Supplementary Materials

Rapid Microwave Synthesis of Nitrogen-Doped Ultramicroporous Coal-Based Carbon with Enhanced CO_2 Adsorption Performance

Yulin Feng[a], Xiaoxiao Meng[a,*], Jingyu Li[a], Naiyuan Xue[a],Wanjing Li[a], Miaoting Sun[a], Jiaxiang Chen[a], Xingxing Wang[b], Ruida Zhou[b], Wenjun Zhuang[b], Jihui Gao[a], Guangbo Zhao[a], Wei Zhou[a,*],

[a] *School of Energy Science and Engineering, Harbin Institute of Technology, Harbin, 150001, P.R. China*

b CHN ENERGY Yuedian Taishan Power Generation Co., Ltd., Taishan, 529200, P.R. China

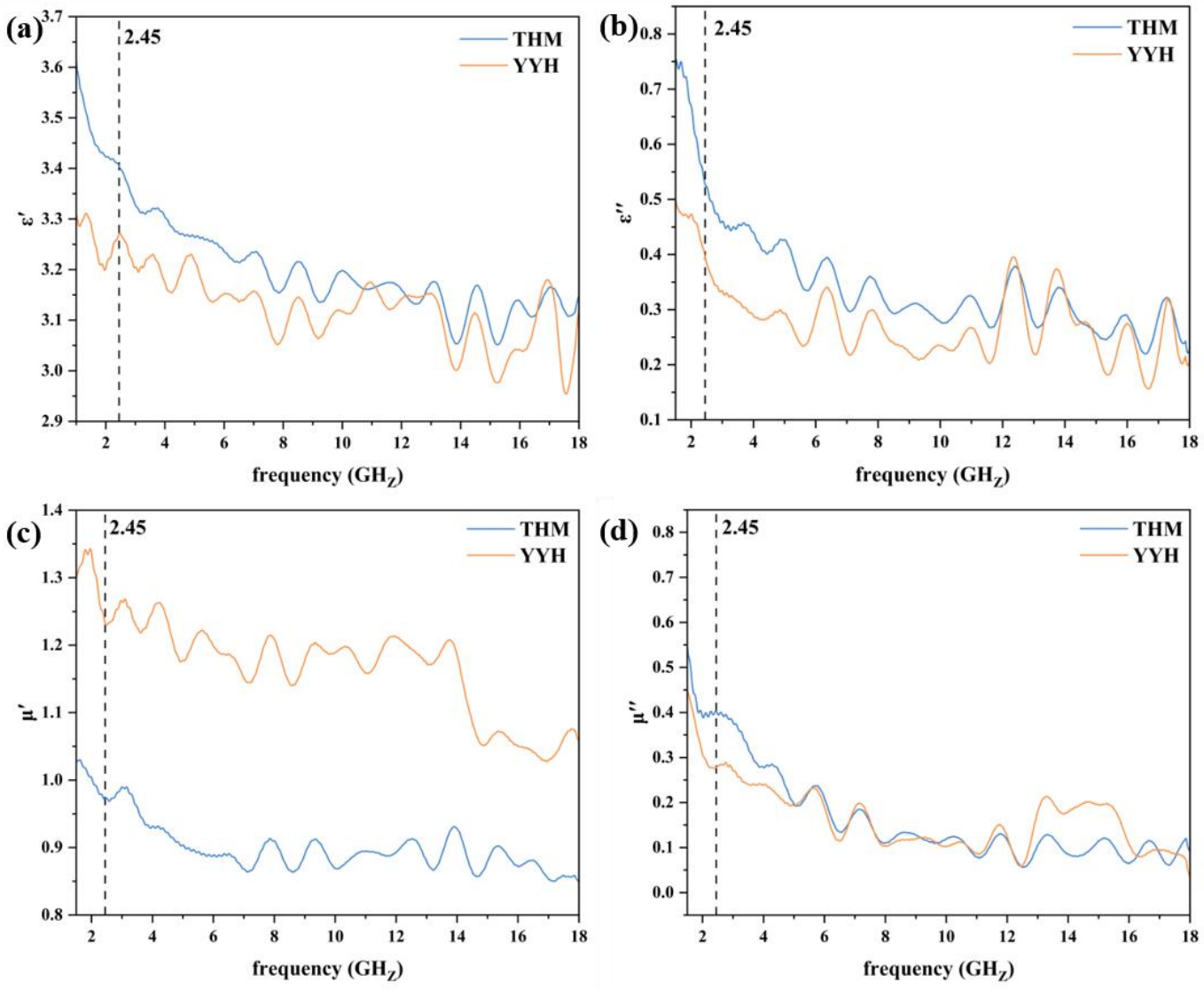
Corresponding Author: * Wei Zhou, Xiaoxiao Meng

