DOI 10.5162/IMCS2018/GS3.3

The Role of Ce Doping in Enhancing Sensing Performance of ZnO-based Gas Sensor by Adjusting the Proportion of Oxygen Species

Yiqun Zhang, Yueying Liu, Linsheng Zhou, Deye Liu, Fengmin Liu, Fangmeng Liu, Xishuang Liang, Xu Yan, Yuan Gao, Geyu Lu**

State Key Laboratory of Integrated Optoelectronics, Key Laboratory of gas sensors, Jilin Province and College of Electronic Science and Engineering, Jilin University, 2699 Qianjin Street, Changchun 1300 12, People's Republic of China

(Corresponding authors:
Fengmin Liu, Tel.: +86 431 85168384; fax: +86 431 85167808;
Email: liufm@jlu.edu.cn.
Geyu Lu, Tel.: +86 431 85167808; fax: +86 431 85167808;
Email: lugy@jlu.edu.cn)

Abstract:

Flower-liked ZnO architectures and Ce doped ZnO materials with different amounts (0.2, 0.5, 1.2 and 2 at% Ce) were successfully synthesized by a simple room-temperature precipitation route. As the gas sensing materials, their sensing performance were investigated systematically. The results indicate that Ce doping can improve the performance of ZnO sensor. The ZnO doped with 0.5 at% Ce exhibited the highest response to ethanol at the operating temperature of 300℃, and the response value was about 72.6 to 100 ppm ethanol. With Ce doping, the proportions of oxygen vacancy and chemisorbed oxygen species were increased obviously, which could greatly promote the gas sensing properties of surface resistance-type metal oxide semiconductors. Thus, the doping of flower-liked ZnO with Ce should be a promising approach for designing and fabricating the high performance gas sensor.

Key words: Ce, ZnO, oxygen species, gas sensor, ethanol

Gas sensing performances

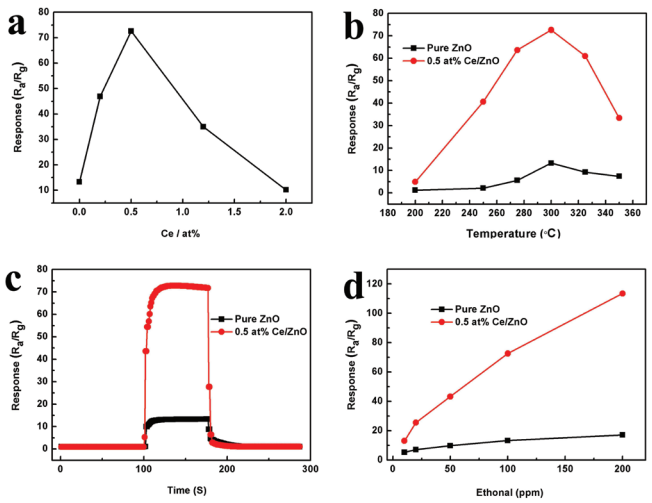

Fig. 1. Response of the sensors based on pure ZnO and Ce doped ZnO materials with different Ce doping amounts (a), responses at different operating temperatures (b) and dynamic response curves to 100 ppm ethanol (c) as well as responses to different concentrations of ethanol (d) of the sensors based on pure ZnO and 0.5 at% Ce/ZnO composites.

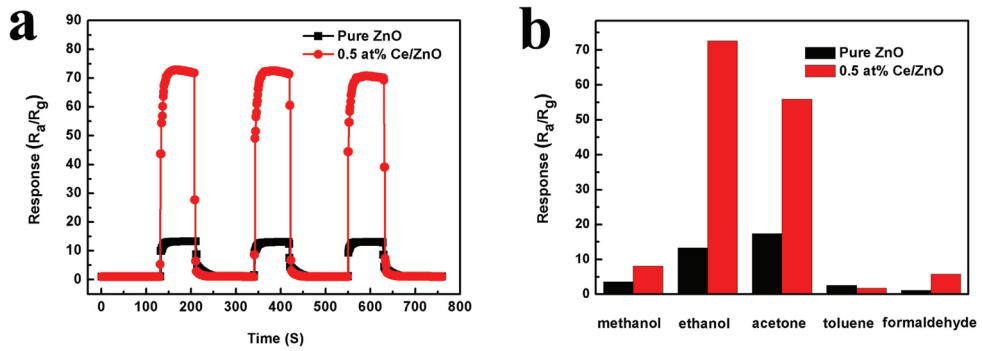

Fig. 2. Three reversible cycles of the sensors based on pure ZnO and 0.5 at% Ce/ZnO composites for successive detection of 100 ppm ethanol (a), and responses of the sensors to 100 ppm of various gases (b).

References

[1] L. Zhu, Y.Q. Li, W. Zeng, Enhanced Ethanol Sensing and Mechanism of Cr-doped ZnO Nanorods: Experimental and Computational Study, *Ceramics International* 43, 14873-14879 (2017); doi: 10.1016/j.ceramint.2017.08.003

[2] L. Zhu, Y.Q. Li, W. Zeng, Hydrothermal Synthesis of Hierarchical Flower-like ZnO Nanostructure and its Enhanced Ethanol Gas-sensing Properties, *Applied Surface Science* 427, 281-287 (2018); doi: 10.1016/j.apsusc.2017.08.229

[3] J.J. Guo, C.Peng, Synthesis of ZnO Nanoparticles with a Novel Combustion Method and their C_2H_5OH Gas Sensing Properties, *Ceramics International* 41, 2180-2186 (2015); doi: 10.1016/j.ceramint.2014.10.017

[4] J. Guo, J. Zhang, M. Zhu, D.X. Ju, H.Y. Xu, B.Q. Cao, High-performance Gas Sensor Based on ZnO Nanowires Functionalized by Au Nanoparticles, *Sensors and Actuators B* 199, 339-345 (2014); doi: 10.1016/j.snb.2014.04.010

[5] Y. Li, G.Z. Li, Y.L. Zou, Q. Wang, Q.J. Zhou, X.X. Lian, Preparation and Sensing Performance of Petal-like RuO_2 Modified ZnO Nanosheets via a Facile Solvothermal and Calcination Method, *Trans, Nonferrous Met. Soc. China* 24, 2896-2903 (2014); doi: 10.1016/S1003-6326(14)63424-5

[6] T. Tharsika, A. S. M. A. Haseeb, Sheikh A. Akbar, Mohd Faizul Mohd Sabri and Wong Yew Hoong, Enhanced Ethanol Gas Sensing Properties of SnO_2-Core/ ZnO-Shell Nanostructures, *Sensors* 14, 14586-14600 (2014); doi: 10.3390/s140814586