Supporting Information

Pitch-Based Hyper-cross-linked Polymers with High Performance for Gas Adsorption

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Table S1. The formula of pitch and $AlCl_3$ in each experiment.[a]

Samples	Pitch				$AlCl_3$/g
	Petroleum pitch/g	Coal tar pitch-1/g	Coal tar pitch-2/g	Coal tar pitch-3/g	
PHCP-1	0.3091	-	-	-	1.2364
PHCP-2	0.3091	-	-	-	1.5455
PHCP-3	0.3091	-	-	-	1.8546
PHCP-4	0.3091	-	-	-	2.4728
PHCP-5	0.3091	-	-	-	2.7819
C1HCP-1	-	0.3091	-	-	1.2364
C1HCP-2	-	0.3091	-	-	1.5455
C1HCP-3	-	0.3091	-	-	1.8546
C1HCP-4	-	0.3091	-	-	2.4728
C1HCP-5	-	0.3091	-	-	2.7819
C2HCP-1	-	-	0.3091	-	1.2364
C2HCP-2	-	-	0.3091	-	1.5455
C2HCP-3	-	-	0.3091	-	1.8546
C2HCP-4	-	-	0.3091	-	2.4728
C2HCP-5	-	-	0.3091	-	2.7819
C3HCP-1	-	-	-	0.3091	1.2364
C3HCP-2	-	-	-	0.3091	1.5455
C3HCP-3	-	-	-	0.3091	1.8546
C3HCP-4	-	-	-	0.3091	2.4728
C3HCP-5	-	-	-	0.3091	2.7819

[a] In all experiments, the fixed amount of $CHCl_3$ is 10 ml.

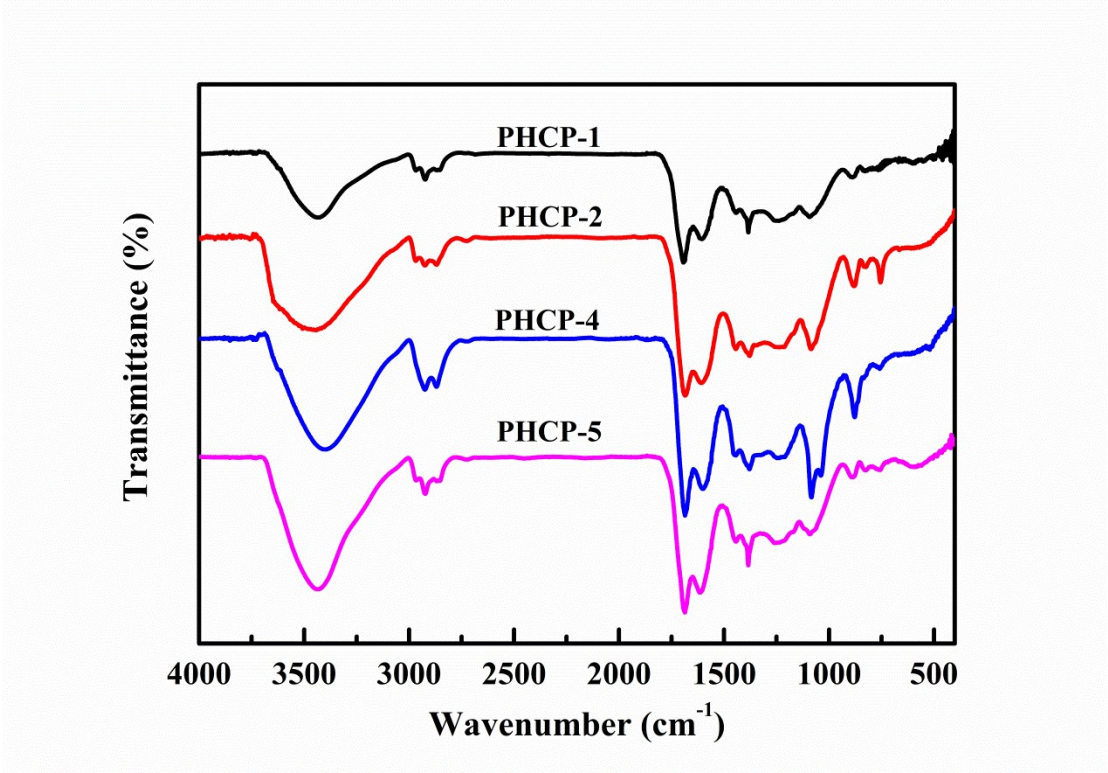

Figure S1. The FT-IR spectra of the PHCP-1, PHCP-2, PHCP-4 and PHCP-5.

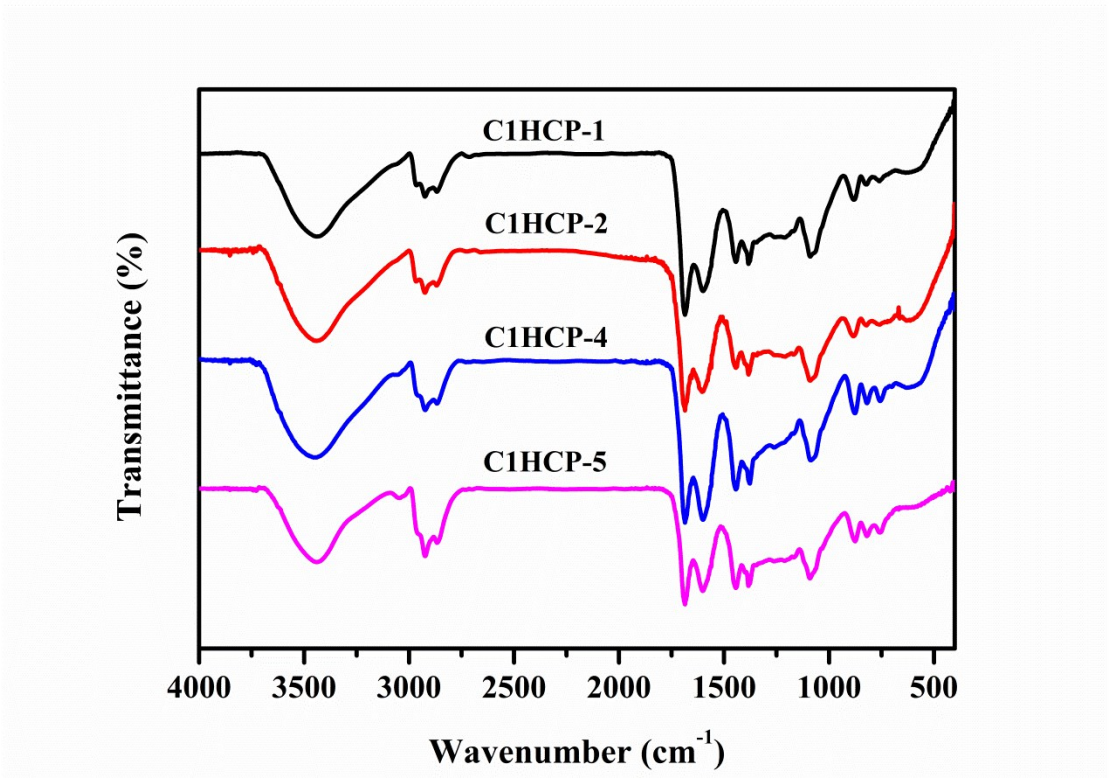

Figure S2. The FT-IR spectra of C1HCP-1, C1HCP-2, C1HCP-4 and C1HCP-5.

