

Sub-ppm CO Gas Sensor

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Abstract

Nanostructures of SnO₂ including nanoparticles,¹ nanowires,² nanobelts,³ and nanotubes⁴ have been widely used in many fields, such as gas sensors, solar cells and lithium batteries. Recently, hierarchical and/or hollow SnO₂ micro- and nanostructures have attracted much interest because of their widespread potential applications such as gas sensors.⁵ We present here the formation of self-assembled tin oxohydroxide (Sn₃O₂(OH)₂) supercrystals organized in a “Russian-doll” structures and obtained by an organometallic synthesis, with finely tuned water addition. These supercrystals have been characterized by transmission and high resolution transmission electron microscopy, field-emission scanning electron microscopy, X-ray powder diffraction, and Fourier transform infra-red spectroscopy. These super-octahedra have been used as gas sensitive layers deposited on silicon devices. After *in-situ* heating, Sn₃O₂(OH)₂ easily oxidizes into SnO₂ while retaining the initial morphology and porosity (fig.1). The response of the sensors to reducing and oxidizing gases has been measured at relative humidity (RH) of 50%. At 500°C and under very low CO concentrations (0.25 to 20 ppm), the sensors present an outstanding dynamic response (7% and 67% of resistance variation) (Fig. 2). These unprecedented detection performances are strongly related to the hierarchical microstructure of SnO₂ supercrystals. These sensitive layers open the way to the development of metal oxide devices dedicated to extremely low gas concentration determination.

References

- ¹ C. Nayral, E. Viala, P. Fau, F. Senocq, J.-C. Jumas, A. Maisonnat, B. Chaudret, *Chemistry, Eur. J.* **2000**, 6, 4082.
- ² M.-S. Park, G.-X. Wang, Y.-M. Kang, D. Wexler, S.-X. Dou, H.-K. Liu, *Angew. Chem.* **2007**, 46, 750.
- ³ E. R. Viana, J. C. Gonzalez, G. M. Ribeiro, A. G. de Oliveira, *J. Phys. Chem. C* **2013**, 117 (15), 7844.
- ⁴ L. Shi, H. Lin, *Langmuir* **2011**, 27, 3977 ; J. Ye, H. Zhang, R. Yang, X. Li, L. Qi, *small* **2010**, 6, 296.
- ⁵ H. Wang, A. L. Rogach, *Chem. Mater.*, **2014**, 26, 123