Electronic supplementary information

Polycarbazole and biomass-derived flexible nitrogen-doped porous carbon materials for gas adsorption and sensing

Li Zhao,[a] Pei-Wen Xiao,[a] Qi Chen,[a] Cheng Fu,[a] Bao-Hang Han*[,a,b]

[a] *CAS Key Laboratory of Nanosystem and Hierarchical Fabrication, CAS Center for Excellence in Nanoscience, National Center for Nanoscience and Technology, 100190 Beijing, China*

[b] *University of Chinese Academy of Sciences, Beijing 100049, China*

Corresponding author:

Bao-Hang Han Tel.: +86 10 8254 5576. E-mail: hanbh@nanoctr.cn

Instrumental characterization

Scanning electron microscopy (SEM) experiments were carried out on a Hitachi S-4800 microscope (Hitachi Ltd., Japan) with an accelerating voltage of 6.0 kV. The transmission electron microscopy (TEM) images were acquired with a Tecnai G2 20 S-TWIN microscope (FEI Company, USA) at an accelerating voltage of 200 kV. X-ray photoelectron spectroscopy (XPS) characterizations were conducted on an ESCALab 220i-XL electron spectrometer (VG Scientific Ltd., UK). The nitrogen sorption isotherms were obtained from 3Flex instrument (Micromeritics, USA) at 273 K. The small gas molecules, such as CO_2 and H_2O, were taken away from the samples by degassing for 12 h under vacuum at 120 °C. The specific surface area of the materials was assessed with Brunauer–Emmett–Teller (BET) model, while the pore size distribution was assessed with the non-local density functional theory (NLDFT) method. Carbon dioxide, nitrogen, and methane uptake experiments (0–1.0 bar at 273 K, carbon dioxide also measured at 288 K) were carried out on a Micromeritics TriStarII 3020 surface area and porosity analyzer (Micromeritics, USA). Elemental analysis results were obtained from a Flash EA 1112 Elemental Analyzer (Thermo Scientific, Italy). Thermal gravimetric analysis (TGA) was carried out on a Pyris Diamond thermogravimetric/differential thermal analyzer (PerkinElmer, U.S.A.). Raman spectra were obtained from the equipment Renishaw inVia plus (Renishaw, UK). The resistance of the FNPC in breakthrough experiment was conducted in a 4-point probes resistivity measurement system (Probes Tech, China). Before every experiments, the sample was

heated at 120 °C under N_2 flow to desorb adventitious CO_2 and water, then slowly cooled down to room temperature. Afterwards, the resistances of the material under calm breath and jogging breath were measured. The breath through experiment was conducted by breathing out to the material time by time, and then the resistances of the material were detected.

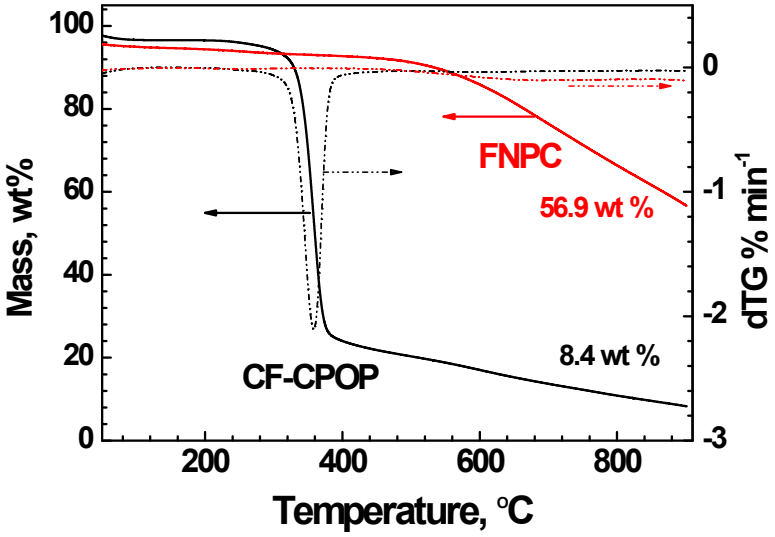

Fig. S1. TGA curves for CF-CPOP and FNPC.

