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Anchoring MOF-derived CoS_2 on Sulfurized Polyacrylonitrile Nanofibers for High Areal Capacity Lithium Sulfur Batteries

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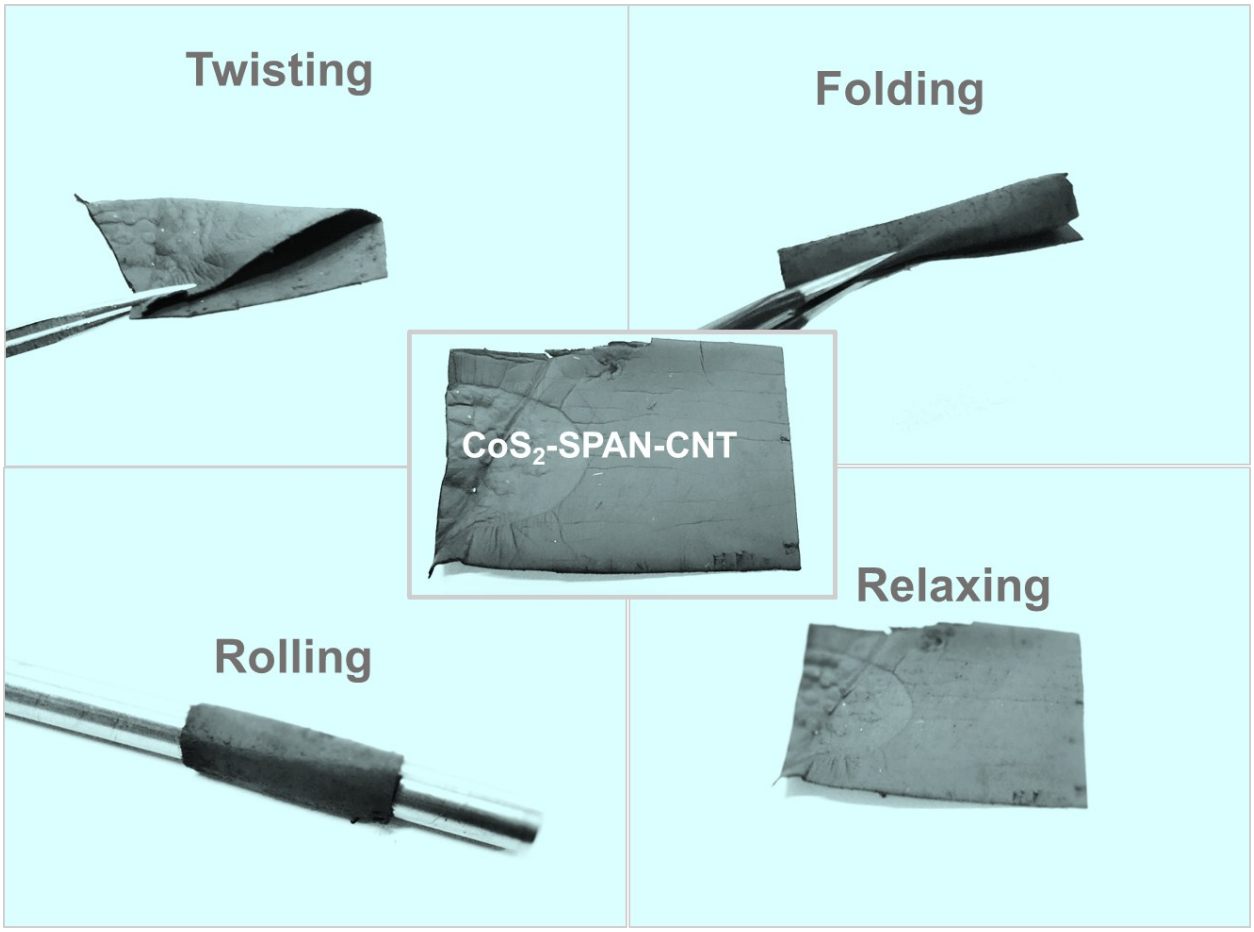

Fig. S1 Photographs of the flexible CoS_2-SPAN-CNT.