E-mail: hitzhouw@hit.edu.cn (W. Zhou); mengxiaoxiao@hit.edu.cn (Xiaoxiao Meng)

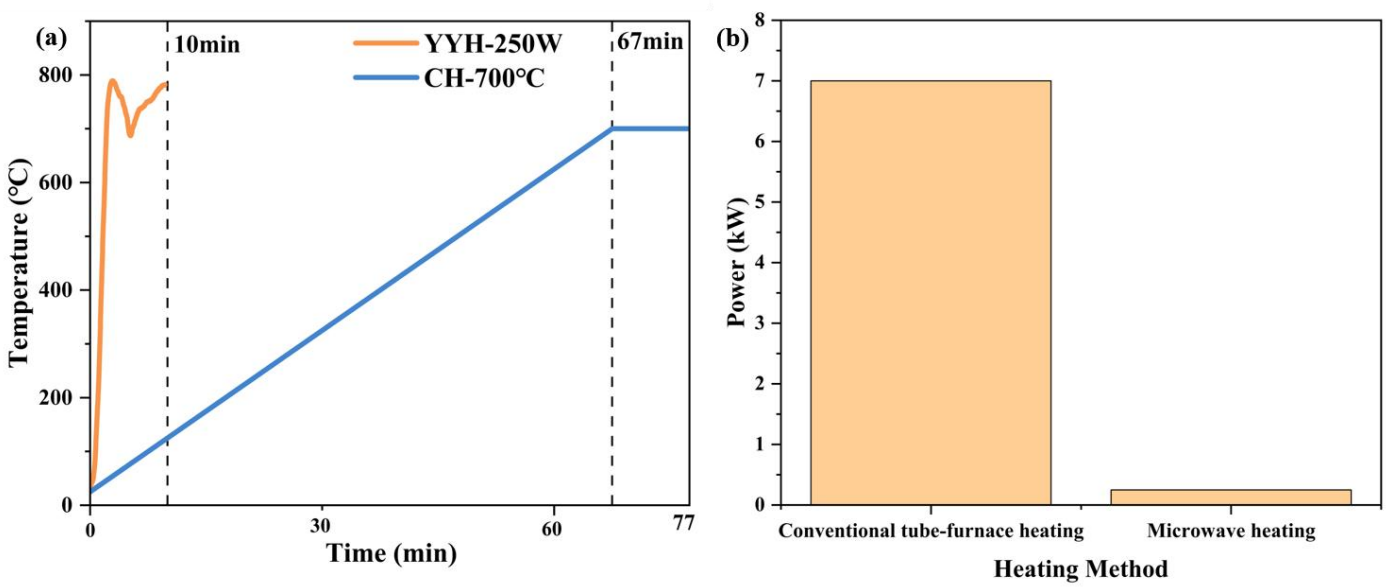
Supplementary Table S1 Proximate and ultimate analyses of Ningdong coal

Proximate analysis (wt.%)			**Ultimate analysis (wt.%, daf)**				
A_d	**FC_d**	**V_d**	**C**	**H**	**O[a]**	**N**	**S**
4.93	68.80	26.27	67.08	4.00	27.37	1.15	0.40

[a]By difference.



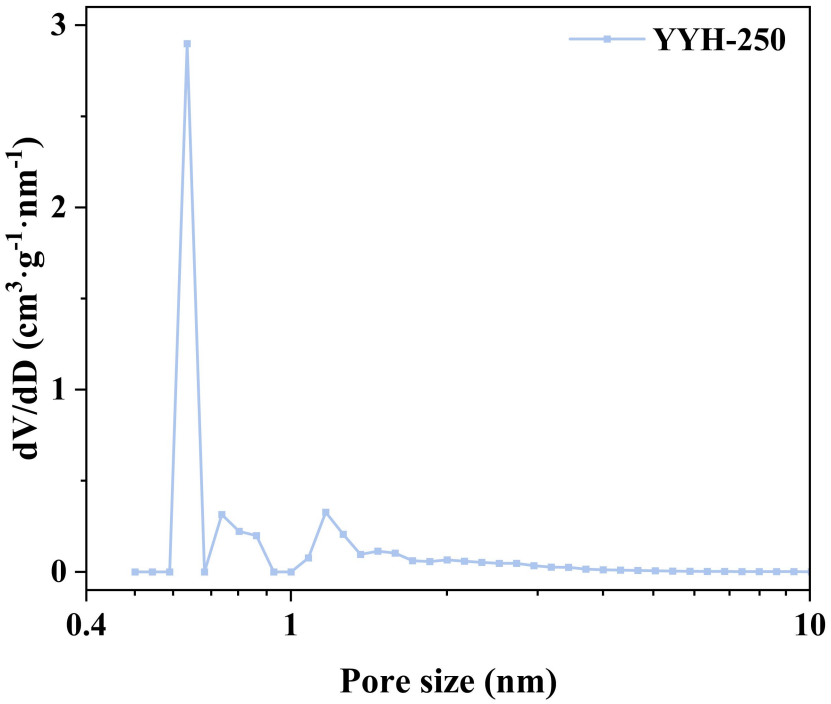
Supplementary Fig. S1. Electromagnetic response of samples: (**a**) ε′ , (**b**) ε″ , (**c**) μ′ , and (**d**) μ″ .



