Electronic Supplementary Material (ESI) for Physical Chemistry Chemical Physics

Supporting Information

Ionothermal Synthesis of Mesoporous SnO_2 Nanomaterials and Their Gas Sensitivity Depending on Reducing Ability of Toxic Gases

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Detailed Experiments

Synthesis:

Synthesis of mesoporous SnO_2 nanomaterials

All the chemicals were of analytic grade and used without further purification. In a typical synthesis, 0.54 g of $Na_2SnO_3 \cdot 3H_2O$ and 20 g of NH_4Cl were mixed together, and then transferred into a 33 mL Teflon-lined stainless-steel autoclave at 180 ^{o}C for 10 h. After the reaction was conducted, the white solid was obtained by centrifugation, washed with absolute alcohol and distilled water for several times, respectively.

Characterization

The morphology and structural characteristics were observed using X-ray diffraction (XRD, Rigaku D/max 2500 diffractometer), high-resolution transmission electron microscopy (HRTEM, JEOL 2010) and nitrogen adsorption–desorption isotherms (ASAP 2020 nitrogen adsorption apparatus). The Brunauer–Emmett–Teller (BET) specific surface areas (S_{BET}) were calculated using the BET equation. Desorption isotherm was used to determine the pore size distribution using the Barret–Joyner–Halender (BJH) method.

Fabrication and analysis of gas sensor

The gas sensor was fabricated according to the literatures.[5, 18] Typically, a proper amount of SnO_2 nanocrystals was grinded with several drops of water in an agate mortar to form a slurry. Then, the slurry was coated onto an alumina tube with a diameter of 1mm and length of 4mm, positioned with two Au electrodes and four Pt wires on each end of the tube. A Ni-Cr alloy filament was put through the tube and used as a heater by tuning the heating voltage. Gas sensing tests were performed on a static test system (HW-30A, HanWei Electronics Co., Ltd., Henan Province, China) using air as the reference and diluting gas at a relative humidity (RH) of 38%. The sensor was placed in a transparent testing chamber with a volume of 15 L and aged for several days before analysis. Target gas such as ethanol was injected into the testing chamber by a micro-syringe. The sensor signal voltage (V_{out}) was collected by a computer at a constant test voltage of 5V. The sensor response is defined as the ratio S = Ra/Rg, where Rg and Ra are the electrical resistance of the sensor in test gas and in air, respectively. The response and recovery time is defined as the time for sensor to reach 90% of its maximum response and falls to 10% of its maximum response, respectively.

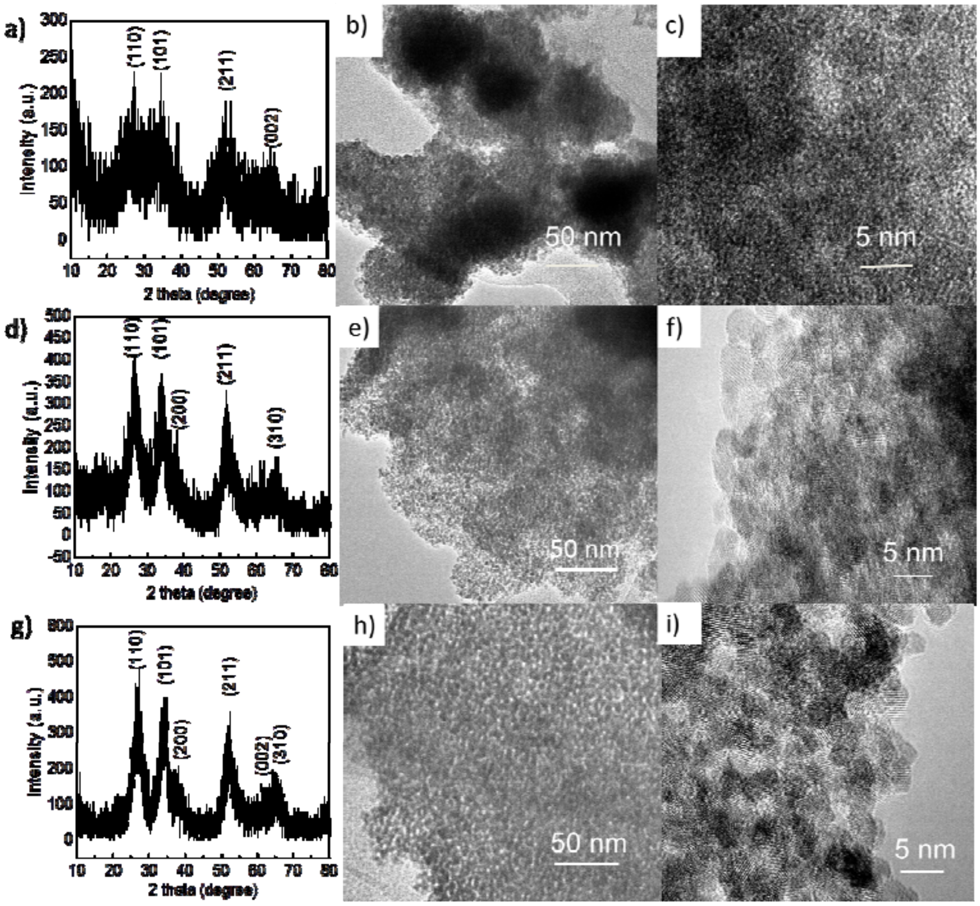

Fig. S1 The mesoporous SnO_2 nanomaterials prepared through terminating the reaction. After 1 hour (a - c): (a) XRD pattern of the mesoporous SnO_2. (b) TEM image and (c) HR-TEM image of the mesoporous SnO_2. After 3 hour (d - f): (d) XRD pattern of the mesoporous SnO_2. (e) TEM image and (f) HR-TEM image of the mesoporous SnO_2. After 5 hour (g - i): (g) XRD pattern of the mesoporous SnO_2. (h) TEM image and (i) HR-TEM image of the mesoporous SnO_2.

