Fabrication of Gas-Sensor:

The procedure for the fabrication of a typical SnO$_2$-based gas sensor is shown in Scheme 1. The as-prepared SnO$_2$ powder was mixed with little deionized water to form a paste. The paste was directly coated on the ceramic tube with a pair of Pt wires covered on Au electrodes, then dried in air. After that, the electrodes were jointed on a basement and a Ni-Cr heating wire was inserted into the ceramic tube. Finally, the as-prepared gas sensors were kept at 300 °C for 10h in order to improve their stability. The working temperature can be controlled by adjusting the heating voltage ($V_h$) of the sensor. The gas-sensor performance was obtained from the $V_{out}$ value of $R_L$ that cascades $R_s$ (the resistance of gas-sensor). Concretely, the $R_s$ can be calculated by the following equation: $R_s = R_L \frac{(V_c - V_{out})}{V_{out}}$. In our experiment, the $V_c = 5$ V and $R_L = 1$ MΩ. The sensor response was defined as $S = R_a / R_g$, where $R_a$ is the resistance in air and $R_g$ is that in the air mixed with detected gases. In addition, the response time was defined as the time required for the conductance to reach 90% of the equilibrium value after a test gas was injected, and the recovery time was the time necessary for a sensor to attain a conductance 10% above its original value in air.

Scheme 1. Schematic illustration of fabrication of the gas sensor using SnO$_2$ particles as sensing material.