Supplementary Fig. S2. Comparison chart of different heating methods: (**a**) temperature, (**b**) reactor power.

Supplementary Table S2 Parameters of pore structure and adsorption performance for ACs

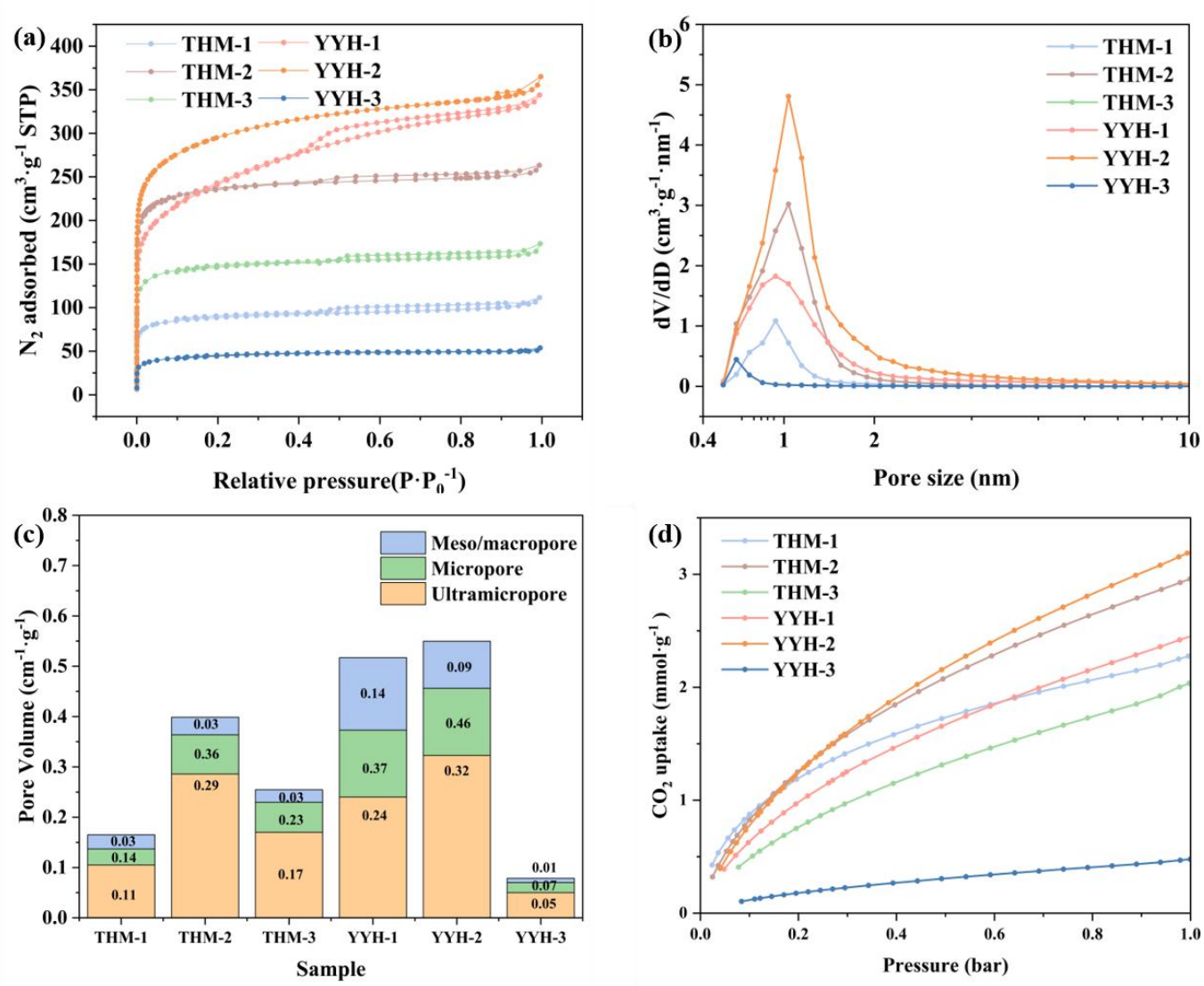
Sample	S_{BET} (m^2 g^{-1})	V_{micro} (cm^3 g^{-1})	V_{total} (cm^3 g^{-1})	V_{micro}/V_{total} (%)	$V_{ultramicro}$ (cm^3 g^{-1})	$V_{ultramicro}/V_{total}$(%)	CO_2 uptake /25 °C (mmol g^{-1})
YYH-250	973	0.18	0.38	47.37	0.13	34.21	3.33



