Supporting Information

Formaldehyde Gas Sensor with Extremely High Response Employing Cobalt-Doped SnO_2 Ultrafine Nanoparticles

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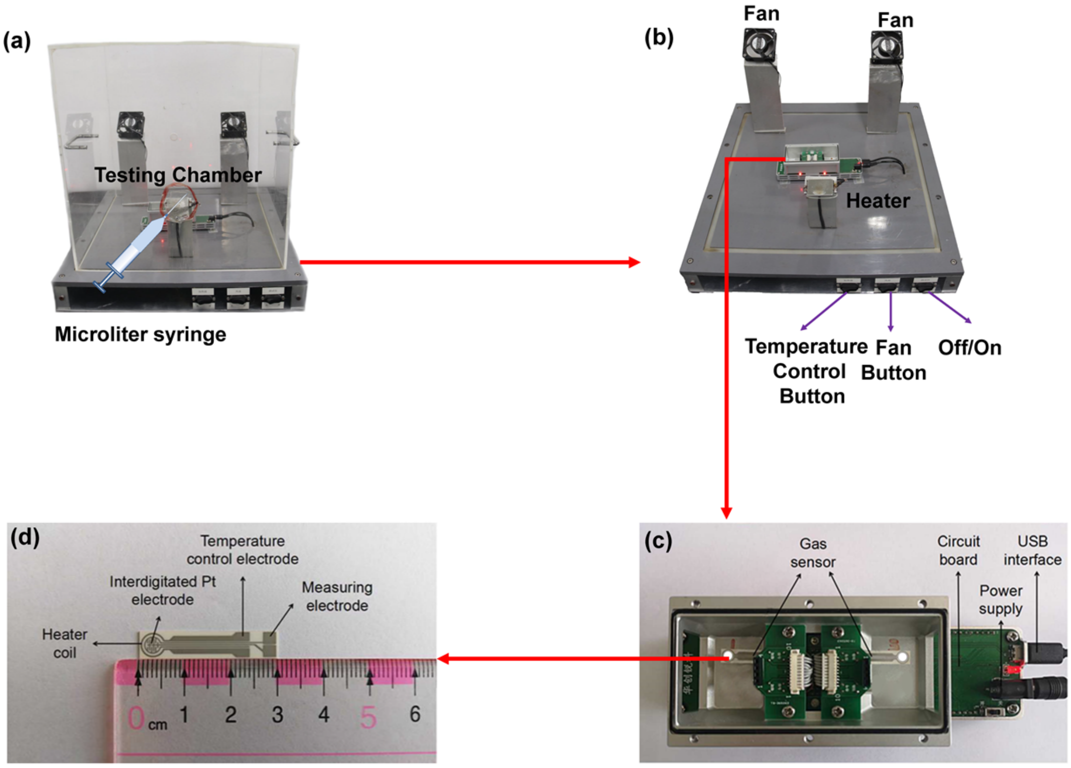

Figure S1 The actual picture of the test device and gas sensor.

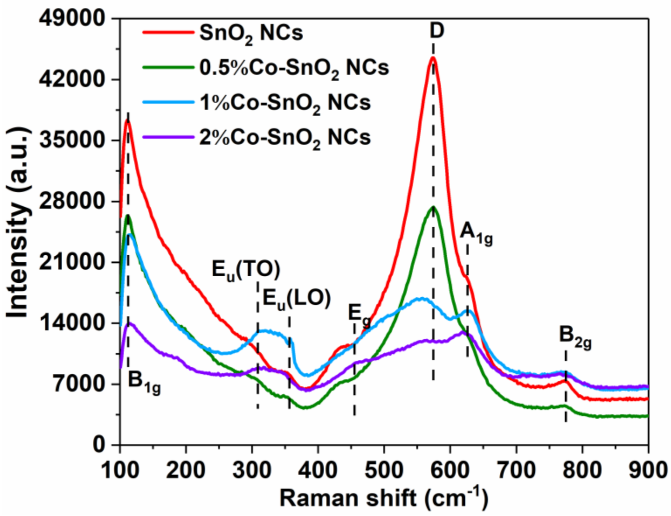

Figure S2 The Raman spectra of SnO_2 NPs, 0.5%Co-SnO_2 NPs, 1%Co-SnO_2 NPs, 2%Co-SnO_2 NPs.

