Supporting Information

Preparation of Porous Co_3O_4 and its Response to Ethanol with Low Energy Consumption

Xiao Zhang, [a b] Yaohua Xu,[a b] Hao Liu,[a b] Wenrui Zhao,[a b] Anjie Ming,[a b] and Feng Wei [a b]*

[a] State Key Laboratory of Advanced Materials for Smart Sensing, General Research Institute for Nonferrous Metals, Beijing 100088, China. Email: zhangxiao@grinm.com

[b] GRIMAT Engineering Institute Co., Ltd, Beijing 101407, China

KEYWORDS: Co_3O_4; Metal-organic frameworks; Catalysts; Effective diffusion; Ethanol detection

Test preparation.

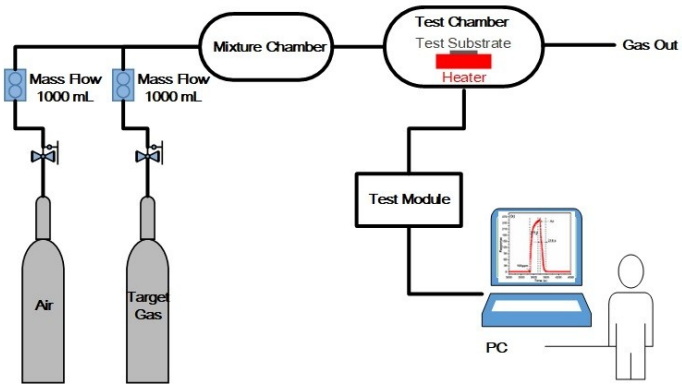

Figure S1. Schematic diagram for the sensing measurements.

In a typical test process, the as-prepared Co_3O_4 samples (about 100 mg) were initially dispersed in absolute ethanol (about 1 mL) to form a suspension, respectively, and then dropped about 0.2 μL suspension onto a ceramic plate substrate (10×15 mm) using a pair of Ag electrodes. All measurements were performed in a temperature-controlled chamber into which was flowed the target gas using N_2 as the carrier gas. The prepared substrate was dried at 60 ℃ for 1 h and then transferred to the test chamber. The chamber was heated by a heating platform surrounded by a pair of probes. The resistance of each sample was acquired by the probes during testing.

The response of the samples to ethanol was calculated using Equations (1):

$$\text{Response}=R_g/R_0 \times 100\% \quad (1)$$

Here, R_g and R_0 are the resistances of the sample in the target gas and air, respectively. In addition, the response time (i.e., time taken for the sample resistance to reach 90% of the final resistance) and recovery time (i.e., time taken for the sample resistance to return to 10% of the saturation resistance) were also determined.