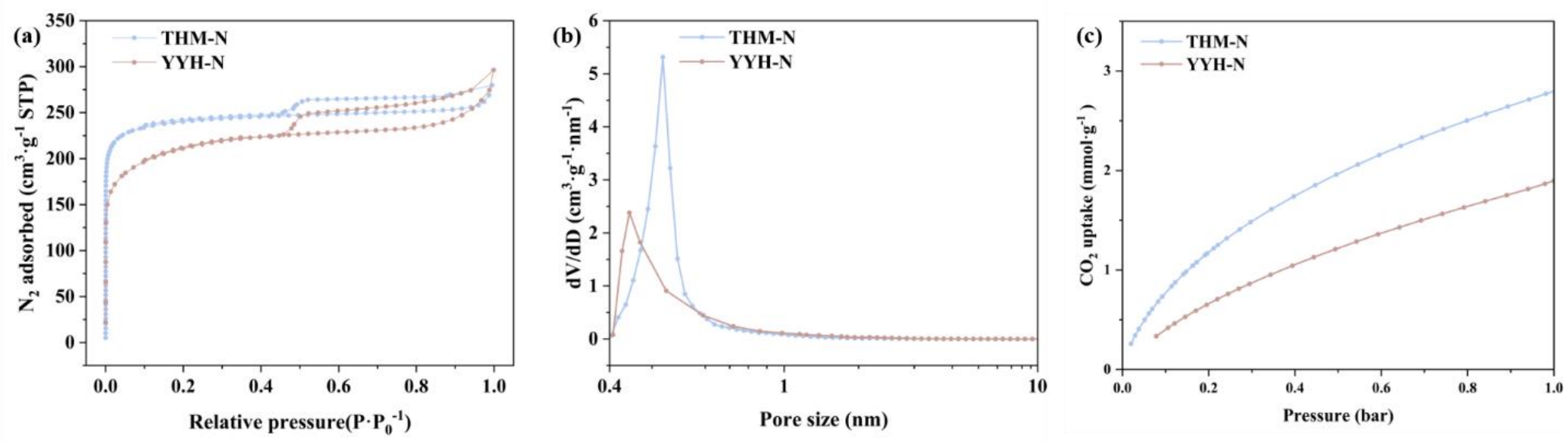
Supplementary Fig. S3. DFT pore size distributions of sample YYH-250.

Supplementary Table S3 Parameters of pore structure and adsorption performance for ACs

Sample	S_{BET} (m^2 g^{-1})	V_{micro} (cm^3 g^{-1})	V_{total} (cm^3 g^{-1})	V_{micro}/V_{total} (%)	$V_{ultramicro}$ (cm^3 g^{-1})	$V_{ultramicro}/V_{total}$(%)	CO_2 uptake /25 °C (mmol g^{-1})
THM-1	340	0.14	0.16	83.07	0.11	63.71	2.28
THM-2	910	0.36	0.40	91.27	0.29	71.74	2.96
THM-3	569	0.23	0.25	90.18	0.17	66.77	2.03
YYH-1	870	0.37	0.52	72.13	0.24	46.41	2.48
YYH-2	1103	0.46	0.55	82.99	0.32	58.73	3.33
YYH-3	167	0.07	0.08	89.20	0.05	63.53	0.48
THM-N	952	0.37	0.42	89.28	0.30	72.08	2.80
YYH-N	780	0.33	0.42	76.82	0.22	51.78	1.90