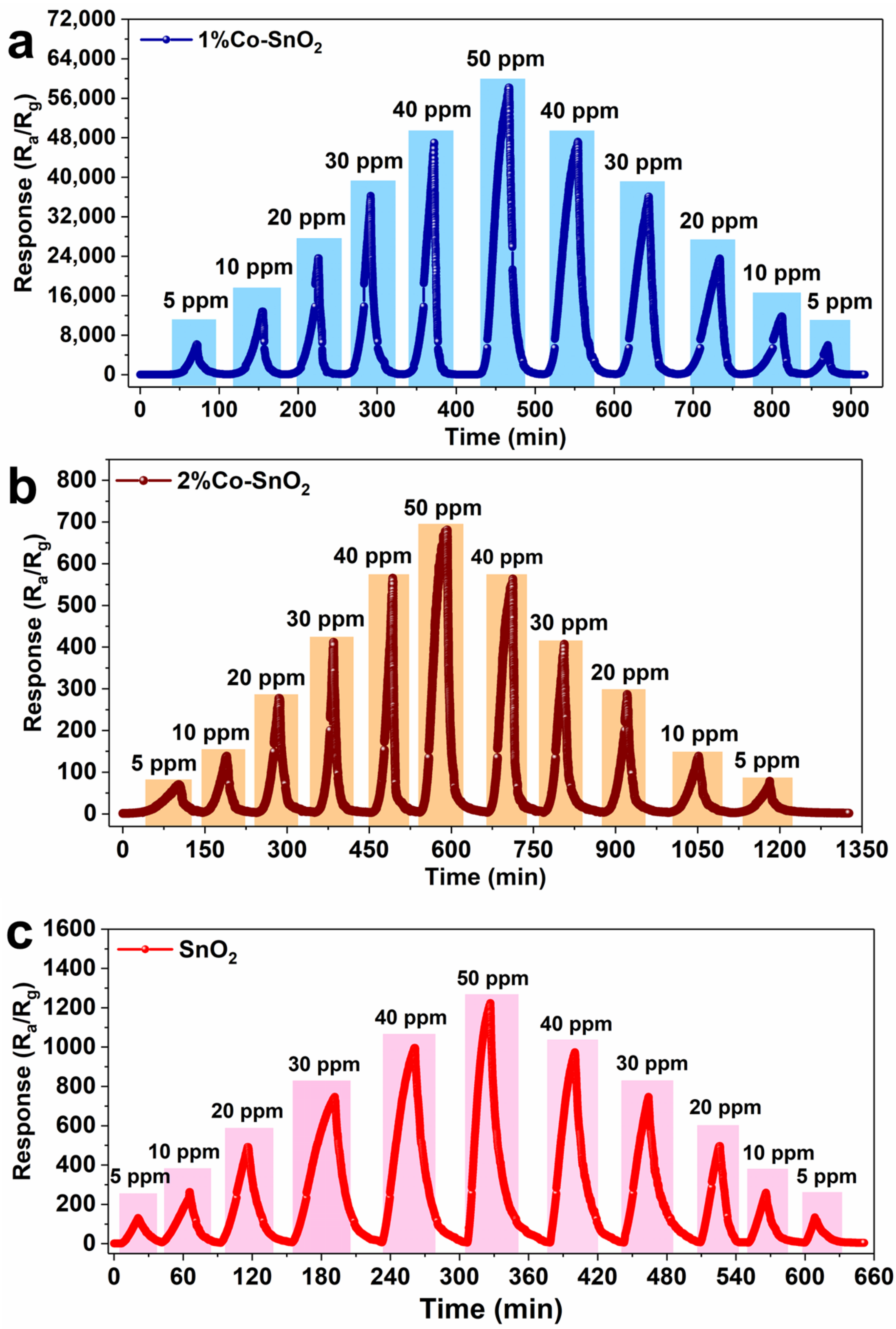

Figure S3 The response transient curves of the (a) 1%Co-SnO_2 NPs, (b) 2%Co-SnO_2 NPs, (c) SnO_2 NPs at 90°C and different formaldehyde concentration.