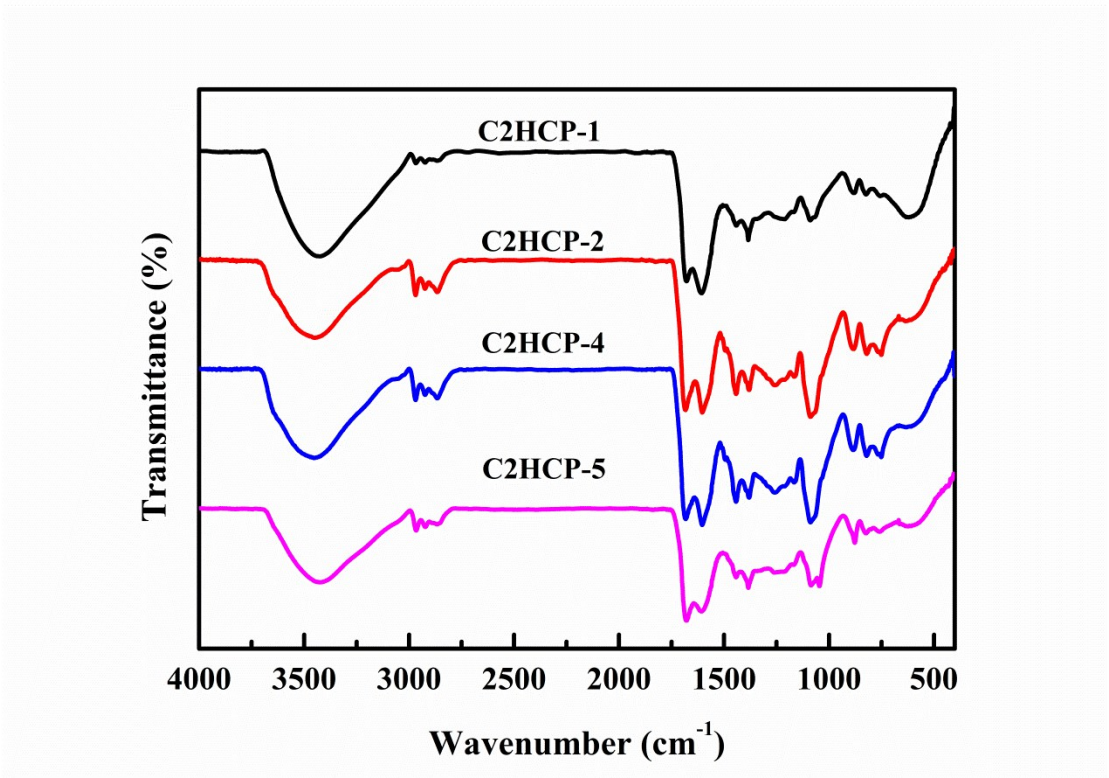

Figure S3. The FT-IR spectra of C2HCP-1, C2HCP-2, C2HCP-4 and C2HCP-5.

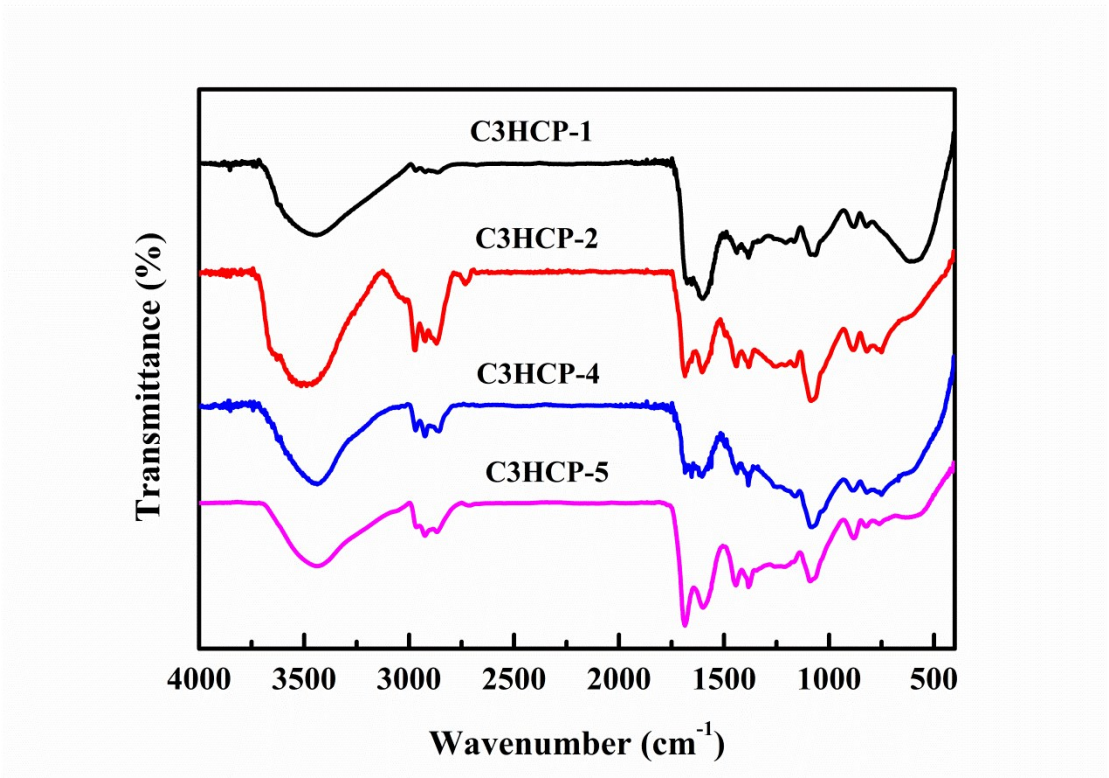

Figure S4. The FT-IR spectra of C3HCP-1, C3HCP-2, C3HCP-4 and C3HCP-5.

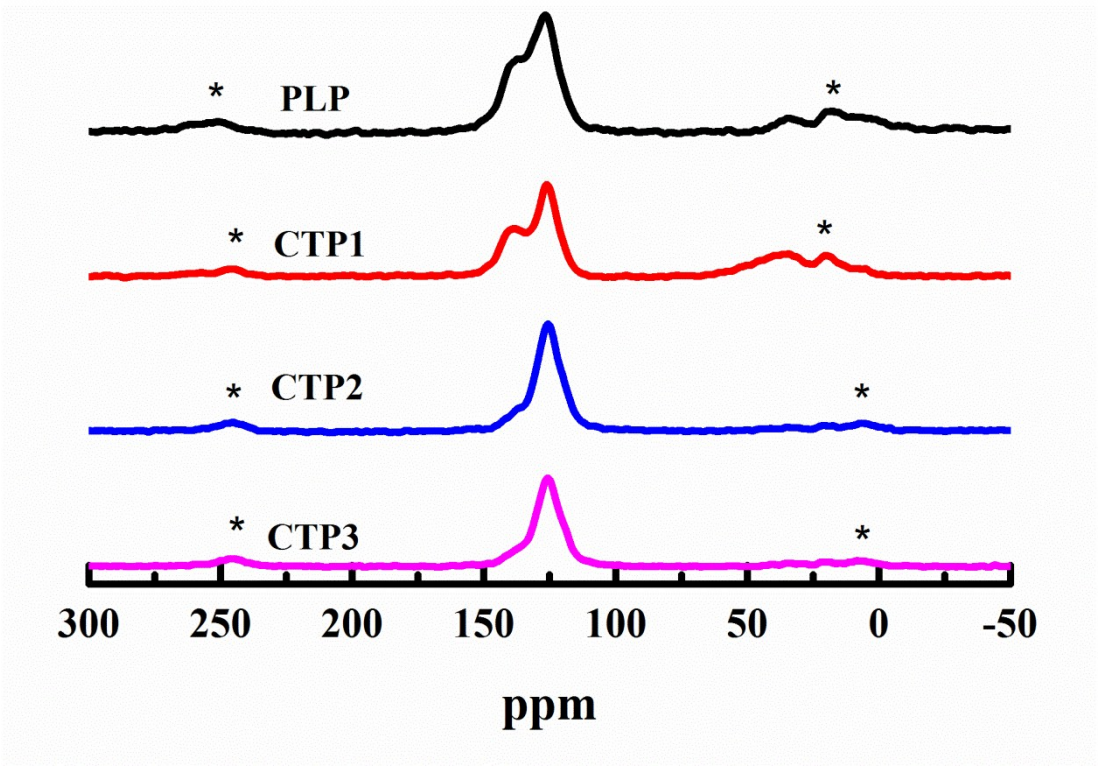

Figure S5. Solid state ^{13}C cross-polarization nuclear magic-angle spinning (CP/MAS) NMR spectra of PLP, CTP1, CTP2 and CTP3. Asterisks denote spinning sidebands.

