

# High Performance Acetone Detector Based on 3D Inverse Opal Structure Hybrid Microspheres

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## Abstract:

Over the past few years, the semiconducting metal oxides (SMOs)-based chemical sensors are currently the subject of scientific and medical research, because of its low cost, real-time, miniaturization and integration. Thus, in order to improve sensor response toward a particular target gas, the rational design of sensing materials with highly ordered and interconnected porous structure is a viable solution, which could provide larger specific surface area, richer surface active sites and rapid mass transfer. Furthermore, the fabrication of hybrid materials composed of different SMOs could lead to further enhancement of gas sensing properties, due to the formation of heterojunction structure. Herein, we presented a novel approach for the fabrication of 3D inverse opal (IO)  $\text{SnO}_2$ -ZnO microspheres. This synthetic route by combining ultrasonic spray pyrolysis (USP) method with self-assembly sulfonated polystyrene (S-PS) spheres, which can be developed to enable porous hybrid sensing materials growth with adjustable pore size. Due to the novel inverse opal microsphere structure and abundant heterointerface, the gas sensor based on 3D IO  $\text{SnO}_2$ -ZnO microspheres exhibited high acetone response ( $R_{\text{air}}/R_{\text{gas}} = 25.6$  at  $275^\circ\text{C}$  @ 25 ppm), better acetone selectivity against other interfering gases, rapid response process (within 1s) and alluring long-term stability (20 days). Therefore, the detector described herein is in principle suitable for diabetes diagnosis.

**Key words:** 3D IO microspheres, hybrid materials, ultrasonic spray pyrolysis, sulfonated polystyrene spheres, gas sensor

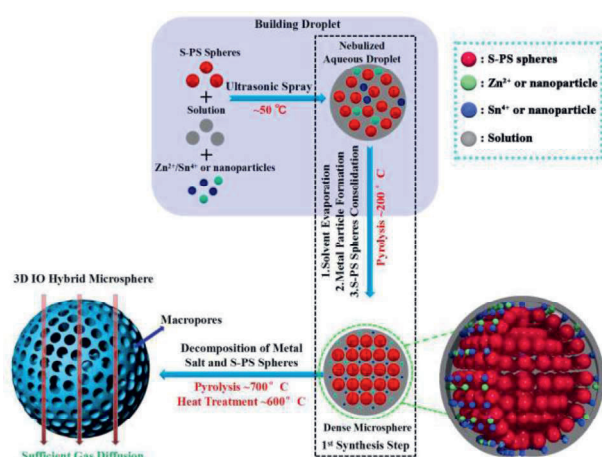


Fig. 1. Illustration of the process flow to fabricate 3D IO  $\text{SnO}_2$ -ZnO microspheres.

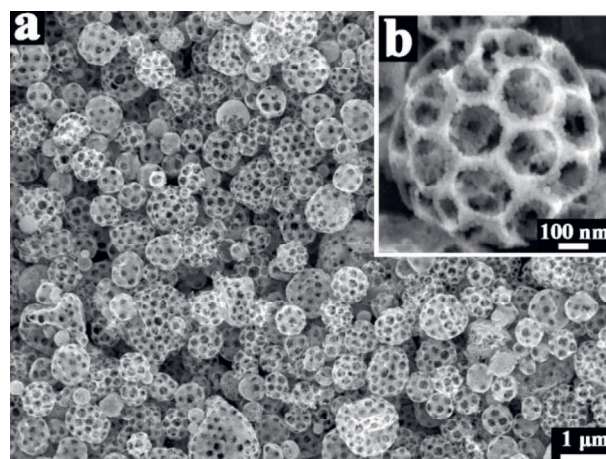
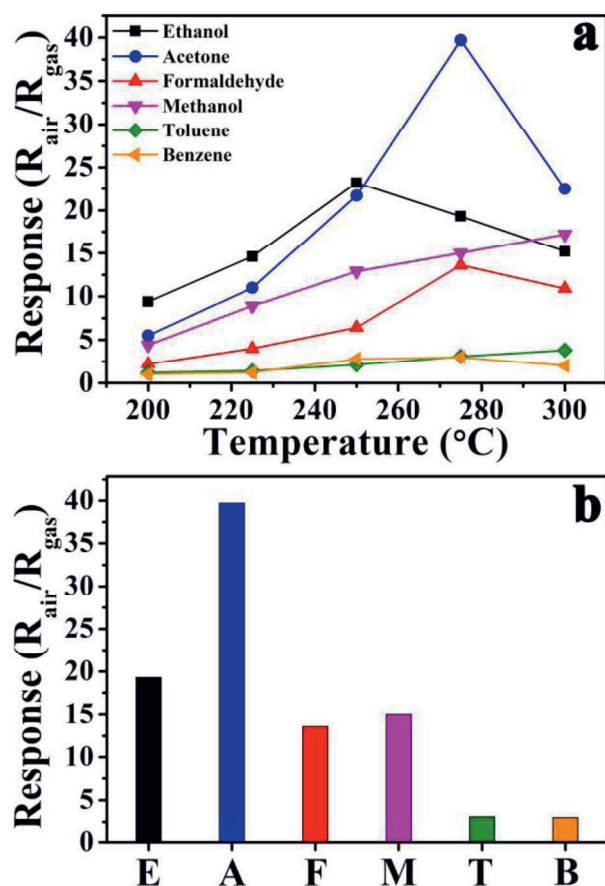


Fig. 2. (a, b) Typical SEM images of the as-prepared product 3D IO  $\text{SnO}_2$ -ZnO microspheres.



Actuat. B-Chem. 211, 255-262 (2015); doi. org/10.1016/j. snb. 2015. 01. 086

Fig. 3. (a) Gas response of the 3D IO SnO<sub>2</sub>-ZnO microspheres-based sensor to 100 ppm ethanol, acetone, formaldehyde, methanol, toluene and benzene at 200-300 °C; (b) Gas response to 5 ppm analyte gases for 3D IO SnO<sub>2</sub>-ZnO microspheres at 275 °C (E, ethanol; A, acetone; F, formaldehyde; M, methanol; T, toluene; and B, benzene).

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