## **Supporting Information**

## Facile Fabrication of Cobalt-doped SnO2 for Gaseous Ethanol Detection and the Catalytic Mechanism of Cobalt

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**Figure S1.** Resistance dynamic curves of Co-SnO<sub>2</sub> samples to 100 ppm ethanol at 350 °C. Figure S1 is the resistance dynamic curve of Co-SnO<sub>2</sub> to 100 ppm ethanol at 350 °C. It is clearly that the resistance of D2-Co-SnO<sub>2</sub> and D3-Co-SnO<sub>2</sub> is higher than other samples. Once these sensors exposed to ethanol, the resistance rapidly decreased and stay a stable state.



Figure S2. Selectivity of Co-SnO<sub>2</sub> to various gases (100 ppm) at 350 °C.

Figure S2 shows the selectivity of Co-SnO<sub>2</sub> samples to 100 ppm various gases at 350 °C. It is clearly that D3-Co-SnO<sub>2</sub> shows the highest response value while D1-Co-SnO<sub>2</sub> shows higher response to 100 ppm acetone and methanol gases at 350 °C.



Figure S3. XRD pattern of different Co-SnO<sub>2</sub> samples.

Figure S3 shows the XRD patterns of Co-SnO<sub>2</sub> samples. The diffraction peaks of these samples match those corresponding to the tetragonal rutile structure of SnO<sub>2</sub> (JCPDS card no. 41-1445) well. There are no evident peaks assignable to cobalt oxide, which is probably due to the low amount and homogeneous distribution of the Co ions. The relative intensities and widths of the peaks differ with the Co/Sn feed molar ratio, suggesting the difference of crystallinity and grain size.



Figure S4. Sn 3d XPS spectra of D1-Co-SnO<sub>2</sub> and D3-Co-SnO<sub>2</sub>.

In Figure S4, the peaks of D1-Co-SnO<sub>2</sub> and D3-Co-SnO<sub>2</sub> at 487.0-487.1 eV and 495.4-495.5 eV are assigned to Sn  $3d_{5/2}$  and Sn  $3d_{3/2}$ , respectively. The energy splitting between the spin-orbit doublets is 8.4 eV, which indicates the existence of Sn<sup>4+</sup> in SnO<sub>2</sub>.<sup>1</sup> Notably, compared with the peaks of D1-Co-SnO<sub>2</sub>, those of D1-Co-SnO<sub>2</sub> shift to lower energies (~0.2 eV), which may be due to the interaction between Sn and Co.



**Figure S5.** Arrhenius plot of  $ln(R_g)$  (rate of resistance change) against inverse temperature after exposure to 100 ppm ethanol.

To study the effect of Co doping more intuitively and determine the effective operating temperature, we estimated the activation energies ( $E_a$ ) of ethanol gas adsorption on the surfaces of D1-Co-SnO<sub>2</sub> and D3-Co-SnO<sub>2</sub>.  $E_a$  is usually considered as the energy required to overcome the barrier (qV) that is established at the interface between oxides in a reaction and can be estimated from the following equation:<sup>2, 3</sup>

$$R_{g} = R_{0}e^{\frac{qV}{k_{B}T}} = R_{0}e^{-\frac{E_{a}}{k_{B}T}},$$
(11)

Here, qV is the barrier at the interface, T is the thermodynamic temperature,  $R_g$  and  $R_0$  are the resistances of the sensor in target gas and air, respectively.  $E_a$  can be estimated by calculating the slope of the plot of  $\ln(R_g)$  against 1/T:

$$\ln R_g = \left(-\frac{E_a}{k_B}\right)\frac{1}{T} + \ln R_0, \qquad (12)$$

Figure S5 shows the linear relationship between  $\ln(R_g)$  and 1000/T within the temperature range of 350-450 °C. Although the slope for D3-Co-SnO<sub>2</sub> is a little larger than that for D1-Co-SnO<sub>2</sub>, they are still almost the same and it means that  $E_a$  of ethanol adsorption and reaction on the surface of D3-Co-SnO<sub>2</sub> is almost the same as that of D1-Co-SnO<sub>2</sub>. Besides, because the catalytic reaction such as ethanol steam reforming is endothermic reaction which means complex reaction on the material, the estimated  $E_a$  is just a reference parameter. There are still other factors for gas sensing performance.

## REFERENCES

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