

Supporting information for

## **Thin-walled NiO tube networks functionalized with catalytic Pt for highly selective C<sub>2</sub>H<sub>5</sub>OH sensors using electrospun fibers as a sacrificial template**

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### **Experimental Section**

#### **Preparation of PVP nanofiber template:**

Poly(vinyl pyrrolidone) (PVP, Mw: 1,300,000 g/mol) nanofibers, used as a sacrificial polymeric template, were electrospun from a solution of N,N-dimethylformamide (DMF, Fluka, 98%). The PVP dissolved in the DMF, was loaded into a plastic syringe with a stainless-steel needle of 0.25 mm (25GA) in diameter. The precursor solution was pumped through a nozzle at a constant rate of 50  $\mu$ L/min. A voltage of 20 kV was applied between the tip and the interdigitated Au electrode arrays (200  $\mu$ m Au fingers spaced 200  $\mu$ m apart), which were placed 15 cm below the needle tip to collect the PVP fiber templates.

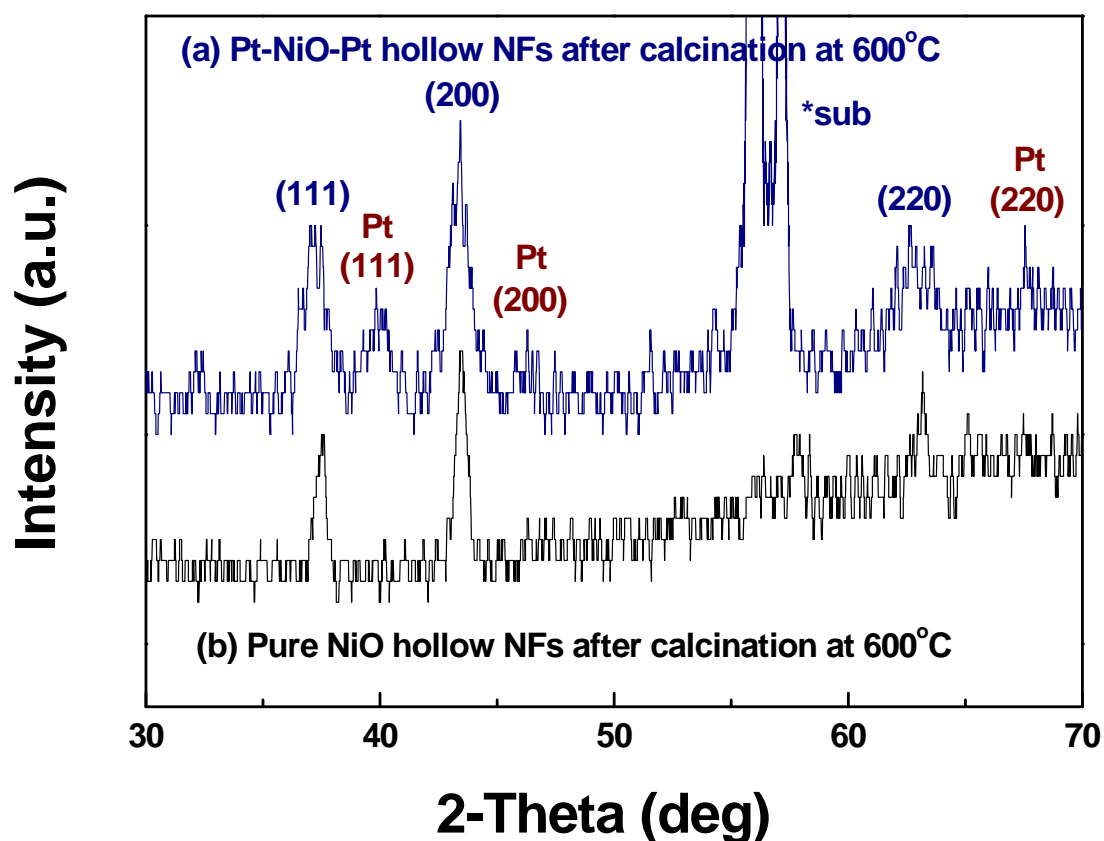
#### **Characterization:**

The morphology and microstructural evolution of NiO and Pt-loaded NiO tubes were examined by field emission scanning electron microscopy (FE-SEM, JEOL JSM 6330F) and a transmission electron microscope (TEM, Tecnai G2 F30 S-TWIN). X-ray diffraction (XRD) was used to examine the crystallinity of NiO and Pt-loaded NiO tube networks.