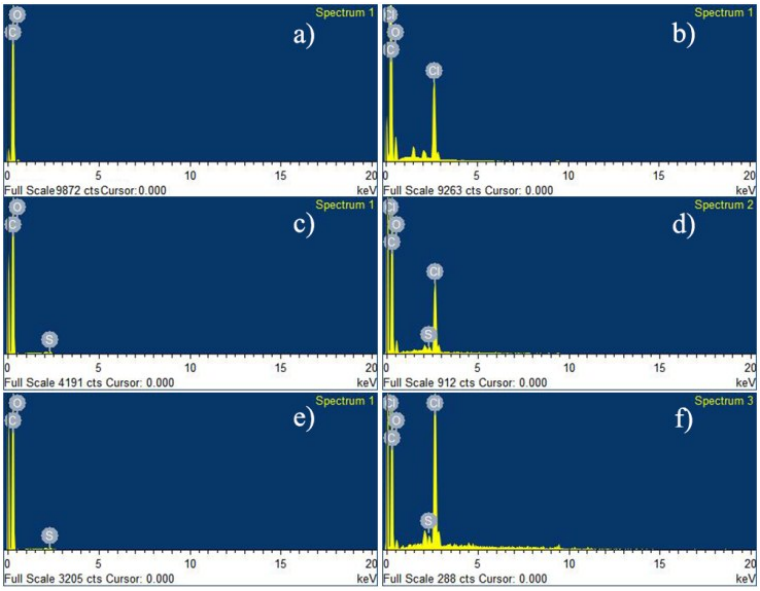

Figure S6. EDS results of the PLP (a), PHCP-3 (b), CTP2 (c), C2HCP-3 (d), CTP3 (e) and C3HCP-3 (f).

Table S2. Elemental analysis of pitch-based HCPs.

Samples	C/wt%	H/wt%	S/wt%
PHCP-3	69.27	3.68	1.00
C1HCP-3	74.42	4.21	0.21
C2HCP-3	49.36	4.29	0.36
C3HCP-3	69.40	3.97	0.88

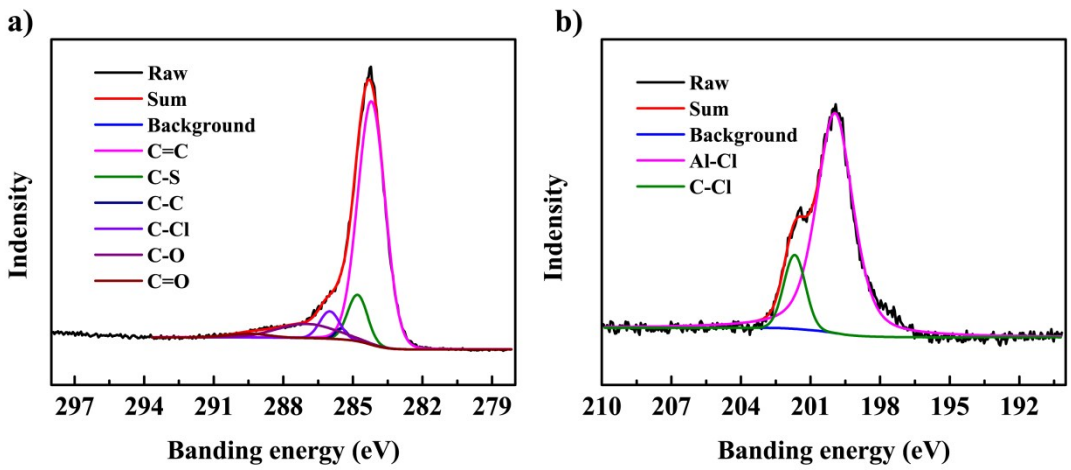

Figure S7. C 1s (a) and Cl 2p (b) XPS spectra of C1HCP-3.

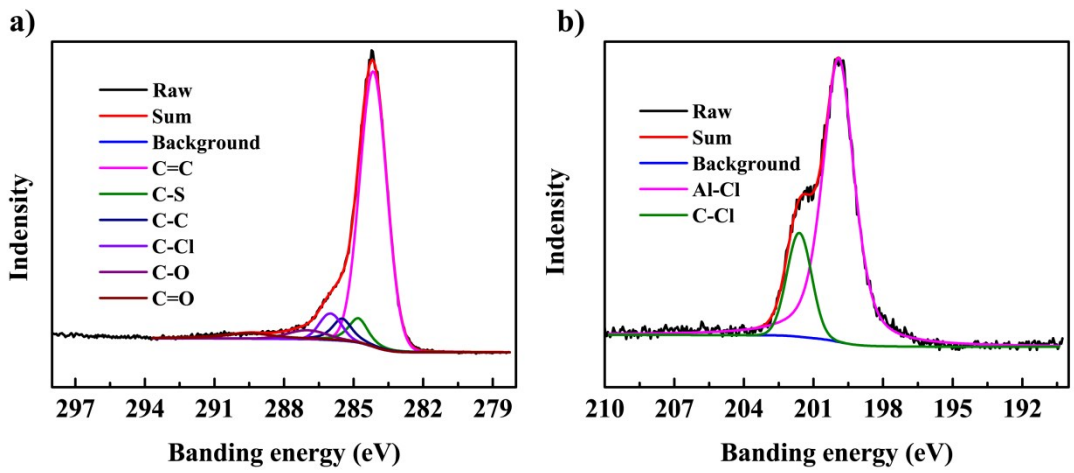

Figure S8. C 1s (a) and Cl 2p (b) XPS spectra of C2HCP-3.

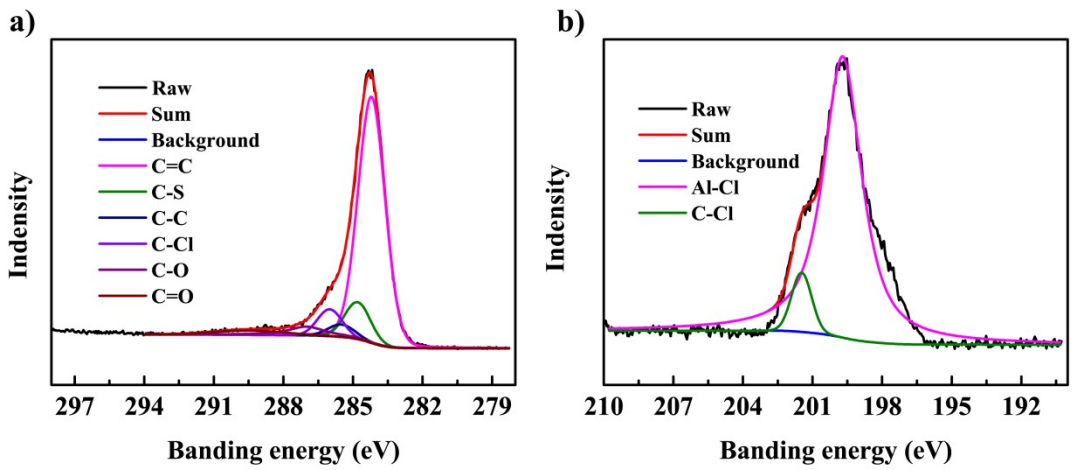

Figure S9. C 1s (a) and Cl 2p (b) XPS spectra of C3HCP-3.