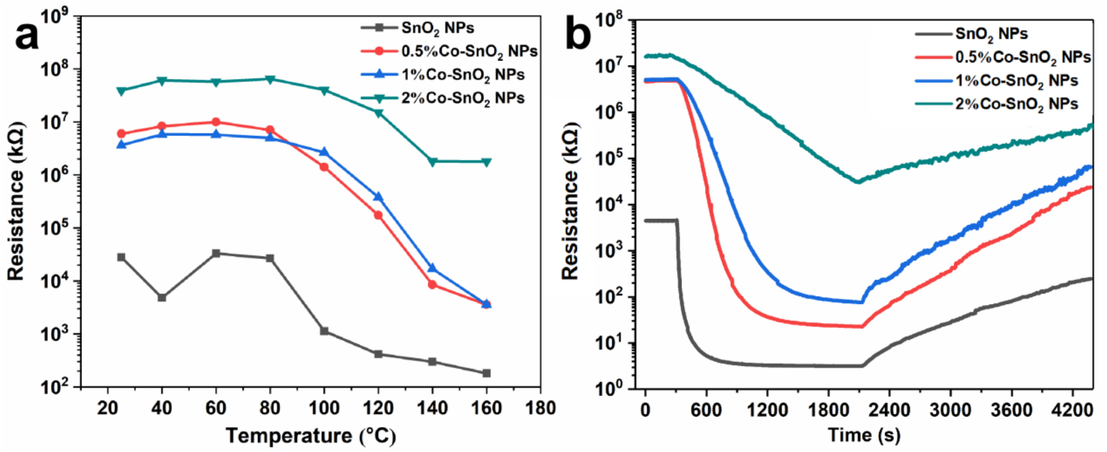

Figure S4 (a) The change curves of resistance R_a of samples in air with temperature, (b) the resistance change curves of the samples with 30 ppm formaldehyde at 90°C.

Limit of detection (LOD) calculation

The sensor noise (RMS_{noise}) is usually calculated from the standard deviation of the sensor baseline. From figure 6 (b), 270 points were collected before the sensor was placed on the target gas, and the calculated standard deviation (S) was 0.0128.

$$RMS_{noise} = \sqrt{\frac{S^2}{N}} \quad \text{(S1)}$$

where N is the number of data points. The value of RMS_{noise} is 0.00078. The ratio of signal (S) to noise (N)(S/N) is 3 (International Union of Pure and Applied Chemistry (IUPAC) definition) and the slope is 4259.0 (From figure 9 (b)), therefore:

$$LOD = 3\frac{RMS_{noise}}{Slope} = 3 \times \frac{0.00078}{4259} = 0.00000055\, ppb \quad \text{(S2)}$$

in this work, the theoretical detection limit of formaldehyde was estimated to be about $5.5 * 10^{-7}$ ppb.

Calcualtion of the Debye lengths of SnO_2

$$\lambda_D = \sqrt{\frac{\varepsilon k_B T}{q^2 N_0}} \quad \text{(S3)}$$

$\varepsilon_{SnO_2} = 13.5 \times 8.85 \times 10^{-12}$ Fm^{-1}

$k_B = 1.38 \times 10^{-23}$ JK^{-1}

$T = 363$ K

$q = 1.6 \times 10^{-19}$ C

$N_{SnO_2} = 3.6 \times 10^{18}$ cm^{-3}

$\lambda_{SnO_2} = 2.55$ nm