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Graphene-Directed Two-Dimensional Porous Carbon Frameworks for High-Performance Lithium-Sulfur Battery Cathodes

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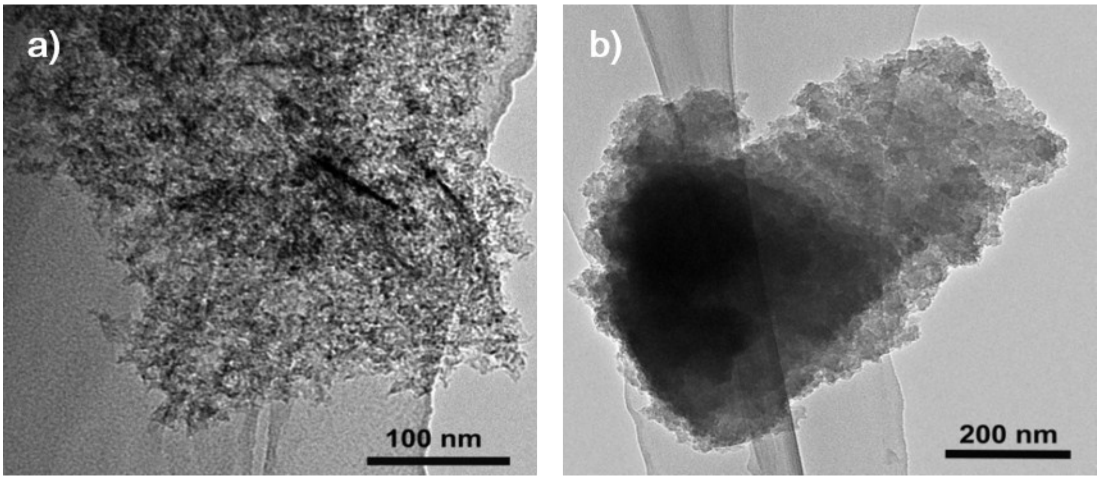

Fig. S1 TEM images of a) GPF-*3* and b) PF.

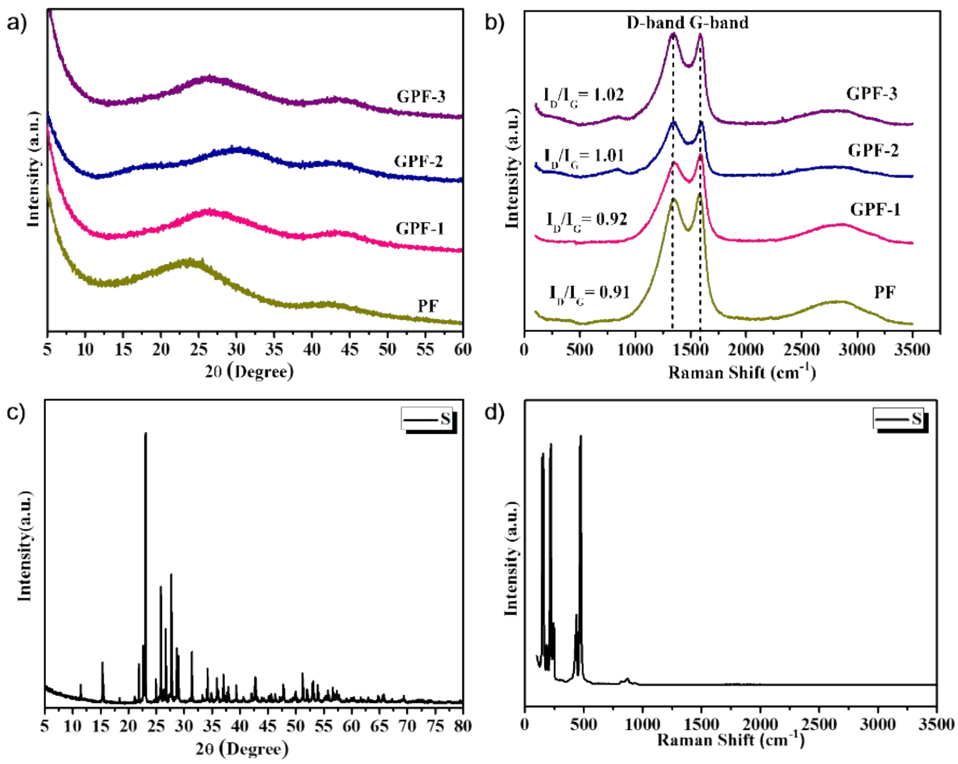

Fig. S2 XRD patterns of a) GPF-*n*, PF (*n*=*1*, *2*, *3*) and c) sublimed sulfur; Raman spectrum of b) GPF-*n*, PF (*n*=*1*, *2*, *3*) and d) sublimed sulfur.

