



HAL
open science

Self-Assembled Hollow SnO₂ Octahedra for sub-ppm Gas Detection Sensors

Justyna Jońca, Andrey Ryzhikov, Myrtil L. Kahn, Katia Fajerweg, Audrey
Chapelle, Philippe Menini, Pierre Fau

► **To cite this version:**

Justyna Jońca, Andrey Ryzhikov, Myrtil L. Kahn, Katia Fajerweg, Audrey Chapelle, et al.. Self-Assembled Hollow SnO₂ Octahedra for sub-ppm Gas Detection Sensors. Trends in Nanotechnology International Conference (TNT2015), Sep 2015, Toulouse, France. hal-02048850

HAL Id: hal-02048850

<https://hal.science/hal-02048850v1>

Submitted on 25 Feb 2019

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Self-Assembled Hollow SnO₂ Octahedra for sub-ppm Gas Detection Sensors

Justyna Jońca¹, Andrey Ryzhikov¹, Myrtil L. Kahn¹, Katia Fajerberg^{1,2}, Audrey Chapelle³, Philippe Menini³, Pierre Fau^{1,2}

1 Laboratoire de Chimie de Coordination (LCC), CNRS, 205 route de Narbonne, 31077 Toulouse Cedex 4, France

2 Université Paul Sabatier, UT III, 118 route de Narbonne, 31062 Toulouse Cedex 9, France

3 Laboratoire d'Analyse et d'Architecture des Systèmes (LAAS), CNRS, 5 avenue du Colonel Roche, 31400 Toulouse, France

e-mail: pierre.fau@lcc-toulouse.fr, myrtil.kahn@lcc-toulouse.fr

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). A response of 196% is obtained under 1 ppm NO₂ at an operating temperature of 300°C. 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.

Figures

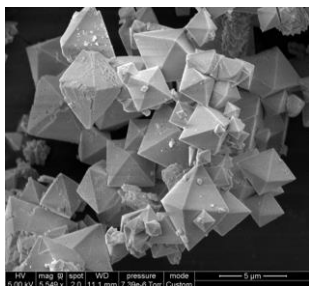


Fig. 1: hollow SnO₂ self-assembled octahedra

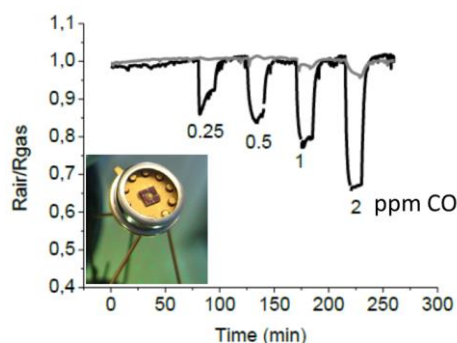


Fig. 2: sub-ppm detection capability for SnO₂ octahedra sensitive layer

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