Ultrasensitive Detection of 3-Hydroxy-2-Butanone Biomarker at Low Temperature by Trace Au Atom Enhancement in Mesoporous SnO_2 Spheres

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The development of semiconductor metal oxide gas sensors with high sensitivity and selectivity under low-temperature operating conditions remains a significant challenge. Herein, mesoporous SnO_2 spheres loaded with trace Au atoms are designed for low-temperature detection of 3-hydroxy-2-butanone, a biomarker of *Listeria monocytogenes* frequently found in food. The designed sensing materials have large pore size (~5.8 nm), high specific surface area (56.9-63.5 m^2/g), and ultra-low Au contents (0.6 wt%). The fabricated gas sensors exhibit ultra-high response (587.3) toward 2 ppm 3-hydroxy-2-butanone at 50 ºC, which is 183.5 times greater than the sensor based on mesoporous SnO_2. The temperature range has been effectively reduced from 100 to 50 °C, while simultaneously achieving an impressive detection limit of only 10 ppb. The sensitivity is as high as 291.5 ppm^{-1}. The gas sensors could be further utilized for discriminating Listeria from other bacterial strains, including *E. coli*, *Salmonella*, *Thermophilus*, and *S. aureus*. The superior sensing performance can be owing to the mesoporous framework with low gas diffusion resistance, and the highly accessible Au-O-Sn sites with strong interactions toward target gas. This work provides a reliable and facile method for synthesis of noble metal single atoms-decorated mesoporous metal oxide spheres, which can be used in various fields, such as chemical sensing, energy and environmental catalysis. The unique modification of noble metal single atoms on the mesoporous semiconductor metal oxides is an efficient strategy for fabrication of high-performance gas sensors operated at low temperature, which is expected to boost the development of high-performance sensors with low energy

consumption for applications in environmental monitoring, food safety, smart home, and intelligent agriculture.