Robust SnO_2 Nanofilm Gas Sensor with Sb Dopant and Metal Nanoparticle Catalysts under Environmental Variation

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Keywords: Gas Sensor; Metal Oxide Semiconductor; Robustness; Metal Catalyst; Doping

Environmental fluctuations, particularly in ambient humidity, can impact the metal oxide gas sensors' responses. In this study, we propose a strategic approach to mitigate the effects of environmental variability on the responses of metal oxide semiconductor gas sensors through the utilization of a heavily doped metal oxide nanofilm channel (2 wt% antimony-doped tin oxide: ATO) and metal catalyst nanoparticles.

Although the sensor response of ATO channels to ethylene decreased significantly compared to that of non-doped SnO_2 channels, the change in sensor response under humidity variation was much less than that of SnO_2 (Fig. 1). XPS analysis indicate that the amount of oxygen on the ATO surface is smaller than that on non-doped SnO_2, indicating reduced redox reactions between gas molecules and surface oxygen (Fig. 2). In addition, the Sb doping could have a masking effect on the changes in sensor electrical resistance due to undesired redox reactions because the number of Sb-induced carriers is much larger than defect-induced carriers (e.g., oxygen vacancies) which are affected by redox reactions.[1] Therefore, ATO is considered to be a robust sensor channel with low activity in redox reactions. Furthermore, Pt nanoparticle modification of ATO surface significantly improves the sensor response with reduced variation of sensor response under humidity fluctuations. This may be due to the electrical and catalytic effects of the Pt particles on ATO surface.[2] As a result, the LOD values were lowest for the sensor with Pt particles modified on ATO.

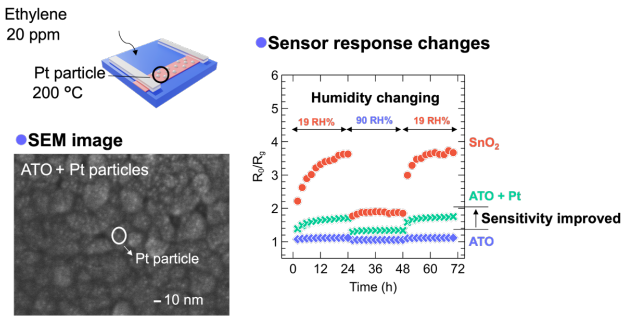

Fig. 1 SEM image and ATO with Pt nanoparticles sensor response during humidity variation.

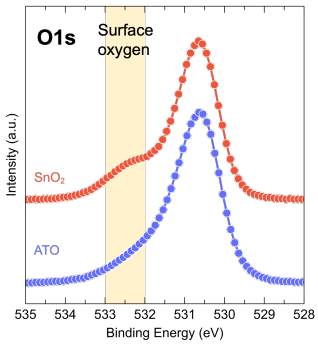

Fig. 2 O1s XPS spectra of SnO_2 and ATO

1) *Sensors and Actuators: B. Chemical.* **2022**, 371, 132603.
2) C. Jiang, *Angew. Chem. Int. Ed.* **2013**, 52, 6265.