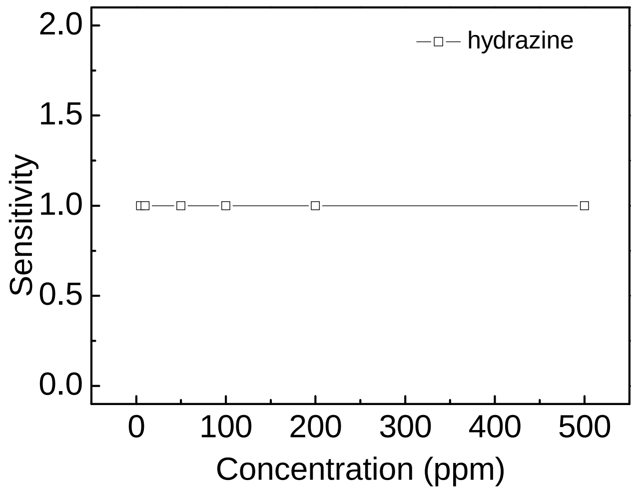

Fig. S2 Sensitivity versus different N_2H_4 concentration of of the commercial SnO_2

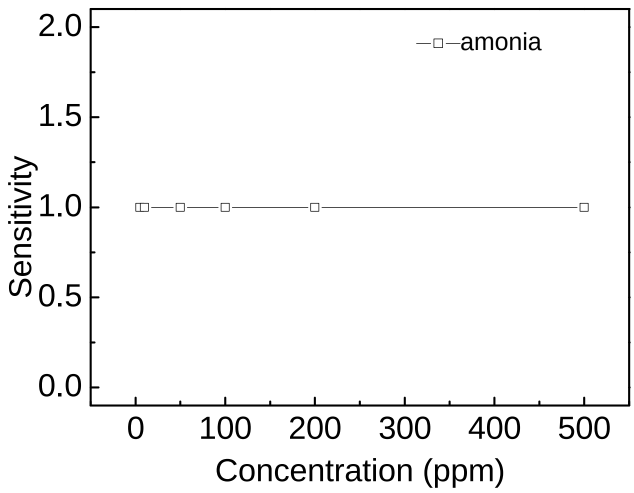

Fig. S3 Sensitivity versus different NH_3 concentration of of the commercial SnO_2

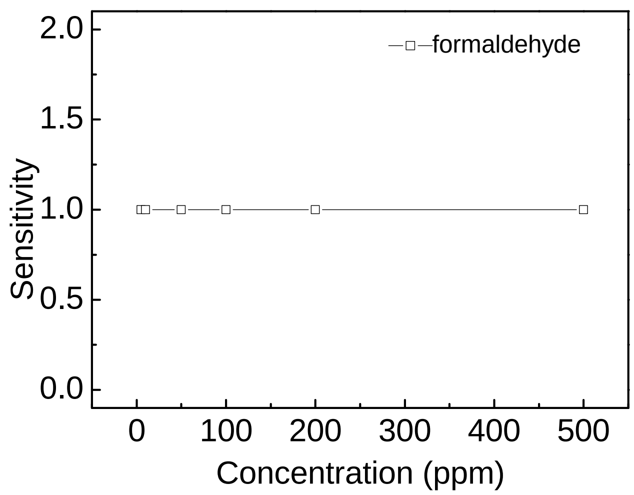

Fig. S4 Sensitivity versus different HCHO concentration of of the commercial SnO_2

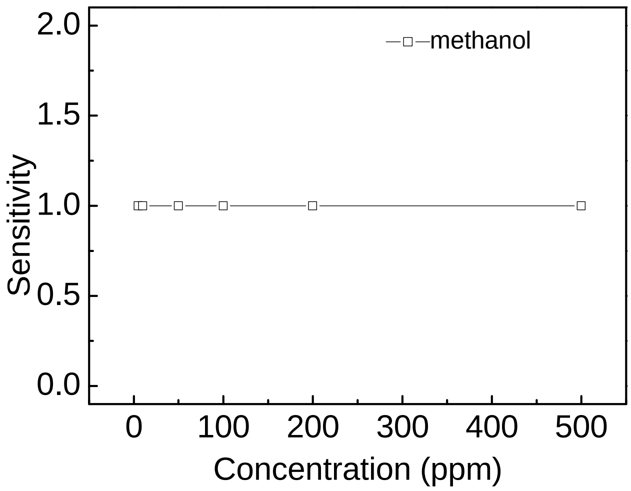

Fig. S5 Sensitivity versus different CH_3OH concentration of of the commercial SnO_2