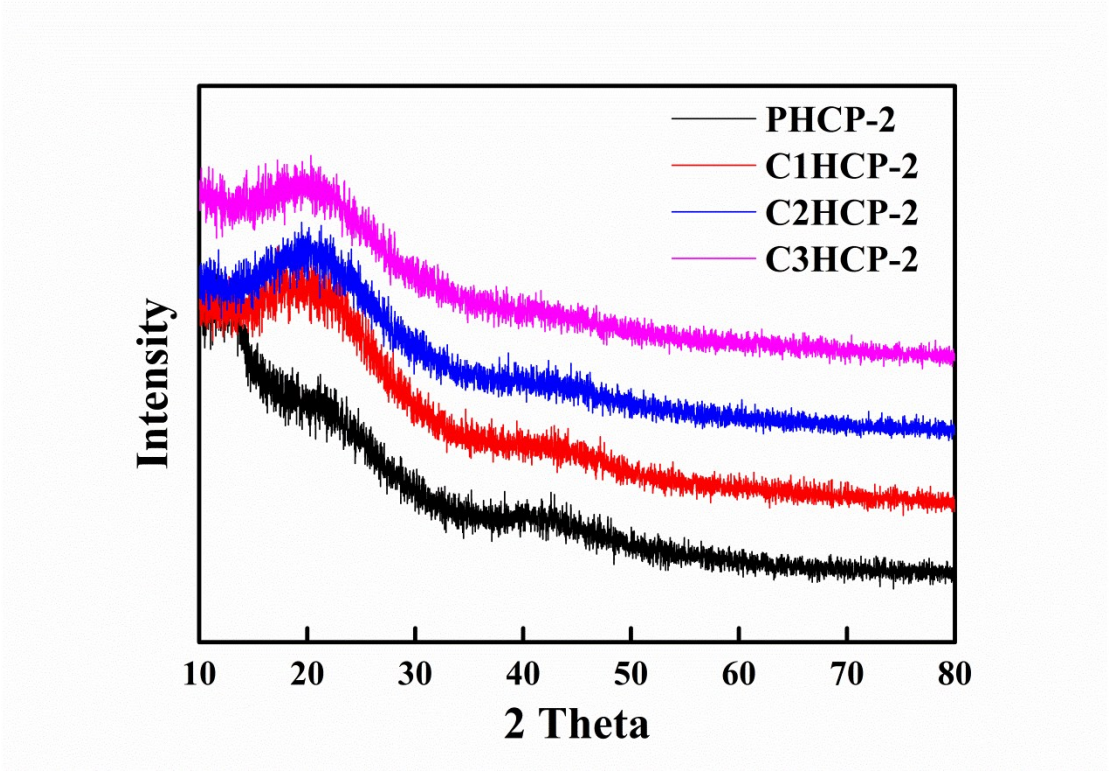

Figure S10. X-ray diffractions spectra of PHCP-2, C1HCP-2, C2HCP-2 and C3HCP-2.

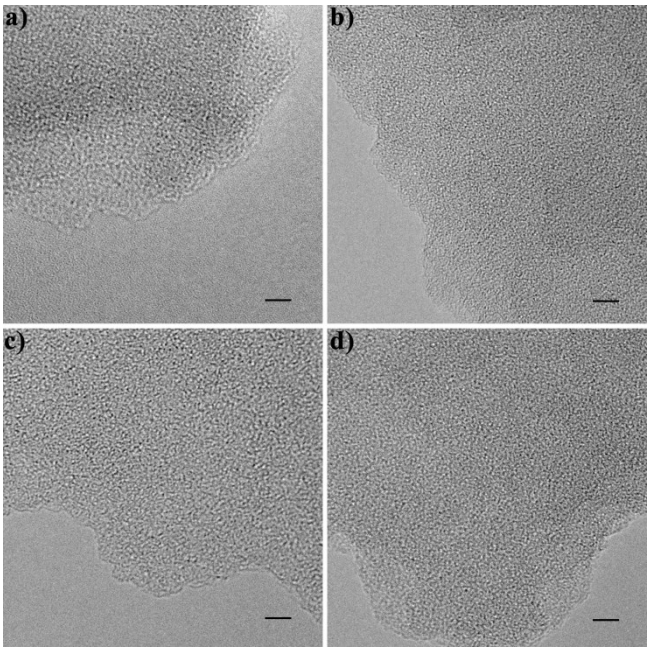

Figure S11. HR-TEM images of PHCP-3 (a), C1HCP-3 (b), C2HCP-3 (c) and C3HCP-3 (d). Scale bar: 5 nm.

Table S3. Surface areas and pore properties of pitch-based HCPs.

Sample	S_{BET}[a] ($m^2\ g^{-1}$)	S_{Micro}[b] ($m^2\ g^{-1}$)	M_{PV}[c] ($cm^3\ g^{-1}$)	PV[d] ($cm^3\ g^{-1}$)
PHCP-1	1119	810	0.48	0.68
PHCP-2	1197	816	0.51	0.74
PHCP-4	1063	765	0.46	0.67
PHCP-5	1108	776	0.48	0.69
C1HCP-1	752	570	0.33	0.42
C1HCP-2	845	689	0.37	0.48
C1HCP-4	751	495	0.32	0.46
C1HCP-5	629	415	0.27	0.43
C2HCP-1	587	475	0.26	0.32
C2HCP-2	621	497	0.27	0.36
C2HCP-4	848	621	0.37	0.51
C2HCP-5	788	579	0.34	0.45
C3HCP-1	345	273	0.15	0.21
C3HCP-2	493	369	0.21	0.31
C3HCP-4	434	325	0.19	0.30
C3HCP-5	375	311	0.16	0.22

[a] Surface area calculated from the nitrogen adsorption isotherms at 77.3 K using the BET equation. [b] Micropore surface area calculated from the nitrogen adsorption isotherms at 77.3 K using the t-plot equation. [c] Micropore volume calculated from the nitrogen isotherm at P/P_0 = 0.15, 77.3 K using the t-plot equation. [d] Pore volume calculated from the nitrogen isotherm at P/P_0 = 0.99, 77.3 K.

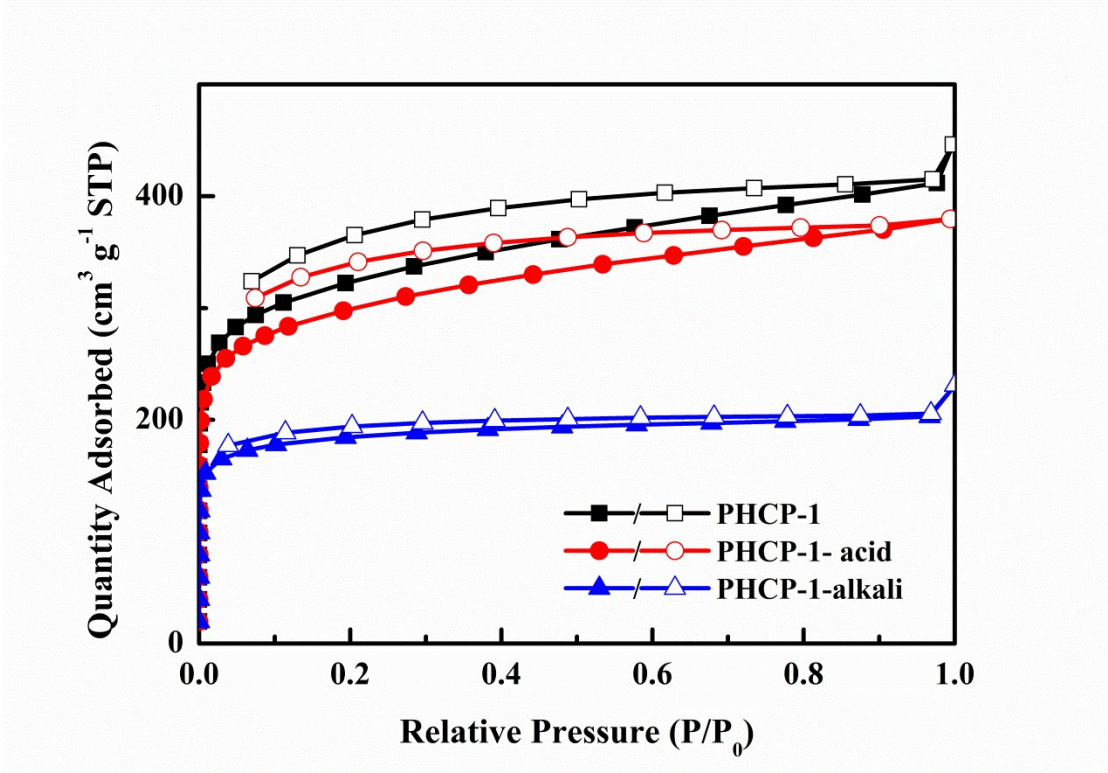

Figure S12. Nitrogen adsorption-desorption isotherms for PHCP-1 before and after being immersed and stirred in 1 M NaOH (blue) and 1 M HCl (red) for 24 h, respectively.