### Gas sensing characteristics:

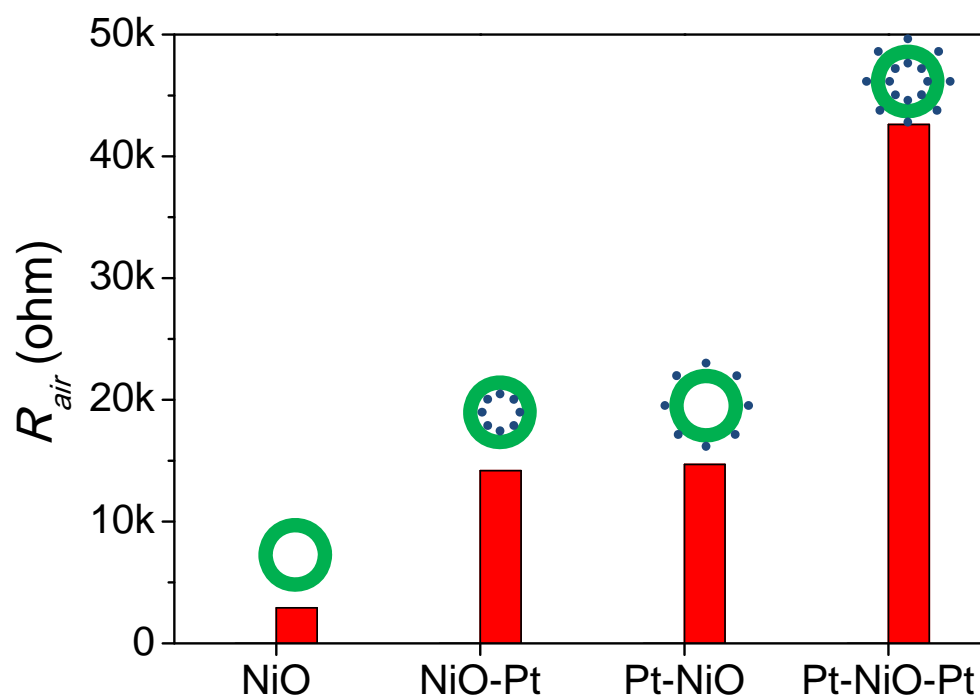
NiO, Pt-NiO, NiO-Pt, and Pt-NiO-Pt tube networks were prepared on alumina substrates fitted with an interdigitated gold electrode (2 fingers, 900  $\mu\text{m}$  long and 600  $\mu\text{m}$  wide, spaced 100  $\mu\text{m}$  apart). Finally, the sensor layer was heat-treated at 600  $^{\circ}\text{C}$  for 2 h. The sensor was placed in a quartz tube and the temperature of the furnace was stabilized at 400  $^{\circ}\text{C}$ . The gas concentration was controlled by changing the mixing ratio of 100 ppm gases ( $\text{H}_2$ , CO and  $\text{C}_2\text{H}_5\text{OH}$ ; in air balance) and employing dry synthetic air. A flow-through technique with a constant flow rate of 500  $\text{cm}^3/\text{min}$  used. The gas response ( $S=R_g/R_a$ ,  $R_g$ :resistance in gas,  $R_a$ : resistance in air) was measured at 400  $^{\circ}\text{C}$ . The dc 2 probe resistance of the sensor was measured using an electrometer interfaced with a computer.

### XRD analysis:



**Fig. S1** XRD pattern of the (a) Pt-NiO-Pt tubes and (b) pure NiO tubes after calcination at 600  $^{\circ}\text{C}$  for 2 hours. The XRD spectra show that the crystalline Pt catalysts were well decorated on NiO tubes.