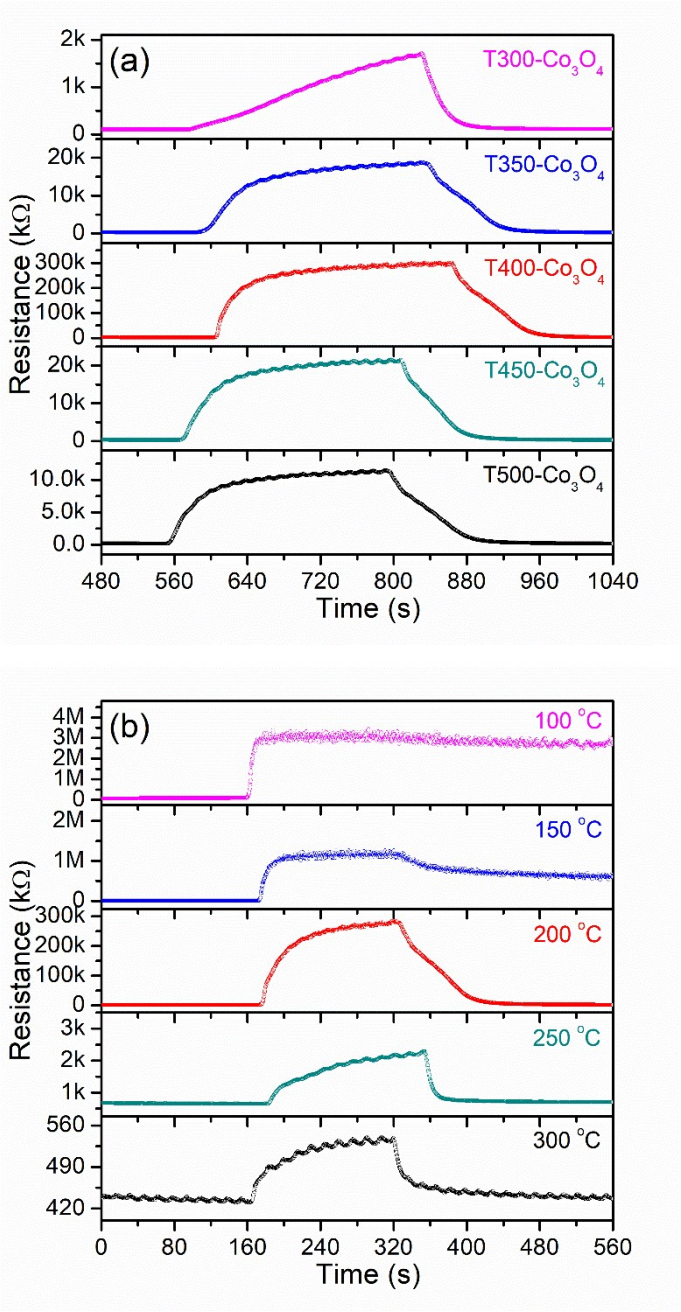

Figure S2. Resistance dynamic curves of (a) Co_3O_4 to 100 ppm ethanol at 200 ℃, and (b) T400-Co_3O_4 to 100 ppm ethanol with different operating temperature.

Figure S2a is the resistance dynamic curve of Co_3O_4 to 100 ppm ethanol at 200 ℃. It is clearly that the resistance of Co_3O_4 firstly increases and followed decreases with the increase of calcination temperature. The T400-Co_3O_4 shows the higher resistance than other samples (Figure S2a). Figure S2b is the resistance dynamic curve of T400-Co_3O_4 to 100 ppm ethanol

with different operating temperature. Obviously, the resistance decreases with the increasing of operating temperature.

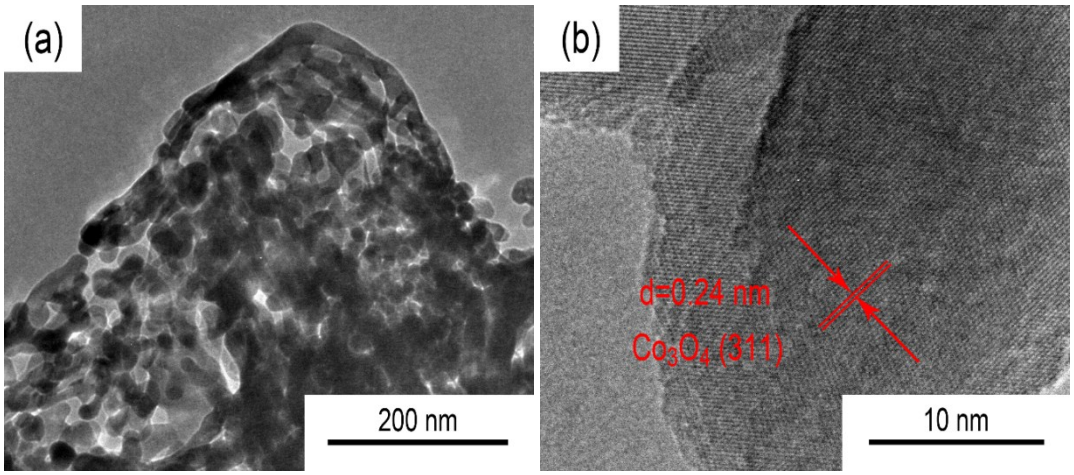

Figure S3. (a) TEM and (b) HRTEM images of T400-Co_3O_4.

Figure S3 shows TEM and HRTEM image of T400-Co_3O_4. Obviously, the basic unit, that is nanorods, gathered and formed rule boundary (Figure S3a). The HRTEM shows the lattice fringes information of the compound, which index to Co_3O_4 (Figure S3b).

