug Sun Hong

Department of Materials Science and Engineering, Seoul National University, Seoul 151-744, Korea

Metal oxide gas sensors based on semiconductor type have attracted a great deal of attention due to their low cost, flexible production and simple usability. However, most works have been focused on n-type oxides, while the characteristics of p-type oxide gas sensors have been barely studied. An investigation on p-type oxides is very important in that the use of them makes possible the novel sensors such as p-n diode and tandem devices. Monoclinic cupric oxide (CuO) is p-type semiconductor with narrow band gap (~1.2 eV). This is composed of abundant, nontoxic elements on earth, and thus low-cost, environment-friendly devices can be realized. However, gas sensing properties of neat CuO were rarely explored and the mechanism still remains unclear.

In this work, the neat CuO layers with highly ordered mesoporous structures were prepared by a template-free, one-pot solution-based method using novel ink solutions, formulated with copper formate tetrahydrate, hexylamine and ethyl cellulose. The shear viscosity of the formulated solutions was 5.79 Pa s at a shear rate of 1 s-1. The solutions were coated on SiO2/Si substrates by spin-coating (ink) and calcined for 1 h at the temperature of 200~600°C in air. The surface and cross-sectional morphologies of the formed CuO layers were observed by a focused ion beam scanning electron microscopy (FIB-SEM) and porosity was determined by image analysis using simple computer-programming. XRD analysis showed phase evolutions of the layers, depending on the calcination temperature, and thermal decompositions of the neat precursor and the formulated ink were investigated by TGA and DSC. As a result, the formation of the porous structures was attributed to the vaporization of ethyl cellulose contained in the solutions. Mesoporous CuO, formed with the ink solution, consisted of grains and pores with nano-meter size. All of them were strongly dependent on calcination temperature. Sensing properties toward H2 and C2H5OH gases were examined as a function of operating temperature. High and fast responses toward H2 and C2H5OH gases were discussed in terms of crystallinity, nonstoichiometry and morphological factors such as porosity, grain size and surface-to-volume ratio. To our knowledge, the responses toward H2 and C2H5OH gases of these CuO gas sensors are comparable to previously reported values.

Keywords: CuO, Mesoporous structure, Gas sensor