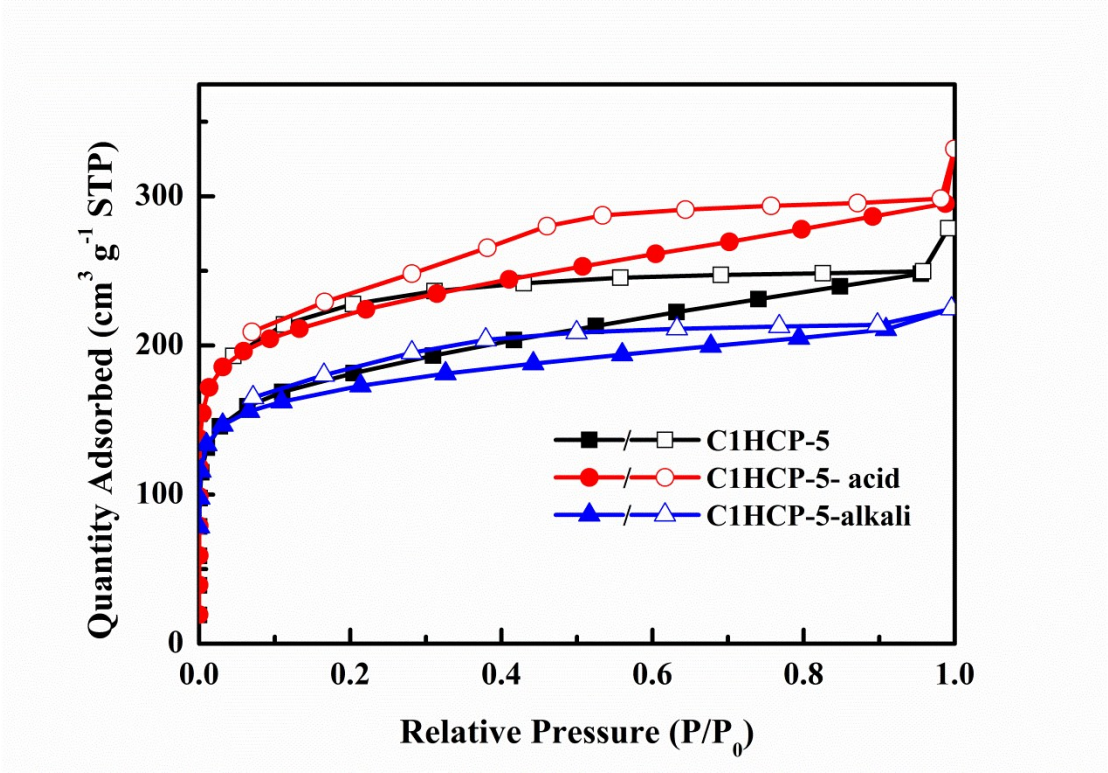

Figure S13. Nitrogen adsorption-desorption isotherms for C1HCP-5 before and after being immersed and stirred in 1 M NaOH (blue) and 1 M HCl (red) for 24 h, respectively.

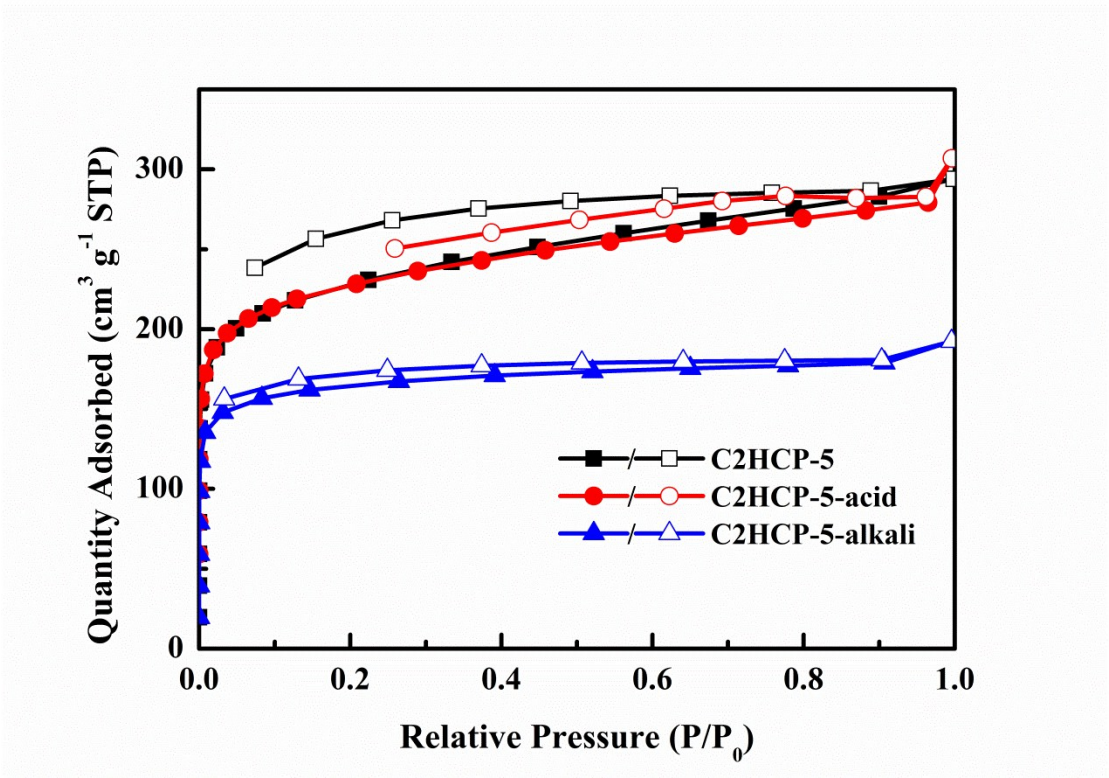

Figure S14. Nitrogen adsorption-desorption isotherms for C2HCP-5 before and after being immersed and stirred in 1 M NaOH (blue) and 1 M HCl (red) for 24 h, respectively.

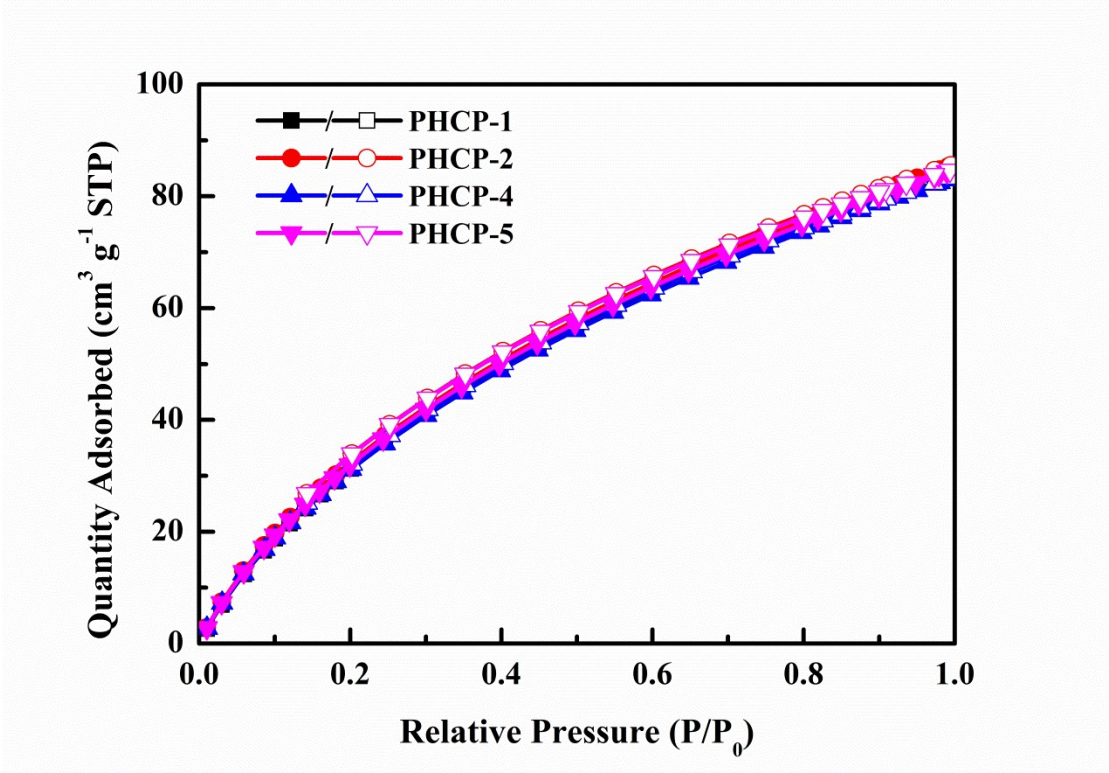

Figure S15. Adsorption (filled) and desorption (empty) isotherms of CO_2 at 273 K for PHCP-1, PHCP-2, PHCP-4 and PHCP-5.

