

Heterostructured $\text{Co}_3\text{O}_4/\text{PEI-CNTs}$ Composite: Fabrication, Characterization and CO Gas Sensors at Room Temperature

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Table S1 TG results of synthesized samples under air

Samples	(After 540 or 910 °C under air)
	$\Delta W \text{ Co}_3\text{O}_4\%$
C-1	6.98
C-3	21.84
C-5	45.1
C-7	32.5

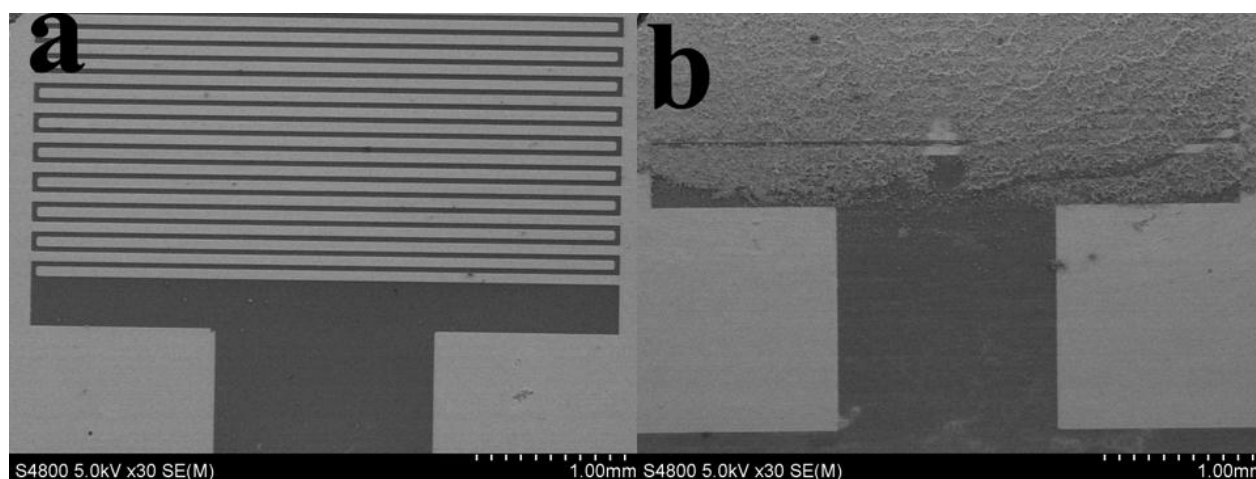


Fig. S1 (a) SEM image of the part of Au electrodes, (b) SEM images of the part of sensor