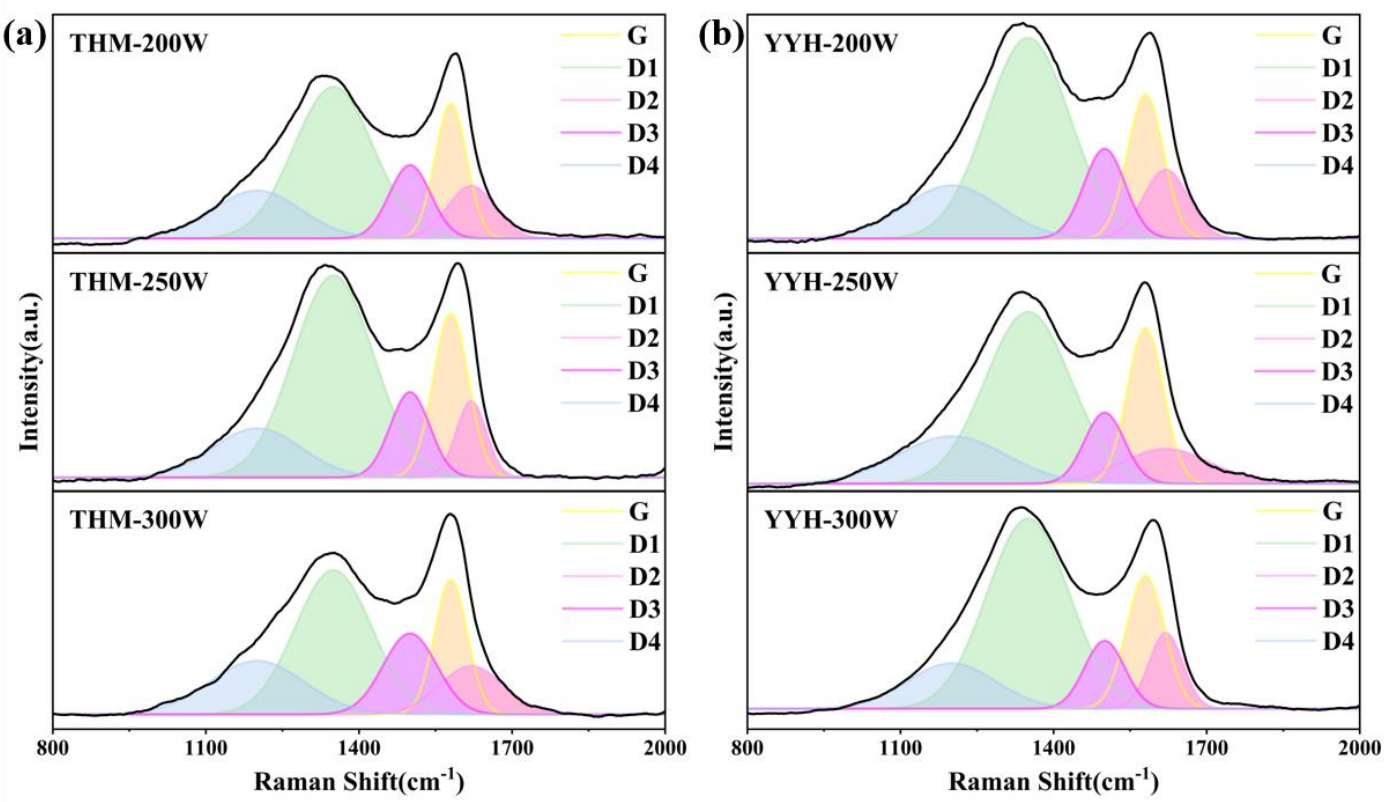
Supplementary Fig. S4. Parameters of pore structure and adsorption performance for ACs: (**a**) N_2 adsorption–desorption isotherms, (**b**) NLDFT pore size distributions of samples, and (**c**) the micropore volume, meso/macropore volume and ultramicro volume of samples, (**d**) The adsorption characteristics of CO_2 at 25 °C.



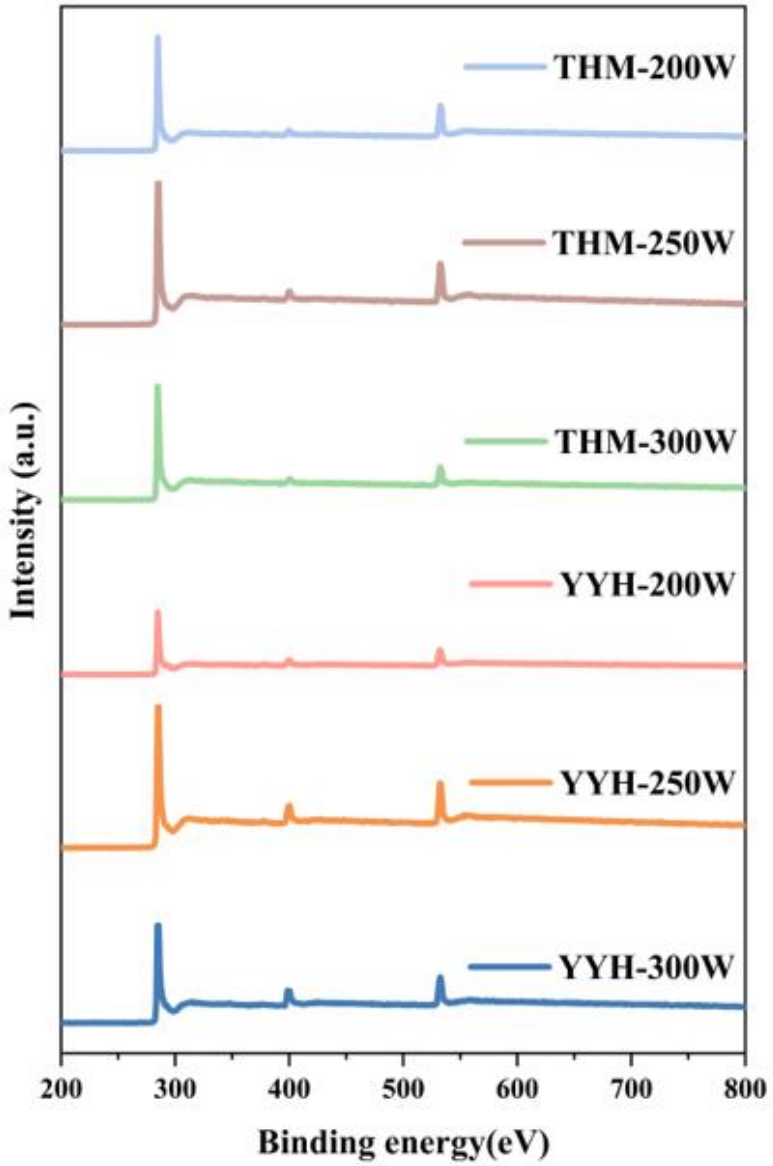
Supplementary Fig. S5. Parameters of pore structure and adsorption performance for N-doped ACs: (**a**) N_2 adsorption–desorption isotherms, (**b**) NLDFT pore size distributions of samples, and (**c**) The adsorption characteristics of CO_2 at 25 °C.

