

Figure S1. SEM images of (a) HPCS and (b) FHPCS.

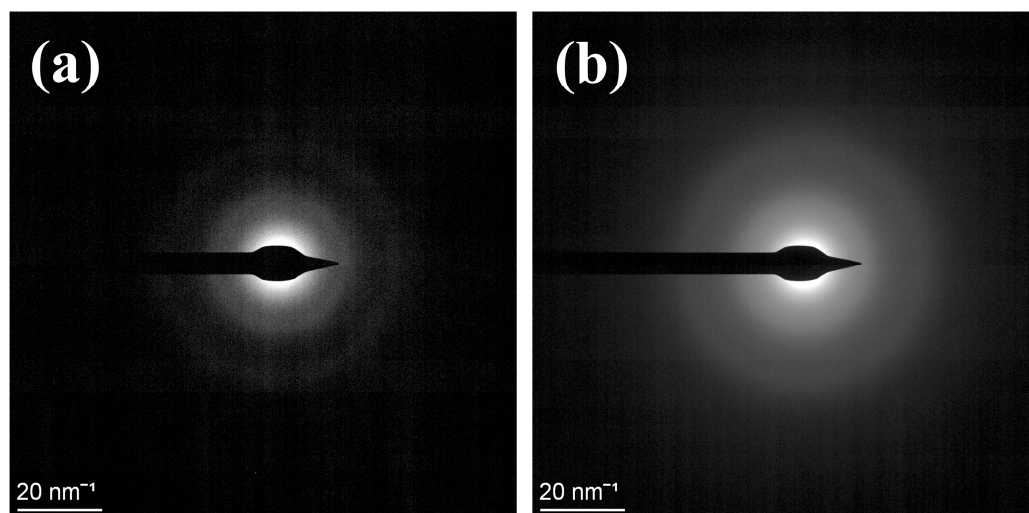


Figure S2. SAED patterns of (a) HPCS and (b) FHPCS.

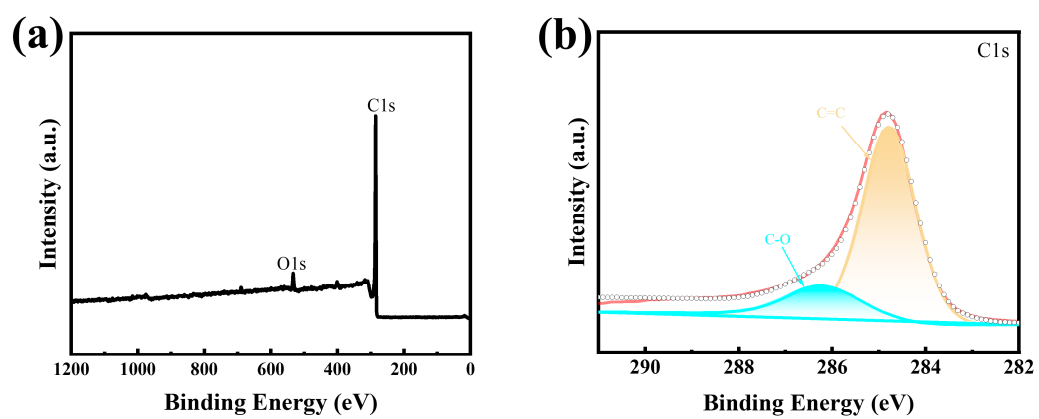


Figure S3. (a) XPS survey spectrum and (b) high resolution C1s spectrum of HPCS.

