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Supplemental information

High-temperature mixed potential CO gas sensor for in-situ combustion control

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1. Supplementary figures and related discussion

Because the size of the as-fabricated NiO sensor is much bigger than the BET sample holder tube, BET cannot be conducted on the sensor as a whole. In addition, the total surface area of the NiO electrode of a single sample is too small to get a valid BET test. Therefore, a scaled-down sample won't work as well. To measure BET, we have to scratch off the NiO electrode from the YSZ substrate, and collet the NiO electrode materials for testing. It is not as good as an in-device measurement, but we believe will still reveal information of the porosity to a large extent. As shown in **Fig. S1(a)** and **(c)**, we fabricated the porous and dense NiO sensor samples via the same preparation procedure in the manuscript. Then, we scratched the NiO electrode from the as-prepared sensor, as seen in **Fig. S1(b)** and **(d)**. Thus, we can obtain ~3 mg NiO powder per porous NiO sensor and ~6 mg NiO pellets per dense NiO sensor. Because the surface area of NiO from one sample is much lower than the threshold of a good BET characterization, we made 80 samples for porous NiO sensor and 75 samples for dense NiO sample, leading to 227 mg NiO powder and 441 mg small NiO pellets for their BET measurements.

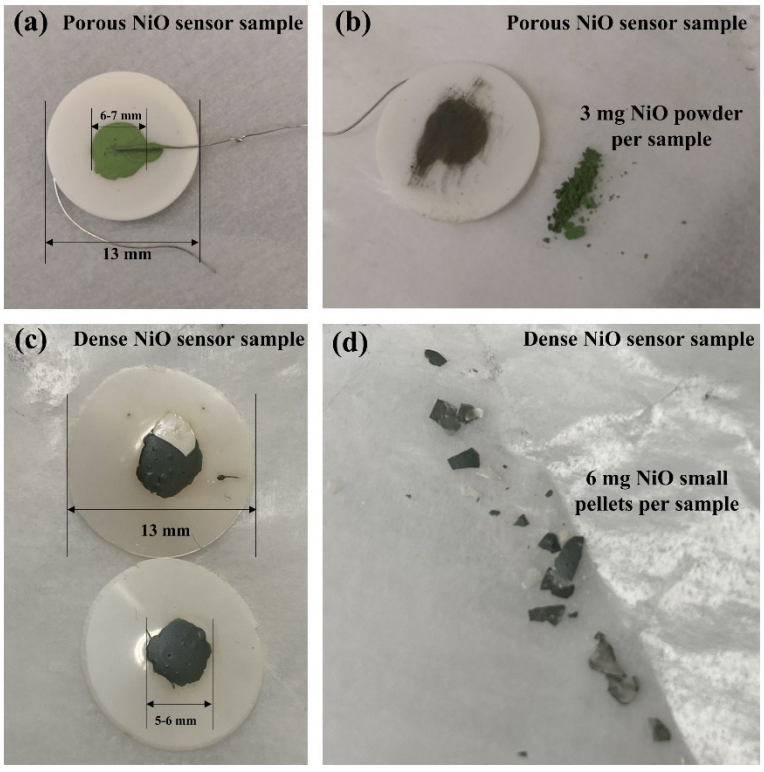

Fig. S1 Porous and dense NiO BET samples preparation procedure

Fig.S2 (a) - (d) show the BET data for porous and dense NiO electrodes. The surface area of porous NiO is calculated as 1.33 m^2/g, as shown in **Fig. S(a) and 2(b)** and the pore size distribution is shown in **Fig. S2(d)** which indicates a large pore size of NiO. However, for the dense NiO, the adsorbed amount is a

negative number with the increase of pressure, which is not possible. This means that the surface area is too small to be well measured by the BET instrument. Therefore, we decided not to add these results to the manuscript.