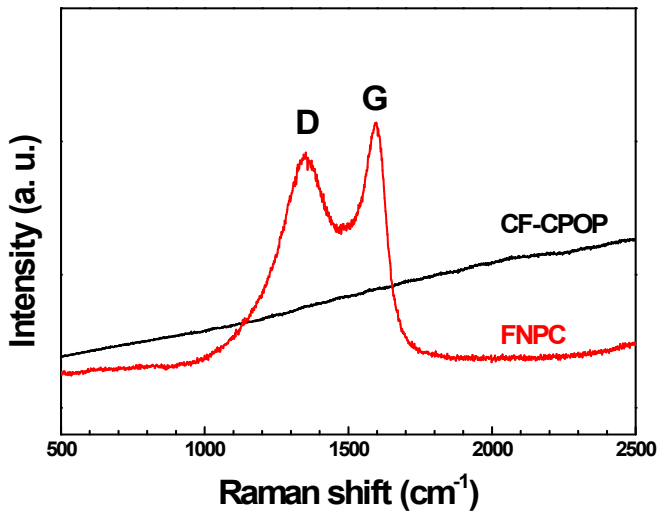

Fig. S2. Raman spectra for CF-CPOP and FNPC.

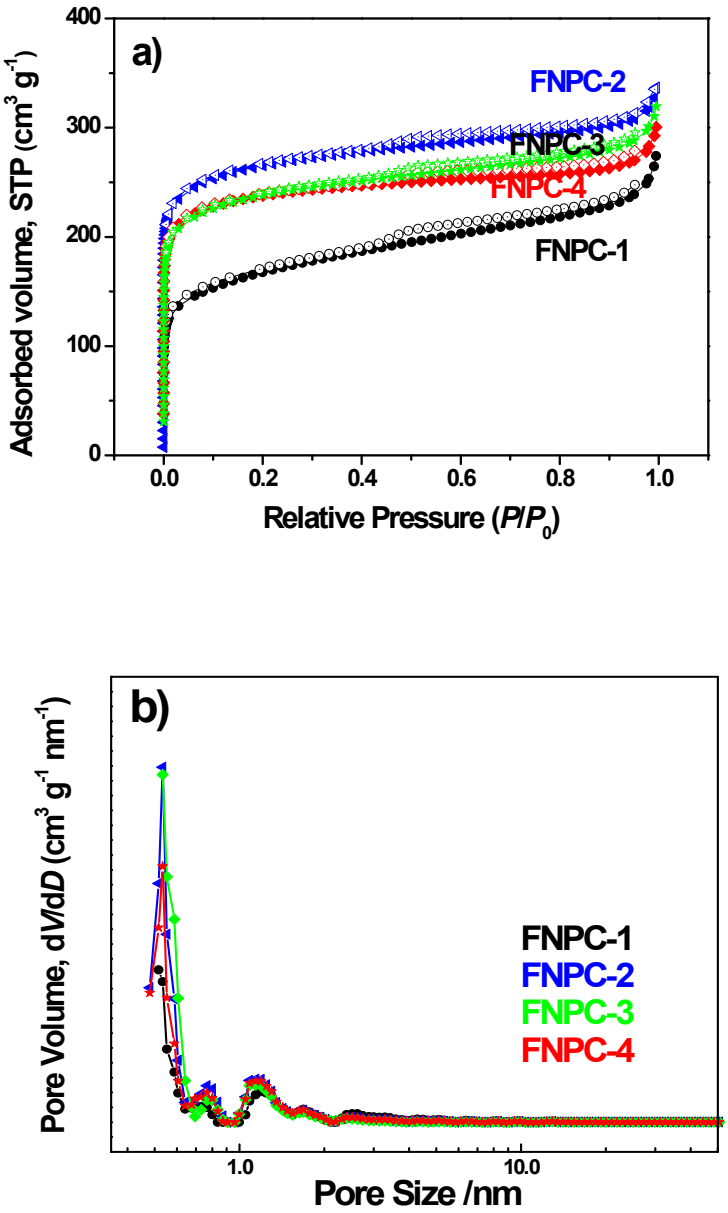

Fig. S3. Nitrogen adsorption–desorption isotherms (a) and pore size distribution profiles (b) of FNPC-x.