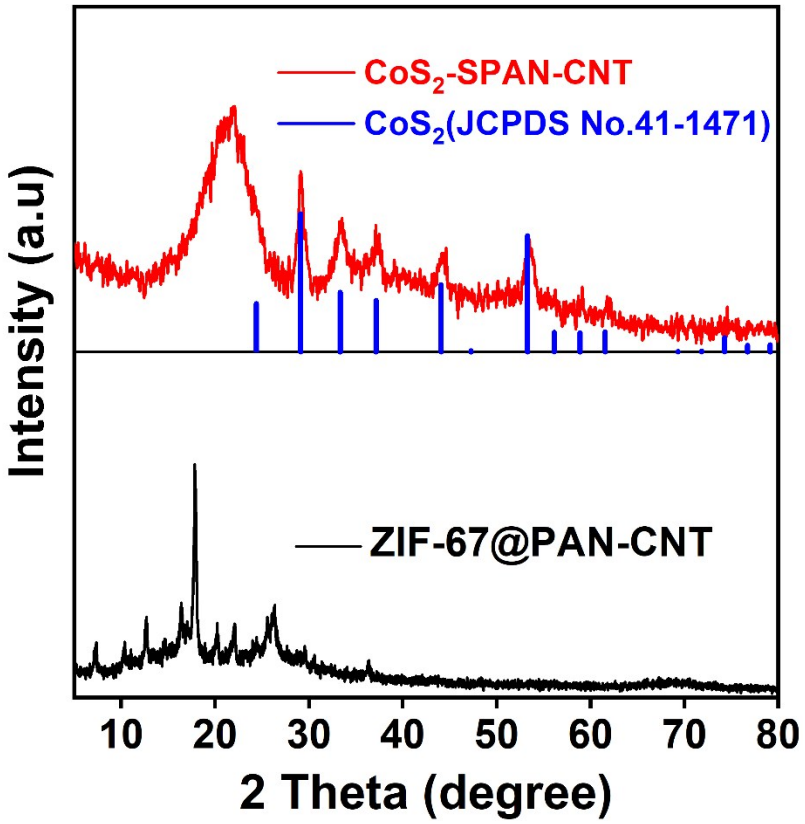

Fig. S2 XRD patterns of ZIF-67@PAN-CNT and Co_2S-SPAN-CNT.

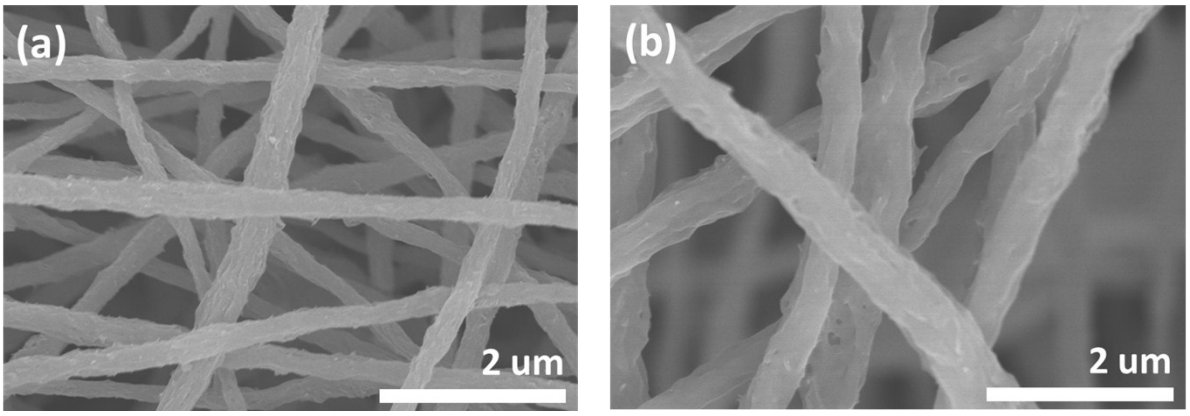

Fig. S3 FE-SEM images of (a) electrospun PAN-CNT and (b) SPAN-CNT.

Table S1. Electrode thickness and amount of electrolyte for composites with different sulfur loading.

Sample	Sulfur loading (mg cm^{-2})	Thickness (μm)	Electrolyte amount (μl)
CoS_2-SPAN-CNT	5.9	97	150
CoS_2-SPAN-CNT	4.9	90	120
CoS_2-SPAN-CNT	2.8	82	70
CoS_2-SPAN-CNT	2.4	77	60
CoS_2-SPAN-CNT	1.7	72	45
CoS_2-SPAN-CNT	0.7	64	20
SPAN-CNT	2.4	294	60
CoS_2-SPAN	2.4	95	60
SPAN	2.4	302	60

Table S2. BET analyses of CoS_2-SPAN-CNT and SPAN-CNT.