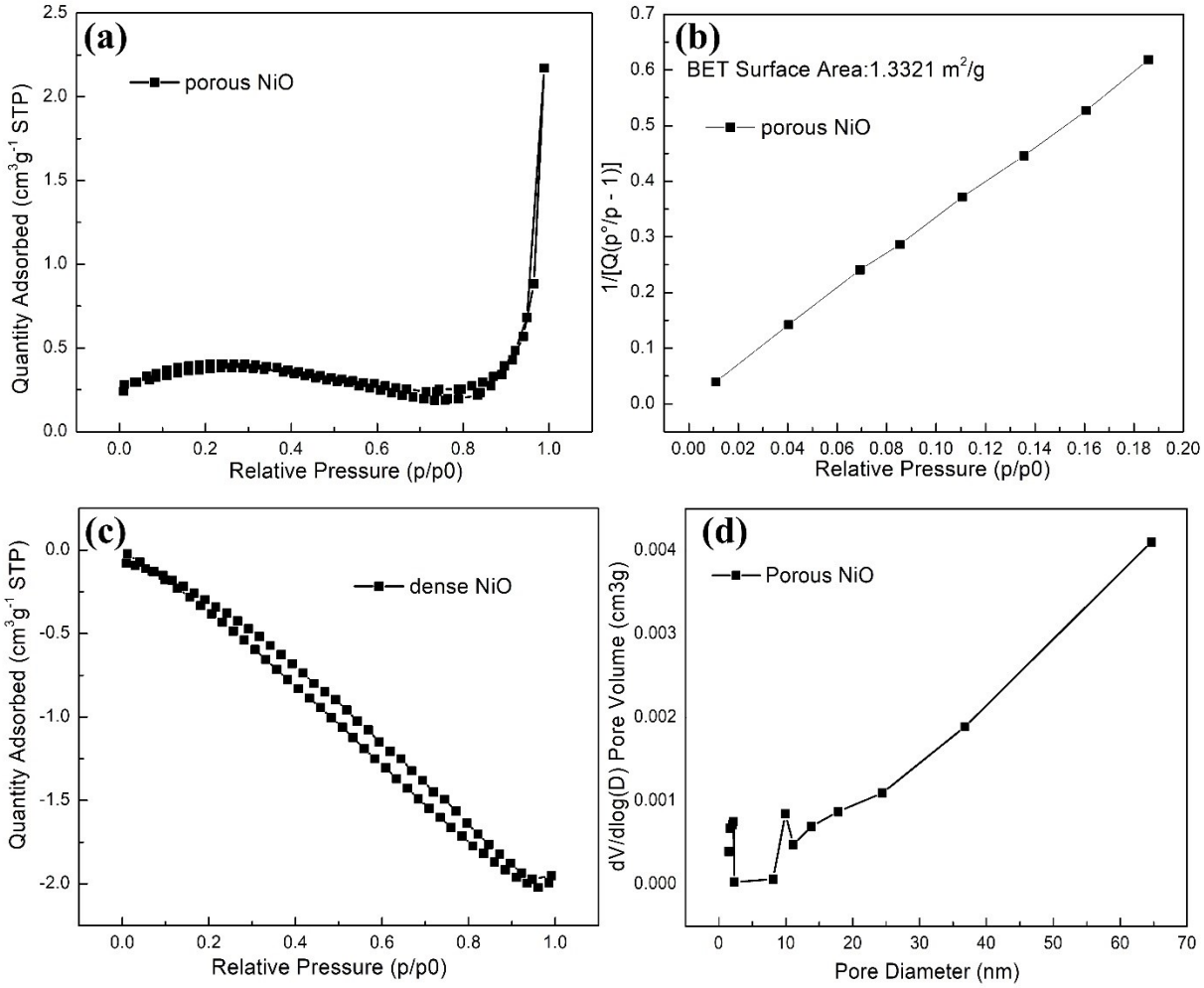

Fig. S2 (a) Isotherm plot for porous NiO (b) BET surface area plot for porous NiO (c) Isotherm plot for dense NiO (d) The pore size distribution of porous NiO

2. Supplementary tables

Table 1 Detailed composition of gas used in this work (manufactured and graded by Matheson Gas Inc)

Gas	compositions				
2000 ppm CO bal. N_2	Mixed **Research grade CO** with **ultra high purity N_2**				
Research grade CO	99.998% CO	<3ppm CO_2	<1ppm H_2	<0.5ppm O_2	<1ppm water
ultra high purity N_2	99.999% N_2	<1ppm CO	<1ppmCO_2	<2ppm O_2	<3ppm water

Table 2 Comparison of responses to ppm CO in various atmosphere and temperature

Sensing Materials/electrodes	Sensing temperature (°C)	CO conc. (ppm)	Oxygen conc. (%)	|Response| (mV)	Reference
NiO	1000	1000	3	36	This work
Nano ZnO	700	400	15	50	[1]
Cr-Fe based spinel Oxides	450	100	21	87	[2]
Zn-Sn-O oxide	600	1140	20	90	[3]
$NiFe_2O_4$	350	1000	-	99	[4]
Tin-doped Indium oxide	613	510	Air	72	[5]
Layered Au-Pt YSZ	600	1000	5	80	[6]
Rh-YSZ	700	400	5	65	[7]

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