Supplementary Table S4 Yields of various ACs samples

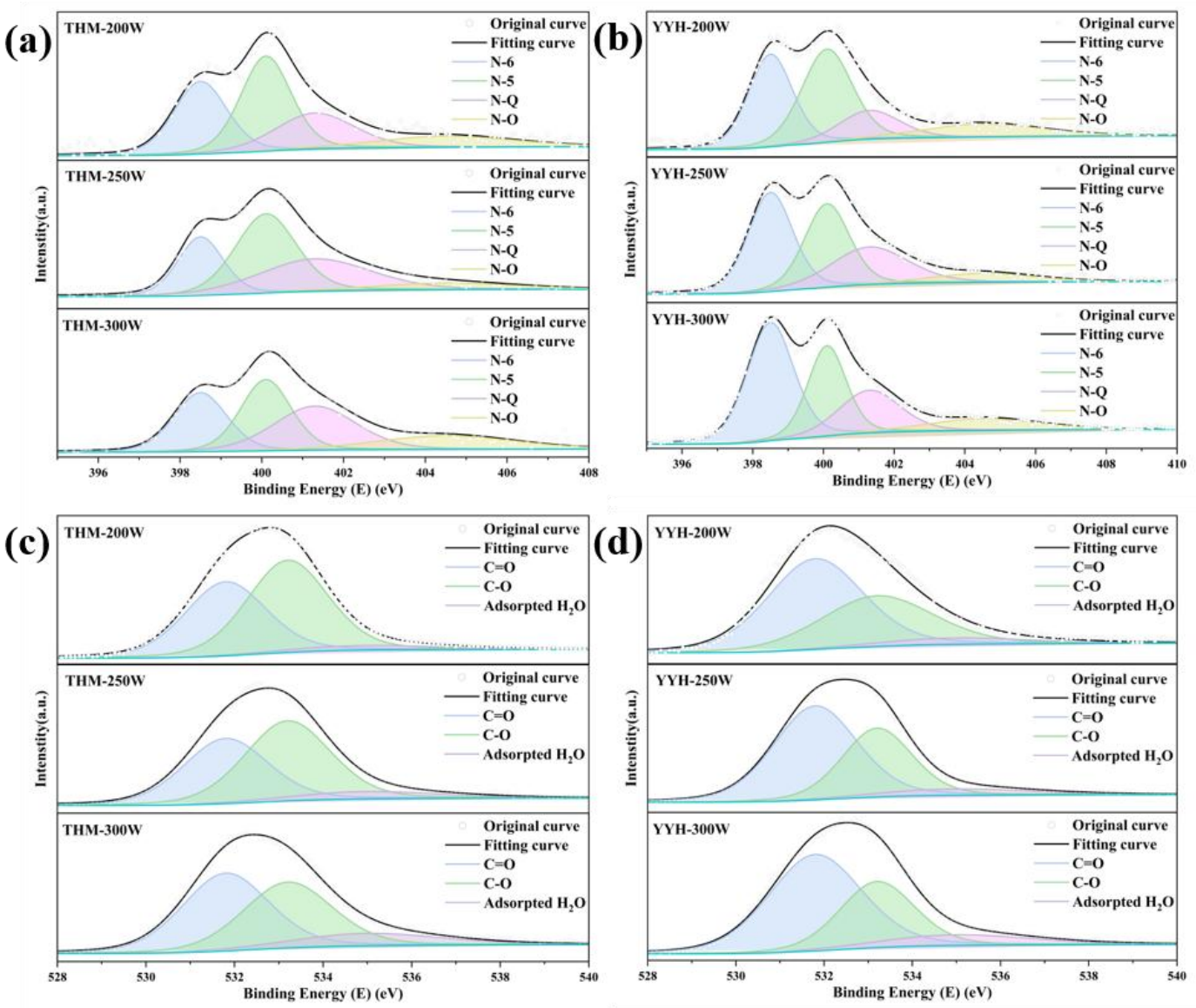
Sample	***THM-200W***	***THM-250W***	***THM-300W***	***YYH-200W***	***YYH-250W***	***YYH-300W***
yields	45%	42%	41%	55%	53%	50%