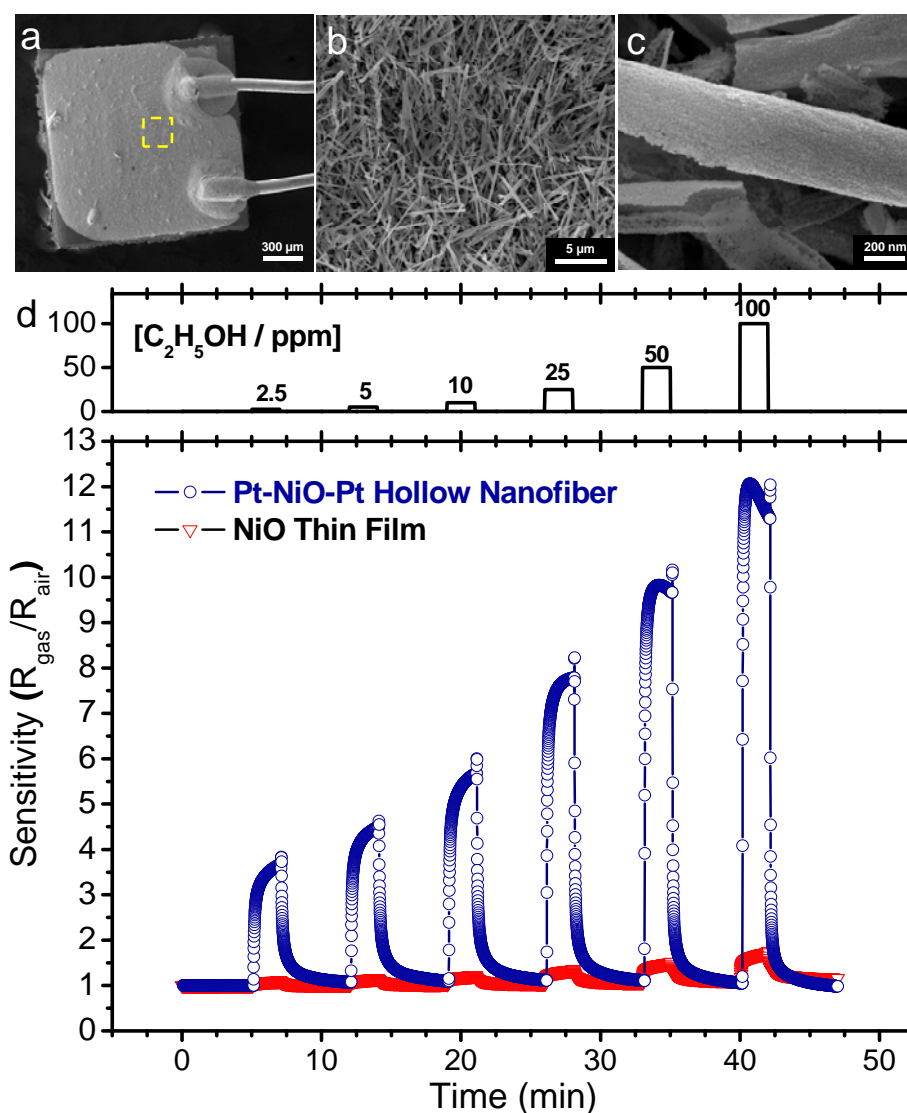
**Base resistance analysis:**



**Fig. S2** Base resistances of NiO, NiO-Pt, Pt-NiO, and Pt-NiO-Pt tube networks measured at 400 °C.

### Gas sensing analysis:

The as-synthesized Pt-NiO-Pt hollow tubes were dispersed in a solvent by ultrasonication. A slurry droplet containing Pt-NiO-Pt tubes was dropped onto the Au interdigitated electrodes and gradually dried. After drying and removing the slurry, the Pt-NiO-Pt tube based sensors were placed in a quartz tube chamber and the electric furnace temperature was stabilized at a constant sensing temperature (400 °C). NiO thin film based sensors were also prepared for the comparison.



**Fig. S3** (a) SEM micrograph of Pt-NiO-Pt tube networks, (b) Magnified SEM image of Fig. S3a, (c) Magnified SEM image of Fig. S3b, (d) Gas response of NiO thin film sensor and Pt-NiO-Pt tube sensor to 2.5 ~ 100 ppm C<sub>2</sub>H<sub>5</sub>OH at 400 °C.