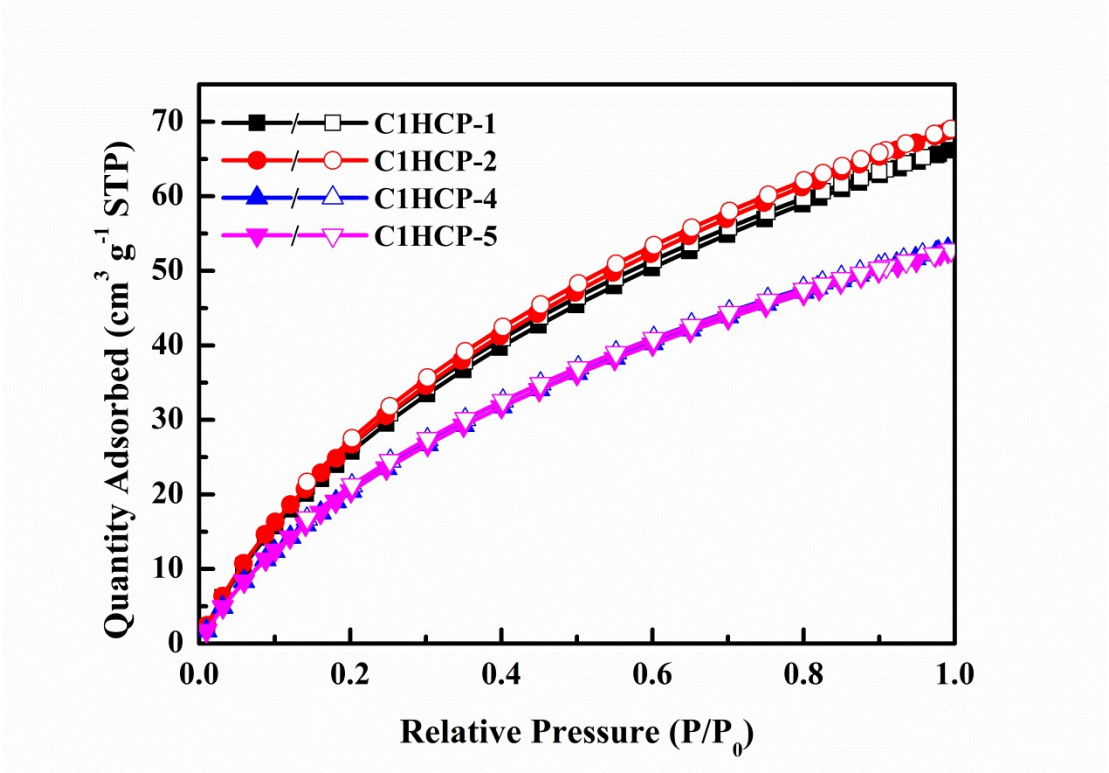

Figure S16. Adsorption (filled) and desorption (empty) isotherms of CO_2 at 273 K for C1HCP-1, C1HCP-2, C1HCP-4 and C1HCP-5.

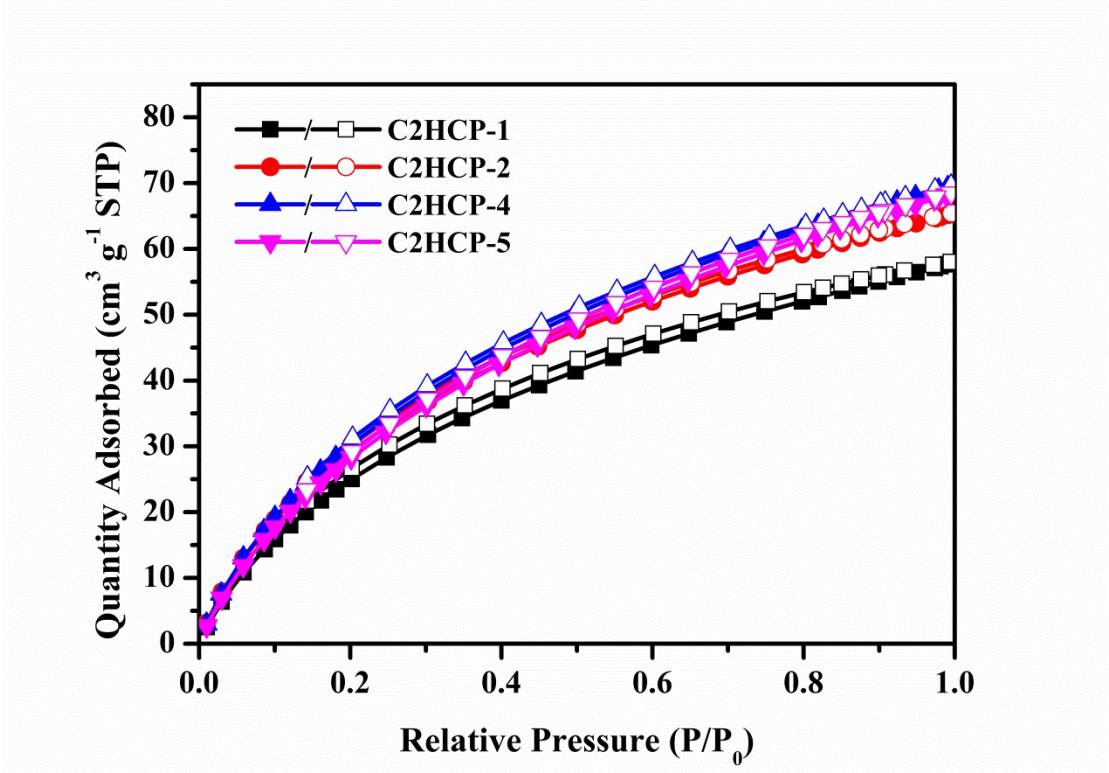

Figure S17. Adsorption (filled) and desorption (empty) isotherms of CO_2 at 273 K for C2HCP-1, C2HCP-2, C2HCP-4 and C2HCP-5.