Table S1. Porous Characteristics of GPF-*n* and PF.

Samples	S_{BET} [a] (m^2 g^{-1})	Total pore volume [b] (cm^3 g^{-1})	Average pore size [c] (nm)	Mesopore ratio (%)	S_{BET} [a] after sulfur loading (m^2 g^{-1})	Total pore volume [b] after sulfur loading (cm^3 g^{-1})
PF	1157	0.66	2.3	34	20	0.06
GPF-*1*	1285	0.93	2.9	60	15	0.07
GPF-*2*	1414	2.59	7.3	97	20	0.16
GPF-*3*	1683	1.57	3.7	82	14	0.07

[a] BET specific surface area. [b] At $P/P_0 = 0.99$. [c] Determined from density functional theory (DFT).

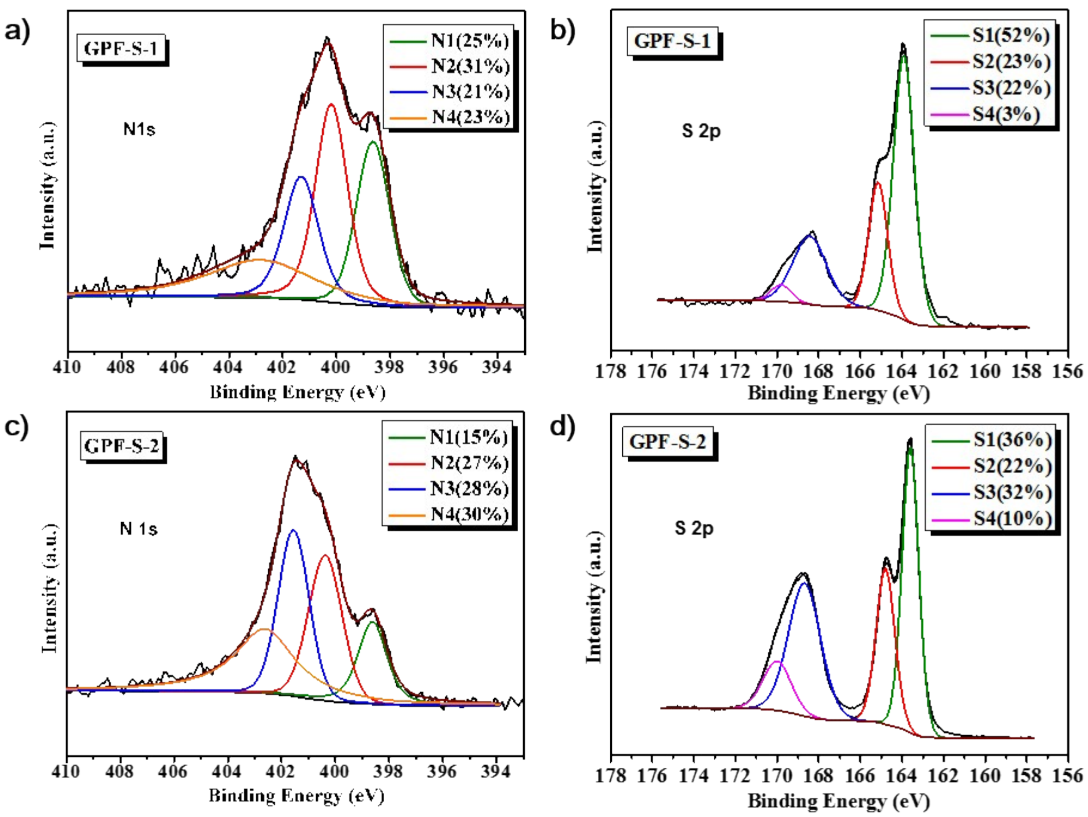

Fig. S3 N 1s XPS spectra of a) GPF-S-*1* and c) GPF-S-*2*; S 2p XPS spectra of b) GPF-S-*1* and d) GPF-S-*2*.

Table S2. Quantitative elemental analysis of GPF-*n*.