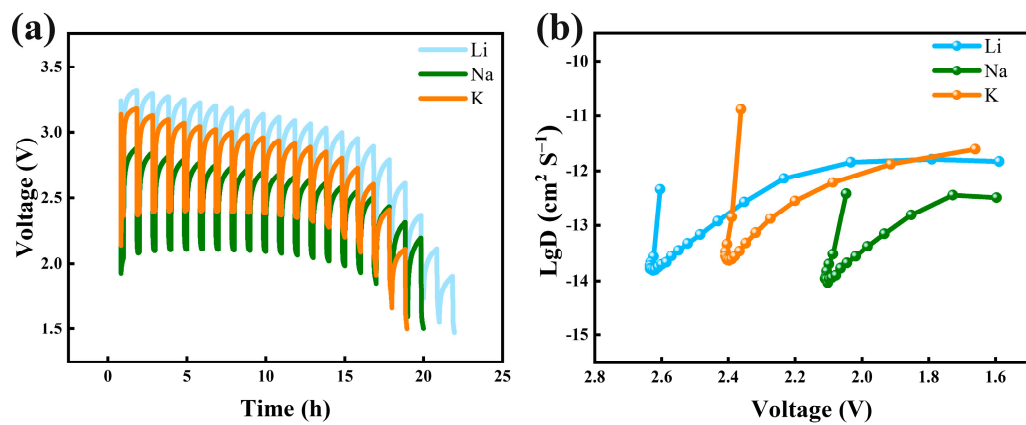


Figure S4. (a) GITT discharge profiles of LPB, SPB and PPB at 200 mA g⁻¹ (b) Comparison of diffusion coefficients of Li⁺, Na⁺ and K⁺.

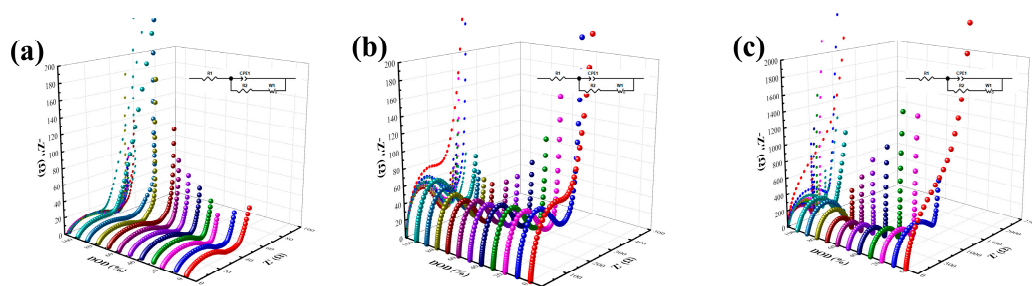


Figure S5. Nyquist plots of FHPCS cathode under different DOD (a) in LPB, (b) in SPB and (c) in PPB.

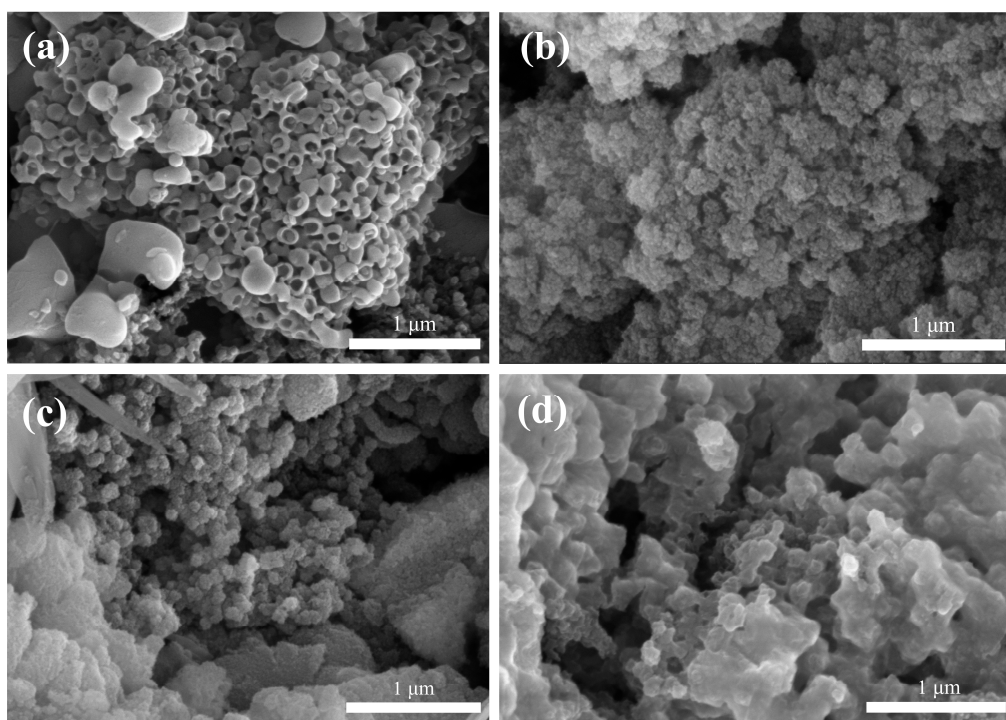


Figure S6. SEM images of FHPCS cathode (a) before discharge, (b) after discharge in LPB (c) after discharge in SPB and (d) after discharge in PPB.