Supplementary Fig. S6 Fitted Raman spectra of ACs: (**a**) Sub-peak fitting of THM samples; (**b**) Sub-peak fitting of YYH samples



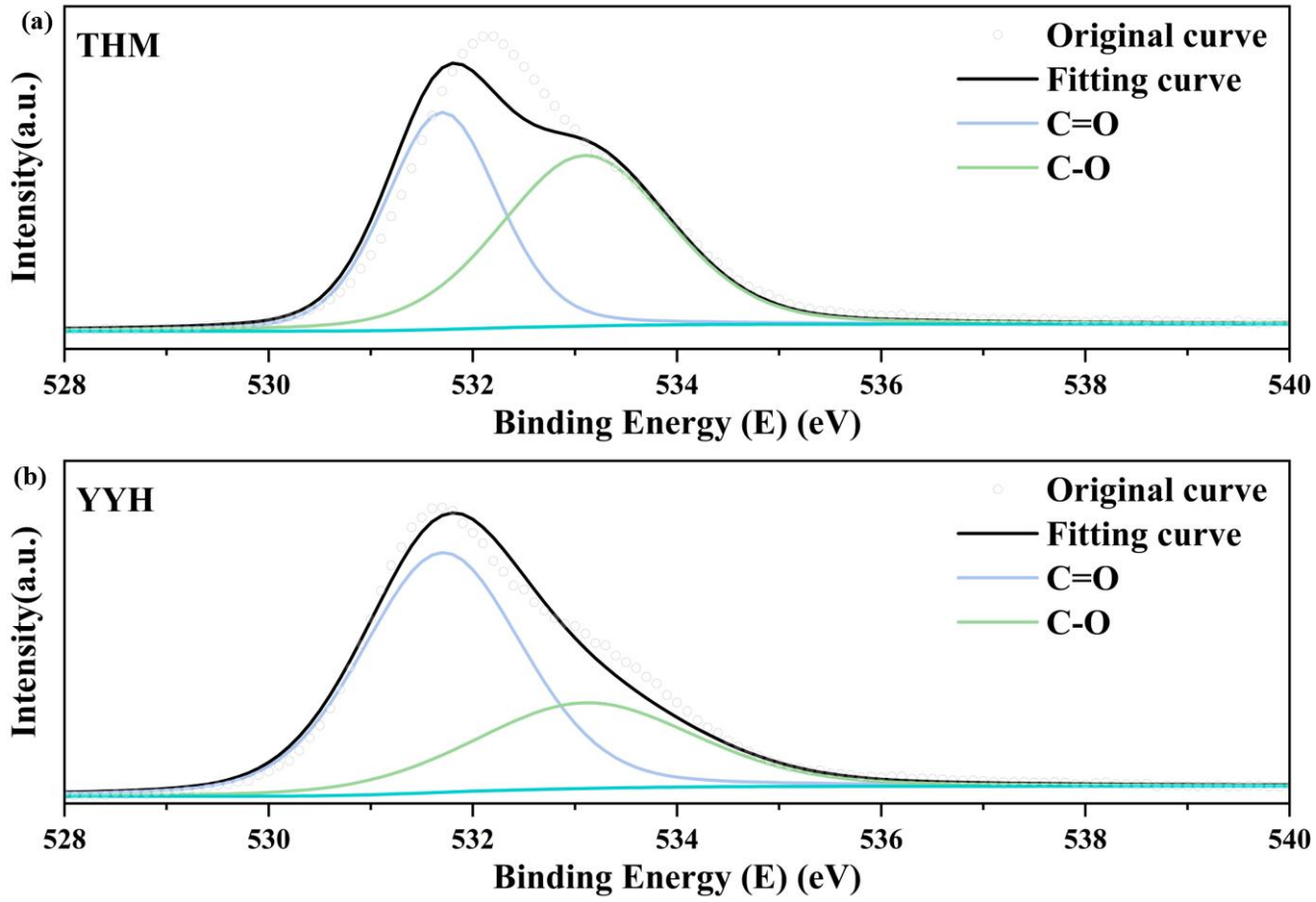
Supplementary Fig. S7 XPS survey spectra of various ACs samples.



