DOI 10.5162/IMCS2018/P2NG.8

Formaldehyde Sensor Based on Flame-made AgO_x-doped SnO_2 Nanoparticulate Sensing Films

K. Khamfoo [1,2], A. Wisitsoraat[3,4], A. Tuantranont[3,5], S. Phanichphant[3], C. Liewhiran[1,3,6]
[1] Department of Physics and Materials Science, Faculty of Science, Chiang Mai University, Chiang Mai 50200, Thailand
[2] Graduate School, Chiang Mai University, Chiang Mai 50200, Thailand
[3] Center of Advanced Materials for Printed Electronics and Sensors, Materials Science Research Center, Faculty of Science, Chiang Mai University, Chiang Mai 50200, Thailand
[4] Carbon-based Devices and Nanoelectronics Laboratory, National Electronics and Computer Technology Center, National Science and Technology Development Agency, Klong Luang, Pathumthani 12120, Thailand
[5] Thailand Organic and Printed Electronics Innovation Center, National Electronics and Computer Technology Center, National Science and Technology Development Agency, Klong Luang, Pathumthani 12120, Thailand
[6] Center of Excellence in Materials Science and Technology, Chiang Mai University, Chiang Mai 50200, Thailand
Corresponding author's e-mail address: cliewhiran@gmail.com (C. Liewhiran)

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 dection 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 spheriodal 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.

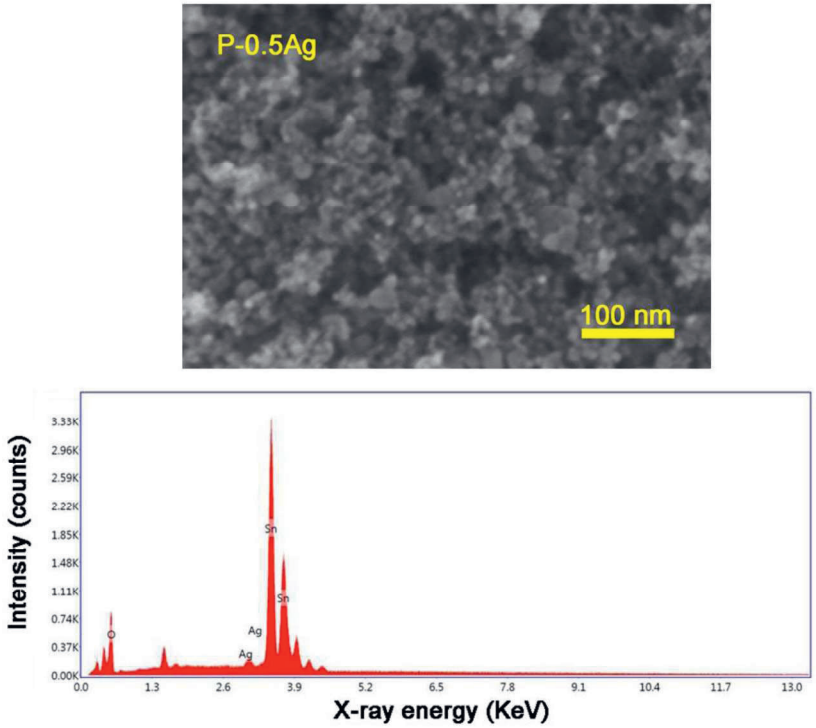

Fig.1. The typical top–view SEM image of 0.5 wt% AgO_x–doped SnO_2 nanoparicles (P–0.5Ag)

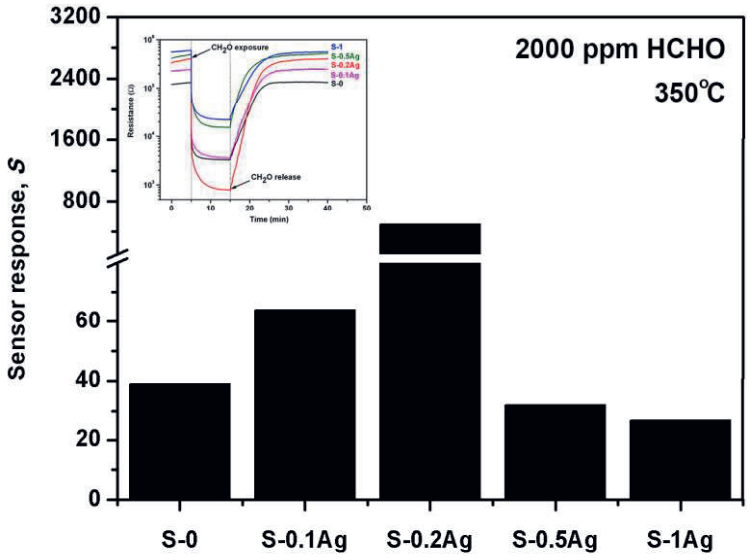

Fig. 2. The histograms of typical sensor response towards 2000 ppm formaldehyde with corresponding change in resistance (inset) of the 0–1 wt% AgO_x-doped SnO_2 (S–0 to S–1Ag) at optimal operating temperatures of 350˚C in dry air.

References

[1] X. Xu et al, Highly sensitive VOCs-acetone sensor based on Ag-decorated SnO_2 hollow nanofiber, *Journal of Alloys and Compounds* 703, 572-579 (2017); doi: 10.1016/j.jallcom.2017.01.348.

[2] P.R. Chung et al, Formaldehyde Gas Sensors: A Review, *Sensors* 13, 4468-4484 (2013); doi: 10.3390/s13040446.