Samples	Elements (wt %)		
	C	N	H
GPF-*1*	86.6	8.7	4.7
GPF-*2*	89.5	7.2	3.3
GPF-*3*	90.0	6.3	3.7

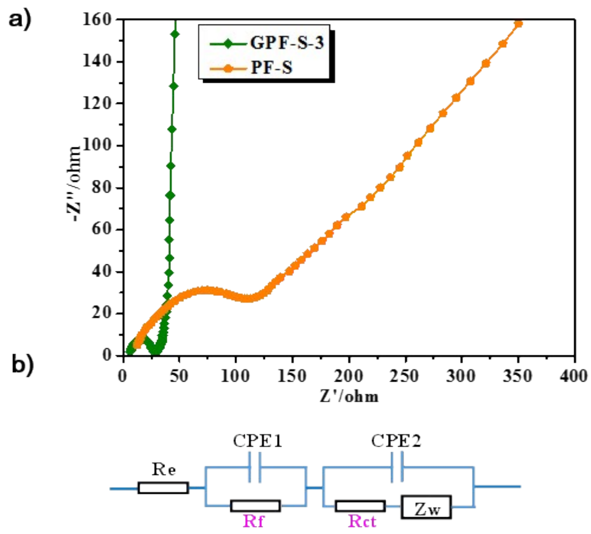

Fig. S4 a) Nyquist plots of PF-S and GPF-S-*3* electrodes obtained by applying a sine wave with amplitude of 5.0 mV over the frequency range 100 kHz to 0.1 Hz; b) equivalent circuit model of the studied system (R_e: the electrolyte resistance; R_f: the resistance of the surface film formed on the electrodes, namely contact resistance; R_{ct} : charge-transfer resistance).

Table S3. Kinetic parameters of GPF-S-*3* and PF-S electrodes.

Samples	R_f (Ω)	R_{ct} (Ω)
PF-S	56.89	146.50
GPF-S-*3*	18.52	24.33

Table S4. Comparison of the electrochemical performance of GPF-*3* and other literature reported porous carbon-based cathode materials for Li-S battery.

Samples	S_{BET}/m^2 g^{-1} (V_{tot}/cm^3 g^{-1})	Specific capacity/mAh g^{-1}			Ref.
		Initial capacity (current density)	Stabilized capacity (current density; cycle numbers)	Capacity at large current density (current density)	
Hollow carbon sphere	648	1070(0.5 C)	970(0.5 C;100)	450(3 C)	1
a-PCNS	1800(5.4)	1300(1 C)	720(1 C;100)		2
L-GPC	2500(1.937)	900(0.5 C)	650(0.5 C;100)	600(5 C)	3
GSH@APC	513(0.853)	1070(1 C)	877(1 C;150)	800(10 C)	4
CA	642(1.02)	1441(0.1 A g^{-1})	820(0.1 A g^{-1};50)	521(3.2 C)	5
MCNs-1	857(0.45)			450(1.8 C)	6
DTG	1628(2.0)	110(1 C)	750(1 C;200)	720(10 C)	7
OMC	2445(2.63)	1050(1 C)	965(1 C;100)		8
PAF	2023(1.73)	850(0.05 C)	700(0.05 C;50)		9
TTCN	822.8(1.77)	1270(0.5 A g^{-1})	915(0.5 A g^{-1};50)	565(6 A g^{-1})	10
N-ACNT/G	217(0.72)	1150(1 C)	900(1 C;80)	780(5 C)	11
PDA-NHC-S	1538(2.02)	1180(0.2 C)	720(0.2 C;200)		12
MMCS	1013(1.26)	1640(0.1 C)	1014(0.1 C;100)	600(2 C)	13
DUT-86	2450(4.97)	1190(0.1 C)	880(0.1 C;100)	200(1 C)	14
MNCS/CNT	615(2.07)	1438(0.84 mA cm^{-2})	1200(1.68 mA cm^{-2};200)		15
850PCNTs	367.2(1.68)	1080(1 C)	600(1 C;250)	150(15 C)	16
3D rGO-HCS	445.07(2.28)	901(0.5 C)	772(0.5 C;400)	770(4 C)	17
GPF-*3*	1683 (1.57)	1461(2 A g^{-1})	962(2 A g^{-1};120)	890(5 A g^{-1}); 652(15 A g^{-1}) 591(20 A g^{-1})	This work

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