Table S1. The obtained parameters from the N₂ adsorption-desorption isotherms of HPCS and FHPCS

Sample	Surface area (m² g⁻¹)	Micropore surface area (m² g⁻¹)	Micropore volume (cm³ g⁻¹)	Total pore volume (cm³ g⁻¹)	Pore width (nm)
HPCS	927.054	266.70	0.084369	0.1434	7.069
FHPCS	245.623	189.75	0.069391	0.1500	0.567

Table S2. Element contents and F/C ratios of HPCS and FHPCS

Sample	C (%)	F (%)	O (%)	F/C
HPCS	94.61	/	5.39	/
FHPCS	42.40	56.60	1.00	1.33

Table S3. C1s peak and F1s peak assignments and proportions of FHPCS

Sample	C1s assignment						F1s assignment		
	C=C	C–C	Semi-ionic	Covalent	CF ₂	CF ₃	Semi-ionic	Covalent	–CF ₂ /–CF ₃
	(%)	(%)	C–F	C–F	(%)	(%)	C–F	C–F	(%)
			(%)	(%)			(%)	(%)	
FHPCS	284.8	287.7	289.5	290.2	291.1	292.2	689.7	689.1	690.2
	(5.20)	(9.64)	(7.06)	(35.28)	(20.01)	(22.81)	(8.85)	(81.83)	(9.32)

Table S4. Comparison of the discharge performances of the FHPCS in this study and previously reported CF_x cathodes.

