Self-Assembled Hollow SnO_2 Octahedra for sub-ppm Gas Detection Sensors

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Abstract

Nanostructures of SnO_2 including nanoparticles,[1] nanowires,[2] nanobelts,[3] and nanotubes [4]have been widely used in many fields, such as gas sensors, solar cells and lithium batteries. Recently, hierarchical and/or hollow SnO_2 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 ($Sn_3O_2(OH)_2$) 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, $Sn_3O_2(OH)_2$ easily oxidizes into SnO_2 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 NO_2 at an operating temperature of 300°C. These unprecedented detection performances are strongly relied to the hierarchical microstructure of SnO_2 supercrystals. These sensitive layers open the way to the development of metal oxide devices dedicated to extremely low gas concentration determination.

Figures

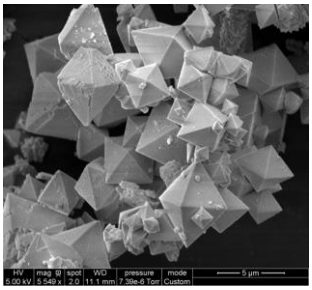

Fig: 1: hollow SnO_2 self-assembled octahedra

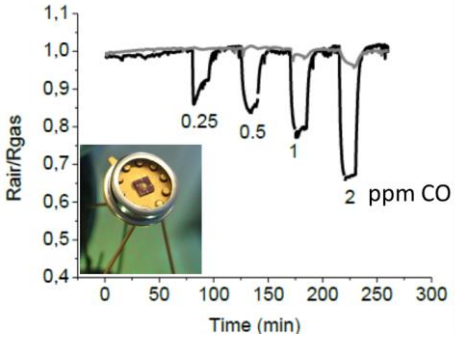

Fig. 2: sub-ppm detection capability for SnO_2 octahedra sensitive layer

References

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