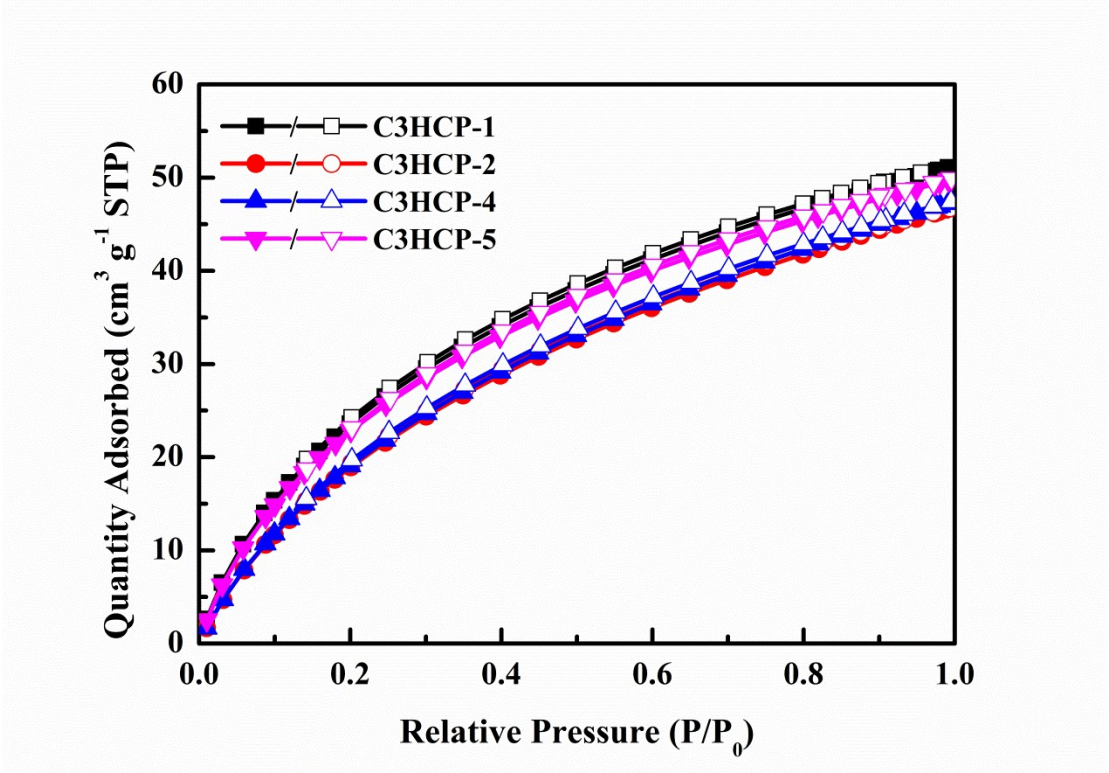

Figure S18. Adsorption (filled) and desorption (empty) isotherms of CO_2 at 273 K for C3HCP-1, C3HCP-2, C3HCP-4 and C3HCP-5.

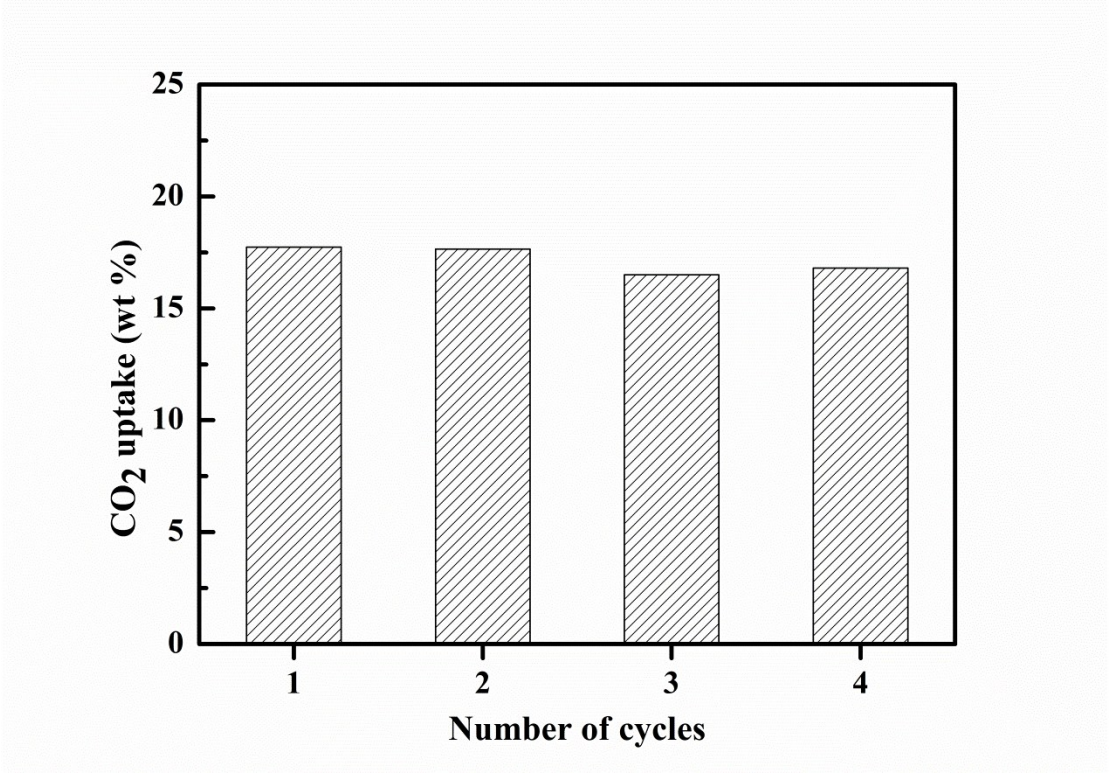

Figure S19. CO_2 adsorption capacity for recycled PHCP-3 at 273 K, 1.0 bar.

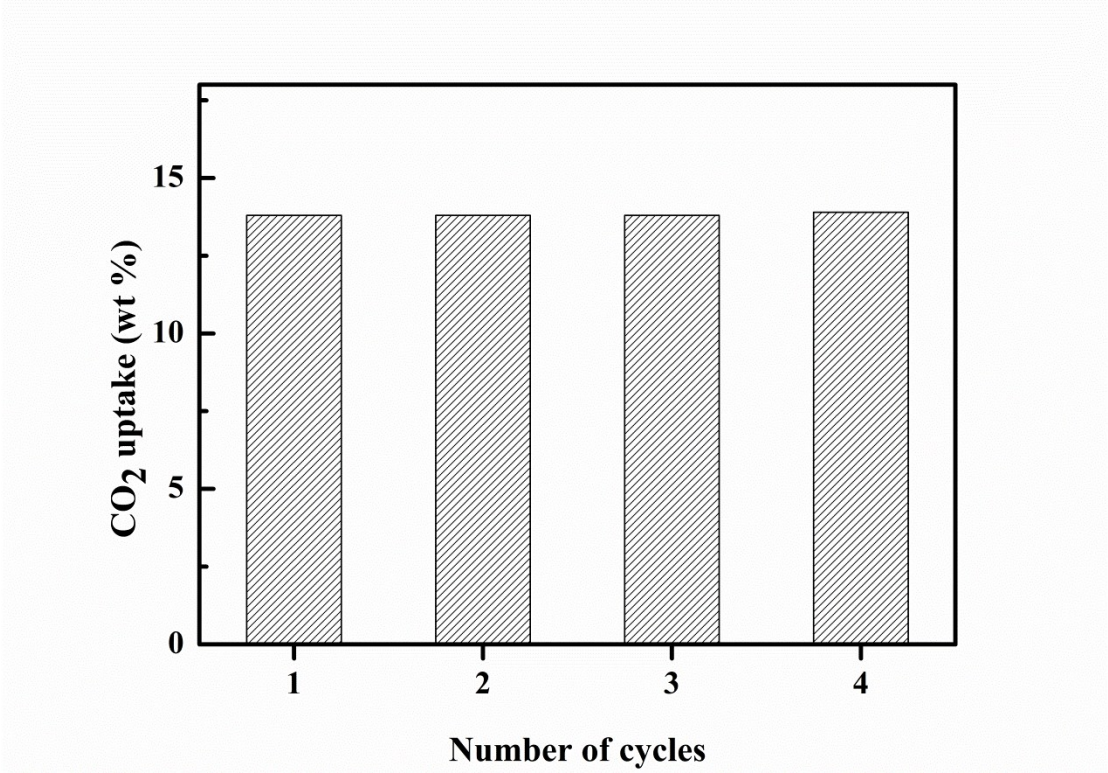

Figure S20. CO_2 adsorption capacity for recycled C1HCP-2 at 273 K, 1.0 bar.