References in MS	Materials	Specific capacity (mAh g ⁻¹)	Power density (W kg ⁻¹)	Electrode components	Electrolyte
Ref.18	Fluorinated carbon nanohorns	797 at 40 mA g ⁻¹ ~689 at 800 mA g ⁻¹ ~565 at 4 A g ⁻¹ ~518 at 8 A g ⁻¹ ~482 at 16 A g ⁻¹	~838 at 800 mA g ⁻¹ ~6420 at 4 A g ⁻¹ ~15595 at 8 A g ⁻¹ 36579 at 16 A g ⁻¹	CF ₃ : SP: PVDF (80:10:10, wt. %)	1.0 M LiBF ₄ PC: DME (1: 1 vol.%)
Ref.19	Fluorinated ketjenblack	925 at 40 mA g ⁻¹ 824 at 800 mA g ⁻¹ 781 at 3.2 A g ⁻¹ 694 at 8 A g ⁻¹ 650 at 16 A g ⁻¹	~2014 at 800 mA g ⁻¹ ~7738 at 3.2 A g ⁻¹ ~16978 at 8 A g ⁻¹ 27493 at 16 A g ⁻¹	CF ₃ : SP: PVDF (80:10:10, wt. %)	1.0 M LiBF ₄ PC: DME (1: 1 vol.%)
Ref.20	Fluorinated microporous carbon spheres	955 at 8 mA g ⁻¹ ~823 at 800 mA g ⁻¹ ~729 at 4 A g ⁻¹ 675 at 8 A g ⁻¹	2012 at 800 mA g ⁻¹ 9343 at 4 A g ⁻¹ 16814	CF ₃ : SP: PVDF (80:10:10, wt. %)	1.0 M LiFSI PC: DME (1:1, vol.%)
Ref.22	Fluorinated multi-walled carbon nanotubes	798 at 10 mA g ⁻¹ 581 at 100 mA g ⁻¹ 525 at 1000 mA g ⁻¹	1443 at 100 mA g ⁻¹ 1207 at 1000 mA g ⁻¹	CF ₃ : SP: PVDF (80:10:10, wt. %)	1.0 M LiClO ₄ PC: DME: DOL (1:1:1, vol.%)
Ref. 36	Carbon-Wrapped Fluorinated Hard Carbon	905 at 8 mA g ⁻¹ ~733 at 4 A g ⁻¹ ~703 at 8 A g ⁻¹ ~625 at 16 A g ⁻¹	8367 at 4 A g ⁻¹ 16325 at 8 A g ⁻¹ ~40461 at 16 A g ⁻¹	CF ₃ : SP: CMC (80:10:10, wt. %)	1.0 M LiBF ₄ EC: DMC: EMC (1:1:1 vol.%)
Ref. 37	Fluorinated N, P co-doped biomass carbon	920 at 8 mA g ⁻¹ 808 at 0.8 A g ⁻¹ 754 at 4 A g ⁻¹ 727 at 8 A g ⁻¹ 702 at 16 A g ⁻¹	1886 at 0.8 A g ⁻¹ 8455 at 4 A g ⁻¹ 16263 at 8 A g ⁻¹ 30363 at 16 A g ⁻¹	CF ₃ : SP: CMC (80:10:10, wt. %)	1.0 M LiFSI PC: DME (1:1 vol.%)
Ref.38	Fluorinated MOF-derived multifunctional nano-porous	850.3 at 10 mA g ⁻¹ ~681 at 100 mA g ⁻¹ ~546 at 1000 mA g ⁻¹ ~362 at 2000 mA g ⁻¹	~5785 at 100 mA g ⁻¹ ~6510 at 1000 mA g ⁻¹ 6540 at 2000 mA g ⁻¹	CF ₃ : SP: PVDF (80:10:10, wt. %)	1.0 M LiPF ₆ PC: DME (1:1, vol.%)
Ref.39	Carbon-coated fluorinated graphite	865 at 40 mA g ⁻¹ 650 at 800 mA g ⁻¹ 370 at 1.6 A g ⁻¹	2068 at 800 mA g ⁻¹ 3526 at 1.6 A g ⁻¹	CF ₃ : SP: PVDF (75:15:10, wt. %)	1.0 M LiPF ₆ EC: DEC (1:1, wt.%)

Ref.40	Sub-	775 at 8 mA g ⁻¹		CF ₂ : SP: PVDF	1.0 M LiPF ₆ EC: DMC: DEC
	fluorinated	520 at 800 mA g ⁻¹	~1444 at 800 mA g ⁻¹	(80:10:10, wt. %)	(1:1:1, vol.%)
	graphite	413 at 1.6 A g ⁻¹	~2809 at 1.6 A g ⁻¹		
	fluorides	228 at 3.2 A g ⁻¹	4038 at 3.2 A g ⁻¹		
Ref.41	Fluorinated	922 at 8 mA g ⁻¹		CF ₂ : SP: PVDF	1.0 M LiBF ₄ PC: DME (1:1,
	hard carbon	672 at 800 mA g ⁻¹	~2312 at 800 mA g ⁻¹	(80:10:10, wt. %)	wt.%)
		556 at 4 A g ⁻¹	8740 at 4 A g ⁻¹		
Ref.42	Fluorinated	939 at 8 mA g ⁻¹		CF ₂ : SP: PVDF	1.0 M LiBF ₄ PC: DME (1:1,
	single-walled	~465 at 800 mA g ⁻¹	~2268 at 800 mA g ⁻¹	(80:10:10, wt. %)	wt.%)
	carbon	~176 at 1.6 A g ⁻¹	~4298 at 1.6 A g ⁻¹		
	nanotubes				
This work	FHPCS	780 at 8 mA g ⁻¹		CF ₂ : SP: CMC	1.0 M LiFSI PC: DME (1:1,
		692 at 800 mA g ⁻¹	1870 at 800 mA g ⁻¹	(80:10:10, wt. %)	vol.%)
		672 at 4 A g ⁻¹	8658 at 4 A g ⁻¹		
		651 at 8 A g ⁻¹	18027 at 8 A g ⁻¹		
		631 at 16 A g ⁻¹	30400 16 A g ⁻¹		