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PPB-Level H_2 Gas-Sensor Based on Porous Ni-MOF Derived NiO@CuO Nanoflowers for Superior Sensing Performance

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Abstract : Nickel oxide (NiO) is an optimal material for precise detection of hydrogen (H_2) gas due to its high catalytic activity and low resistivity. However, the gas response kinetics of H_2 gas molecules with the surface of NiO concurrence limitation imposed by its solid structure, leading to a diminished gas response value and slow electron-hole transport. Herein, NiO@CuO NFs with porous sharp-tip and nanospheres morphology were successfully synthesized by using a metal-organic framework (MOFs) as a precursor. The fabricated porous 2 wt% NiO@CuO NFs present outstanding selectivity towards H_2 gas, including a high sensitivity of a response value (170 to 20 ppm at 150 °C) higher than that of porous Ni-MOF (6), low detection limit (300 ppb) with a notable response (21), short response and recovery times at (300 ppb, 40/63 s and 20 ppm, 100/167 s), exceptional long-term stability and repeatability. Furthermore, an understanding of NiO@CuO sensor functioning in an actual environment has been obtained by using the impact of relative humidity as well. The boosted hydrogen sensing properties may be attributed due to synergistic effects of numerous facts including p-p heterojunction at the interface between NiO and CuO nanoflowers. Particularly, a porous Ni-MOF structure combined with the chemical sensitization effect of NiO with the rough surface of CuO nanosphere, are examined. This research presents an effective method for development of Ni-MOF derived metal oxide semiconductor (MOS) heterostructures with rigorous morphology and composition, suitable for gas sensing application.

Keywords : NiO@CuO NFs, metal organic framework, porous structure, H_2, gas sensing
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