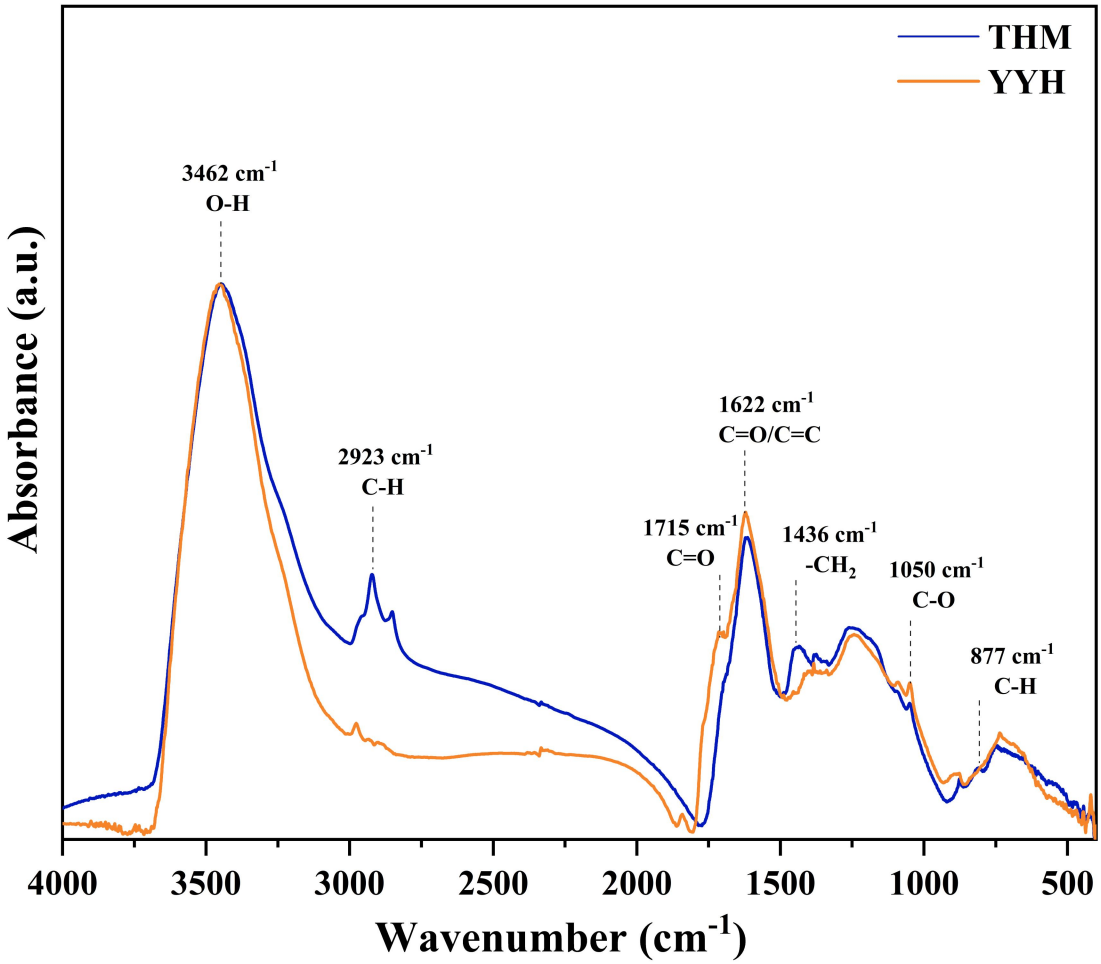
Supplementary Fig. S8 XPS Deconvolution spectra of ACs: (**a**) Nitrogen functional groups in THM samples; (**b**) Nitrogen functional groups in YYH samples; (**c**) Oxygen functional groups in THM samples; (**d**) Oxygen functional groups in YYH samples.

Supplementary Table S5 Composition of samples as determined by XPS analysis.

Sample	C1s (at.%)	O1s (at.%)	N1s (at.%)	C=O (at.%)	C-O (at.%)
THM	66.8	27.3	5.9	12.6	14.7
YYH	59.9	33.6	6.6	22.6	11.0



Supplementary Fig. S9. Deconvoluted O1s spectrum of samples: (**a**) THM, (**b**) YYH.



Supplementary Fig. S10. FTIR spectral characteristics of coal samples before and after pre-oxidation treatment.