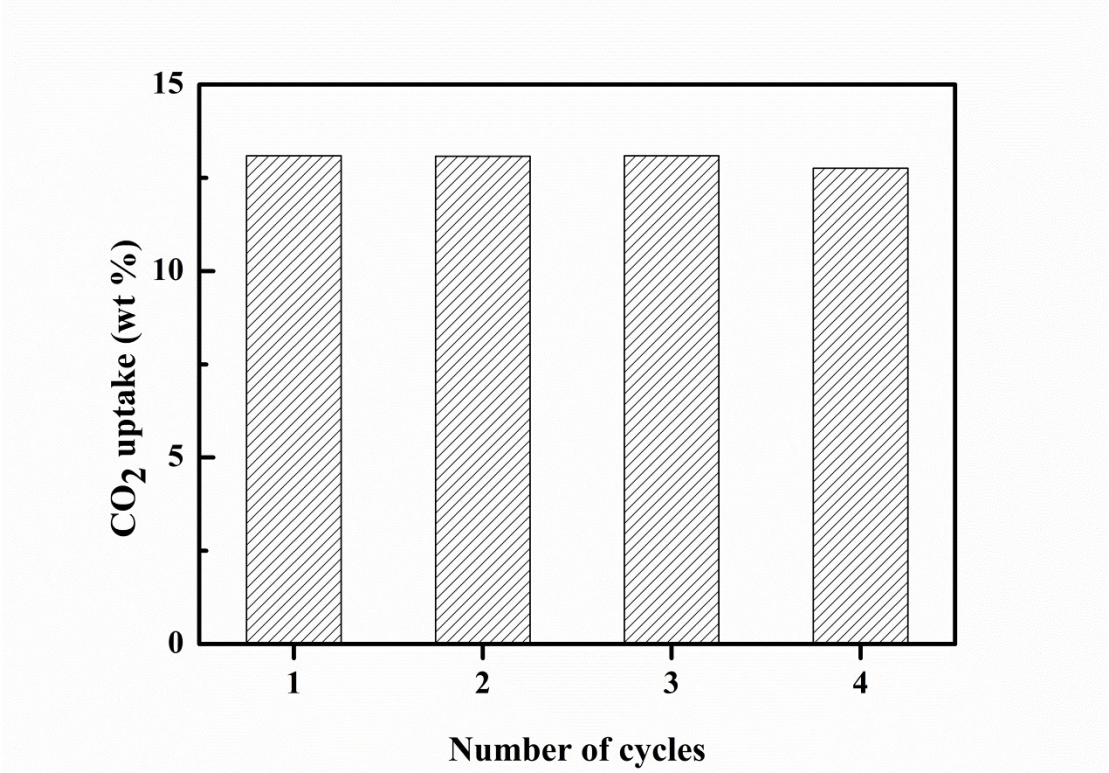

Figure S21. CO_2 adsorption capacity for recycled C2HCP-2 at 273 K, 1.0 bar.

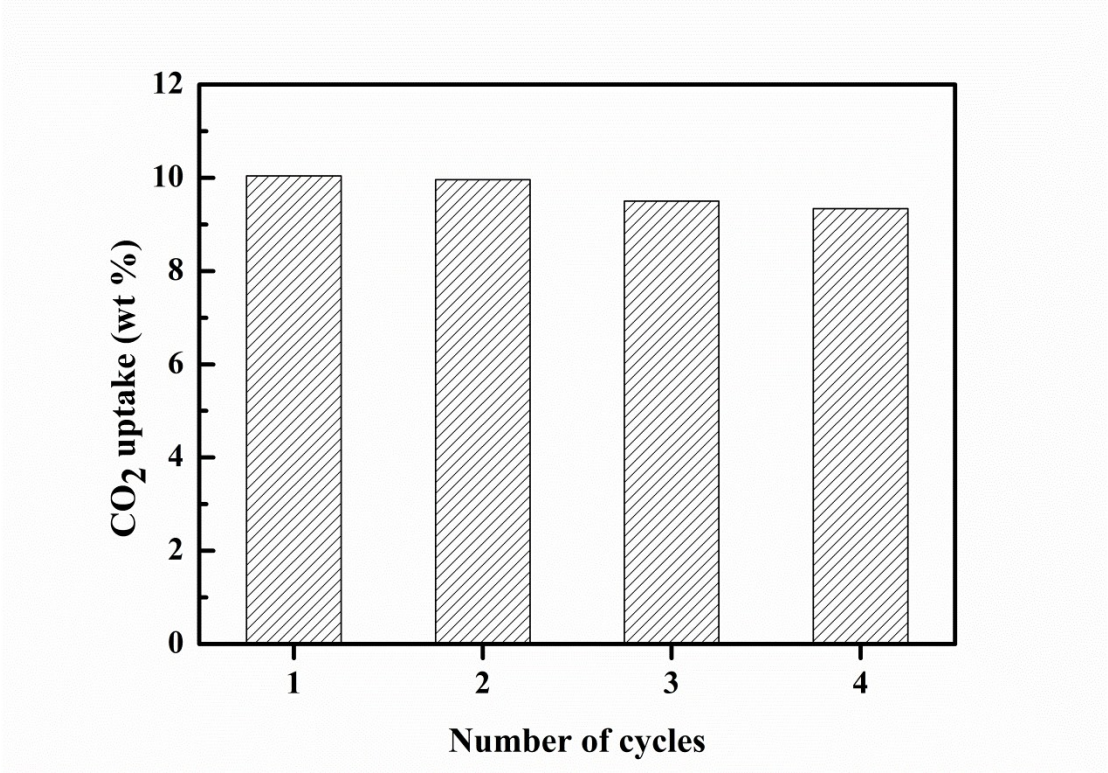

Figure S22. CO_2 adsorption capacity for recycled C3HCP-2 at 273 K, 1.0 bar.

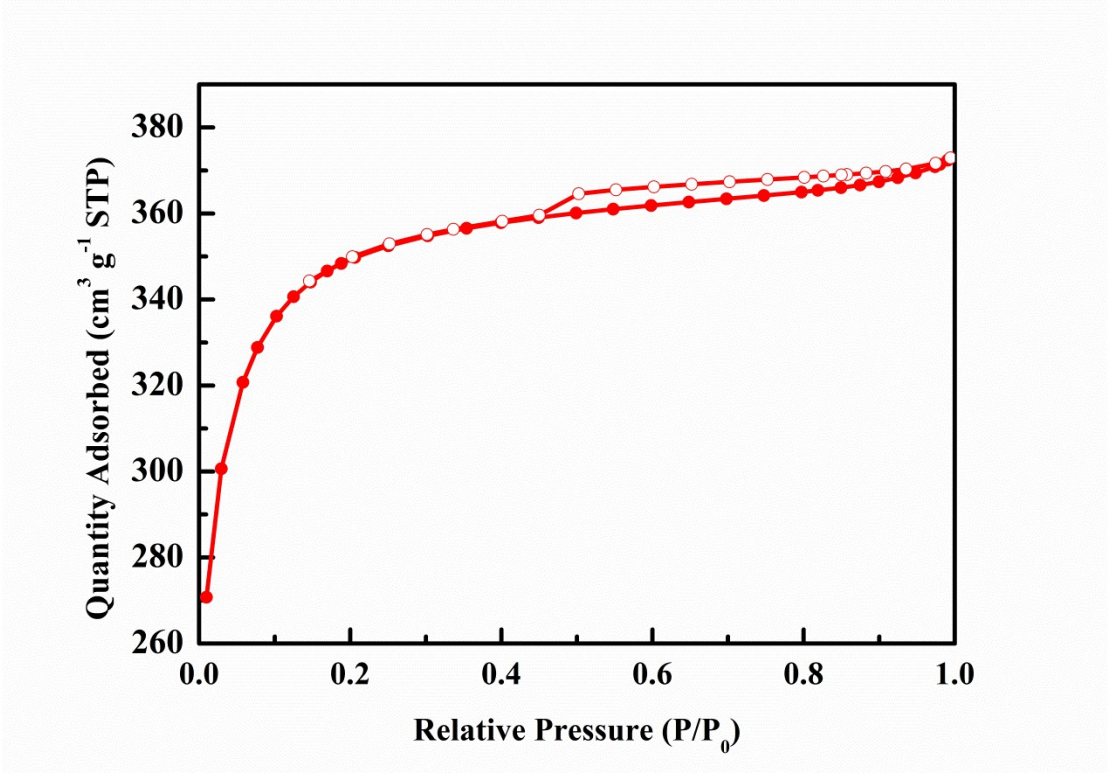

Figure S23. Nitrogen adsorption/desorption isotherms for activated carbon.