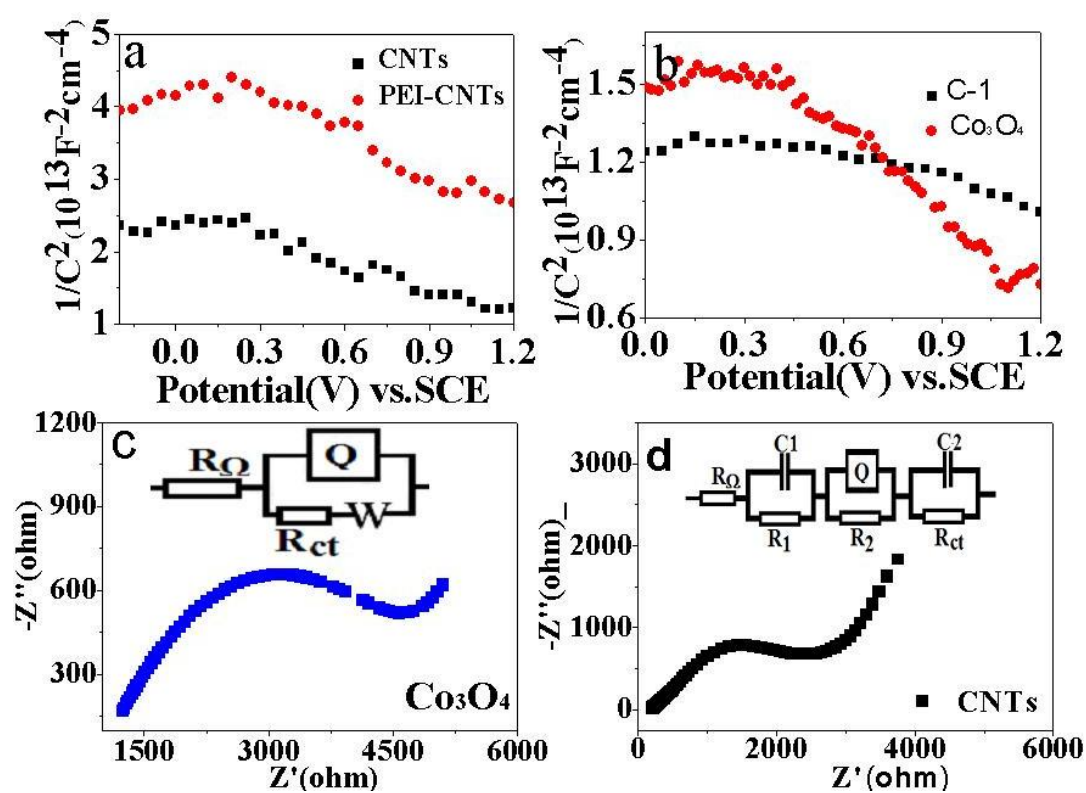


Fig. S2 Mot-Schottky plots of samples electrodes measured in 3 M KOH solution with a frequency of 12 kHz (a) CNTs and PEI-CNTs, (b) Co_3O_4 NPs and C-1, (c) Nyquist plots of Co_3O_4 NPs and equivalent circuit model of samples (inset) measured in the frequency range from 0.01Hz to 100 kHz with 0.4V, (d) Nyquist plots of CNTs

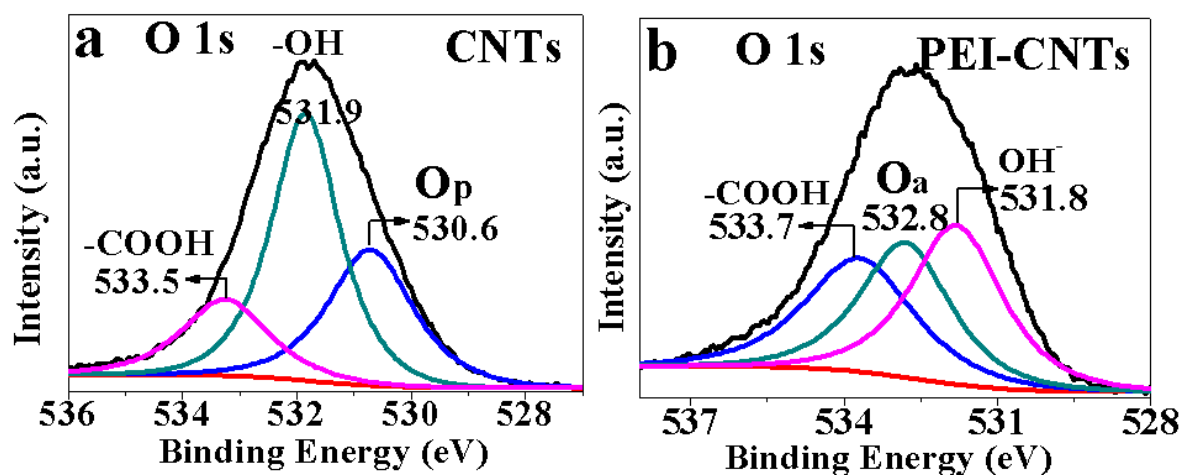


Fig.S3 XPS spectra of the O1s of (a) CNTs, (b), PEI-CNTs.

Fig.S3 shows the XPS spectra of O1s CNTs and PEI-CNTs. The O1s spectra of samples are shown in Fig.S3 (a, b). The O1s peak confirmed the presence of some carboxylic and hydroxyl functions onto the CNTs and PEI-CNTs surface at 533.5 ± 0.2 eV and 531.9 ± 0.1 eV, respectively. Furthermore, physically adsorbed oxygen/carbonates were detected at 530.6 eV (O_p) on the CNTs¹. The peak at 532.8 eV on the PEI-CNTs are due to chemisorbed oxygen¹.