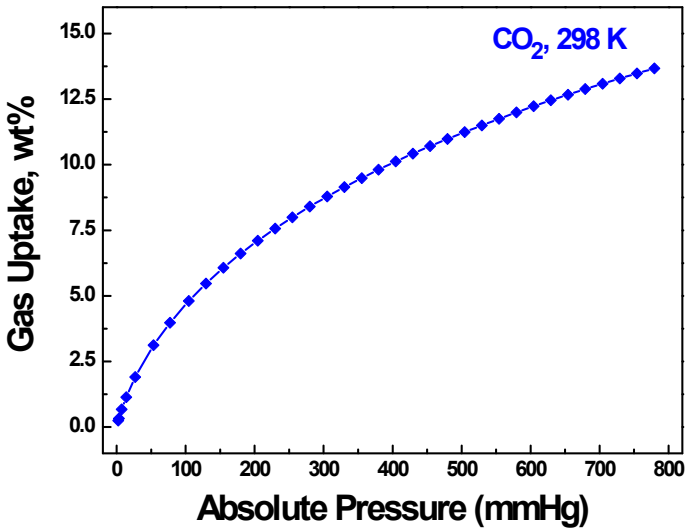

Fig. S4. CO_2 uptake performances of FNPC at 298K.

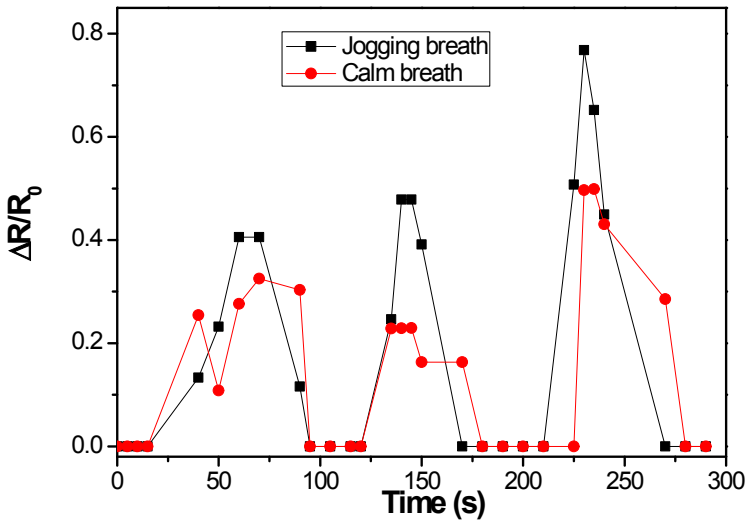

Fig. S5. The resistivity changes of FNPC material to human exhaled gas when jogging breath and calm breath.

Table S1. Chemical composition of FNPC.

Sample	Element Analysis (wt %) [a]			XPS (wt %) [b]		
	C	H	N/S	C	O	N/S
FNPC	70.5	2.1	4.0/–	87.5	8.4	5.1/–

[a] Determined from elemental analysis results; [b] Determined from XPS results.

Table S2. Comparison of carbon dioxide uptake performance (at 273 K and 1.0 Bar) of FNPC with the literature reported materials.

Adsorbent	S_{BET} (m^2 g^{-1})	CO_2 (wt%)	Ref
NMC600-330-1 h	907	17.5	S1
HCM-DAH-1-900-1	670	21.5	S2
NMC-x	272–664	19.3–22.4	S3
NSC	1608	21.1	S4
HTC-K1-T8 (activated carbon)	1013	21.5	S5
L2600 (activated carbon)	1277	23.3	S6
ZIF-8 (24 h@500 °C)	942	13.2	S7
NENU-520 (MOF)	387	15.7	S8
Bio-MOF-14 (MOF)	–	18.0	S9
CPOP-1	2220	21.2	S10
FNPC-2	**1020**	**21.0**	**This Work**

Table S3. Gas uptake properties of FNPC.

Sample	273 K [a]			298 K [a]
	CO_2	N_2	CH_4	CO_2
FNPC	21.0	2.0	3.5	13.7

[a] Data collected at 1.0 bar.

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