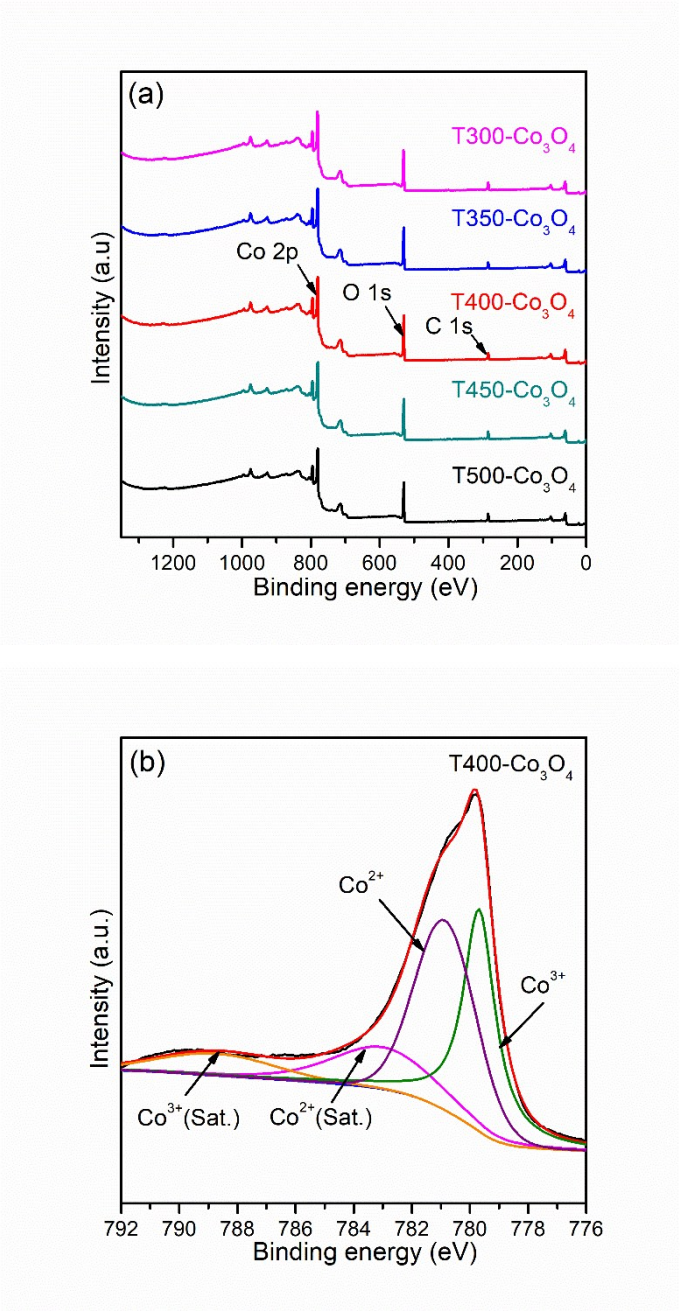

Figure S4. (a) XPS survey spectra of Co_3O_4 samples, and (b) high resolution Co 2p XPS spectrum of T400-Co_3O_4.

The full rang spectrum of Co_3O_4 samples are shown in Figure S4. The sharp peaks at 780.08, 530.08 and 285.08 eV are corresponding to Co 2p, O 1s and C 1s, respectively, indicating the purity of these Co_3O_4 samples (Figure S4a). Figure S4b is the high-resolution Co 2p XPS spectrum of T400-Co_3O_4. The peaks at 779.65 and 780.7 eV are corresponding to the

characteristic peak of Co^{3+} and Co^{2+}, while the satellite peak of Co^{2+} and Co^{3+} are at 784.2 and 789.1 eV [1, 2].

Table S1. Amount (at. %) of Oxygen with different valence states in Co_3O_4 samples.

Sample	Oxygen	Surface Lattice Oxygen	Oxygen Vacancies	Adsorbed Oxygen
T300-Co_3O_4	50.38	49.42	36.88	13.70
T350-Co_3O_4	51.54	69.02	19.25	11.73
T400-Co_3O_4	50.43	69.55	20.88	9.57
T450-Co_3O_4	50.23	60.02	32.55	7.43
T500-Co_3O_4	50.46	68.82	22.31	8.87

REFERENCES

(S1) B. Chen, X. He, F. Yin, H. Wang, D. J. Liu, R. Shi, J. Chen and H. Yin, *Adv. Funct. Mater.*, 2017, 27, 1700795.

(S2) X. Yi, X. He, F. Yin, B. Chen, G. Li and H. Yin, *Electrochim. Acta*, 2019, 295, 966-977.