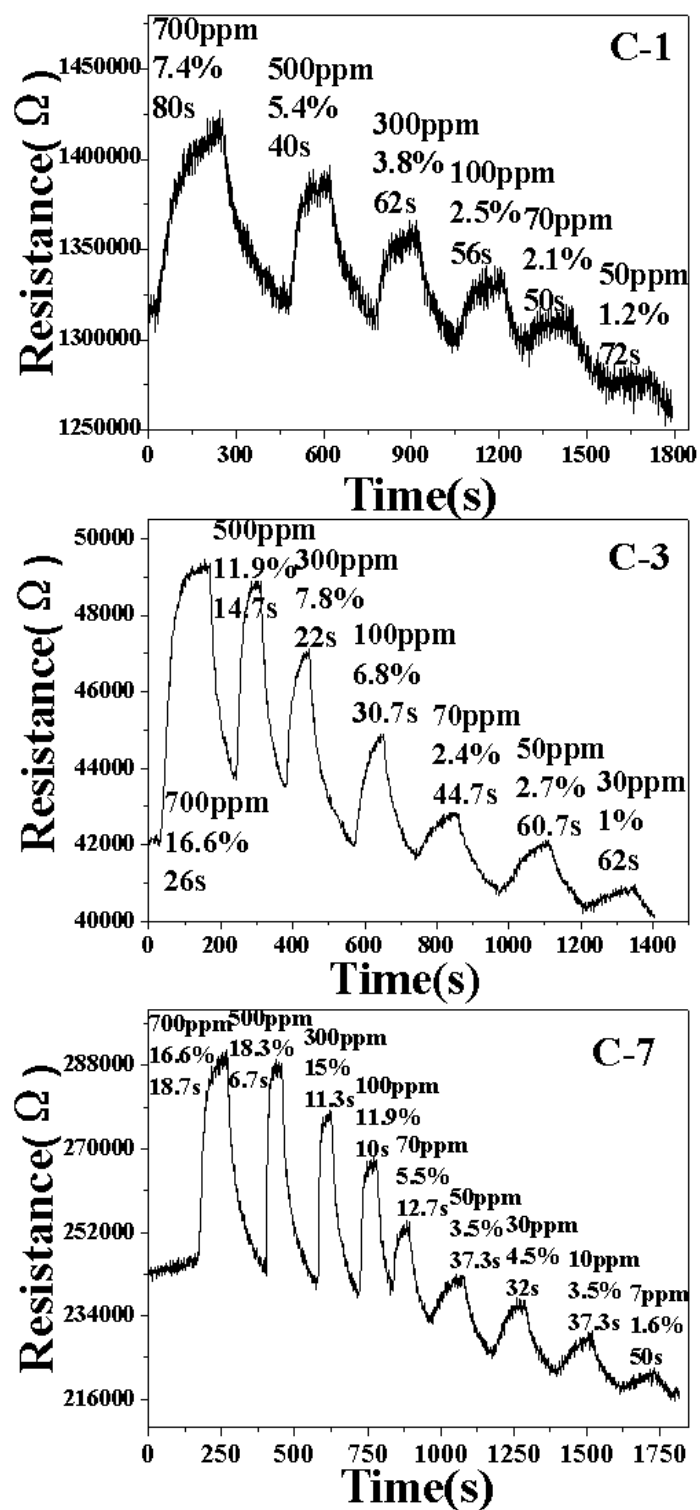


Fig.S4 Dynamic response-recovery curves of $\text{Co}_3\text{O}_4/\text{PEI-CNTs}$ composites thin film sensors with different the hydrothermal time to 5-7000 ppm CO at room temperature (RT) in air. (a) C-1, (b) C-3, (c) C-7 (RH: 26%)

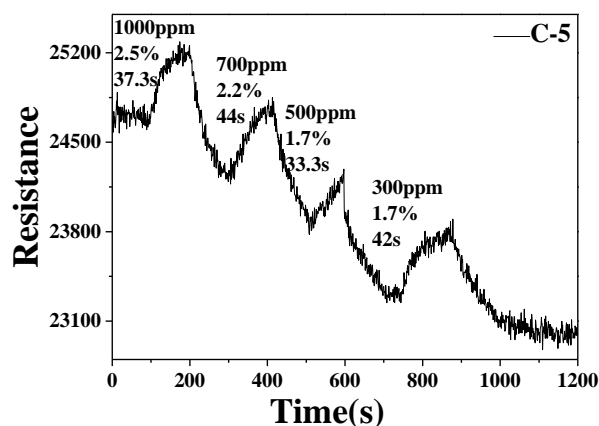


Fig.S5 Dynamic response-recovery curves of C-5 thin film sensor to CO at RT in pure nitrogen.

Table S2 The response-recovery results of C-5 sensor to CO

Volume Concentration	1000 ppm	700 ppm	500 ppm	300 ppm	70 ppm	50 ppm	30 ppm	10 ppm	5 ppm
Sensitivity (%)	30.3	27.4	24.8	23	12.7	8.6	7.7	5.1	3.2
Response time (s)	8	8	4.7	4.7	11.3	16.7	16.7	33.3	43.3
Recovery time (s)	30	26	26.3	28	28.6	31.3	36.7	45	48

The recovery time of C-5 sensor was defined according to the references^{2, 3}.

References

1. V. Datsyuk, M. Kalyva, K. Papagelis, J. Parthenios, D. Tasis, A. Siokou, I. Kallitsis and C. Galiotis, *Carbon*, 2008, 46, 833-840.
2. C.-S. Chu and Y.-L. Lo, *Sensors and Actuators B: Chemical*, 2007, 124, 376-382.
3. L. Li, P. Gao, M. Baumgarten, K. Müllen, N. Lu, H. Fuchs and L. Chi, *Advanced Materials*, 2013.