Formaldehyde Sensor Based on Flame-made AgO$_x$-doped SnO$_2$ Nanoparticulate Sensing Films

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Abstract:
Formaldehyde (HCHO) is one kind of the most volatile organic compounds (VOCs) that was widely used in household materials associated with many health risk factors and is identified as a major cause of sick building syndrome (SBS) [1, 2]. It is thus important to develop sensitive gas sensors capable of formaldehyde detection below its threshold limit value (TLVs) for health safety. In this work, flame-made 0–1 wt% AgO$_x$-doped SnO$_2$ nanoparticles were developed and characterized for detection of HCHO. The structural properties of as-prepared materials and their fabricated sensors were characterized by X-ray diffraction, Energy-dispersive X-ray spectroscopy, nitrogen adsorption, and electron microscopy. The results indicated that the AgO$_x$-doped SnO$_2$ nanoparticles (5–20 nm) had spheroidal morphology with highly crystalline tetragonal cassiterite SnO$_2$ structure and AgO$_x$ may form a solid solution with SnO$_2$ matrix. For gas sensing test, the gas sensing properties of the pure SnO$_2$ and AgO$_x$-doped SnO$_2$ sensing film were systematically tested under exposure towards 50–200 ppm HCHO with different operating temperatures ranging from 150–400°C in dry air. From the sensing data, AgO$_x$ doping with an optimal Ag content of 0.2 wt% led to significant enhancement of HCHO response by more than one order of magnitude compared with undoped one. In particular, 0.2 wt% AgO$_x$-doped SnO$_2$ sensing film exhibited a high response of ~500 to 2000 ppm HCHO at 350°C. Therefore, the flame-spray-made 0.2 wt% AgO$_x$-doped SnO$_2$ sensor is one of the most promising candidate for sensitive HCHO detector and may be useful in environmental and SBS applications.

Keywords: Flame spray pyrolysis, AgO$_x$, SnO$_2$, Formaldehyde sensor, sick building syndrome.
Fig. 1. The typical top-view SEM image of 0.5 wt% AgOx-doped SnO2 nanoparticles (P–0.5Ag).

Fig. 2. The histograms of typical sensor response towards 2000 ppm formaldehyde with corresponding change in resistance (inset) of the 0–1 wt% AgOx-doped SnO2 (S–0 to S–1Ag) at optimal operating temperatures of 350°C in dry air.

References