Material	Specific Surface Area (m^2 g^{-1})	Pore Volume (cm^3 g^{-1})	Average Pore Size (nm)
SPAN-CNT	27.3	0.08	16.6
CoS_2-SPAN-CNT	17.8	0.08	17.4

Fig. S4 The thickness comparison of CoS_2-SPAN-CNT and SPAN-CNT at specific sulfur loadings.

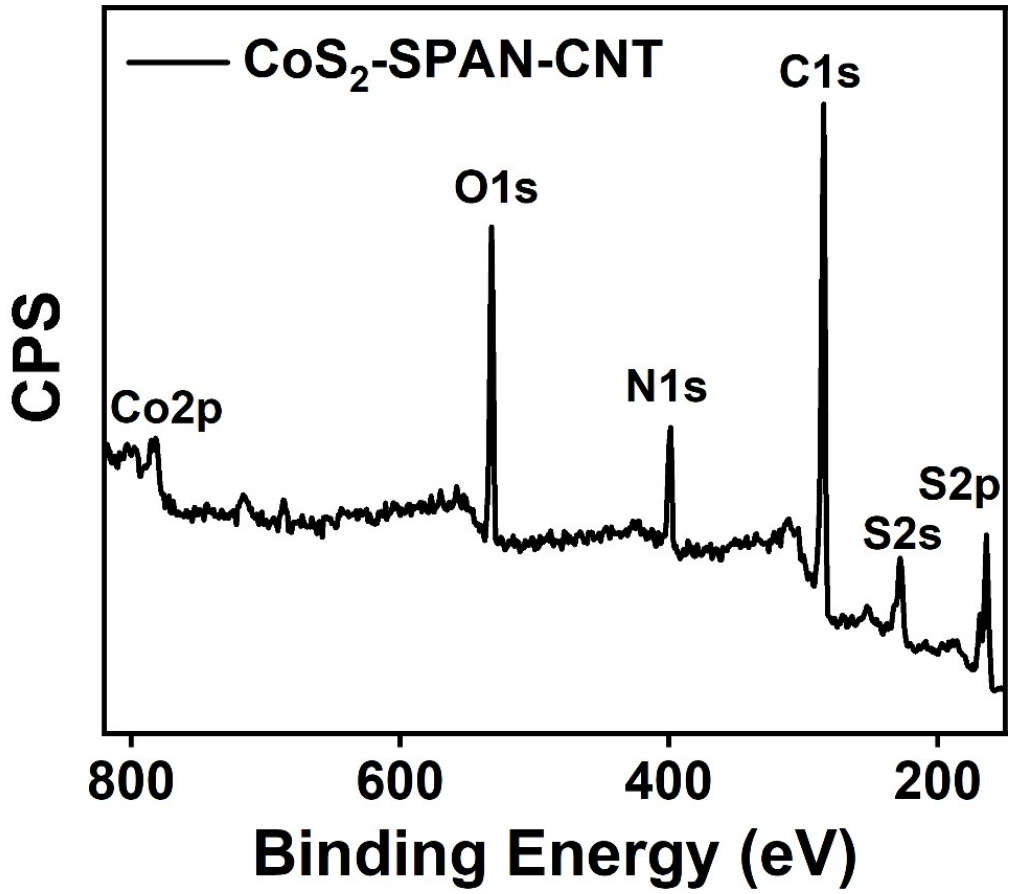

Fig. S5 XPS survey spectrum of CoS_2-SPAN-CNT.

Table S3. ICP results of the CoS_2 -SPAN-CNT and CoS_2-SPAN.

Material	Co wt%
CoS_2-SPAN	5.7
CoS_2-SPAN-CNT	4.3

Sample	Total S wt%	C wt%	N wt%	S wt% from SPAN	S wt% from CoS_2
SPAN	42.5	41.4	14.4	42.5	-
SPAN-CNT	39.9	43.3	13.5	39.9	-
CoS_2-SPAN	44.6	42.2	13.8	38.4	6.2
CoS_2-SPAN-CNT	43.2	38.7	11.3	38.5	4.7

Table S4. Elemental analysis of various composites.

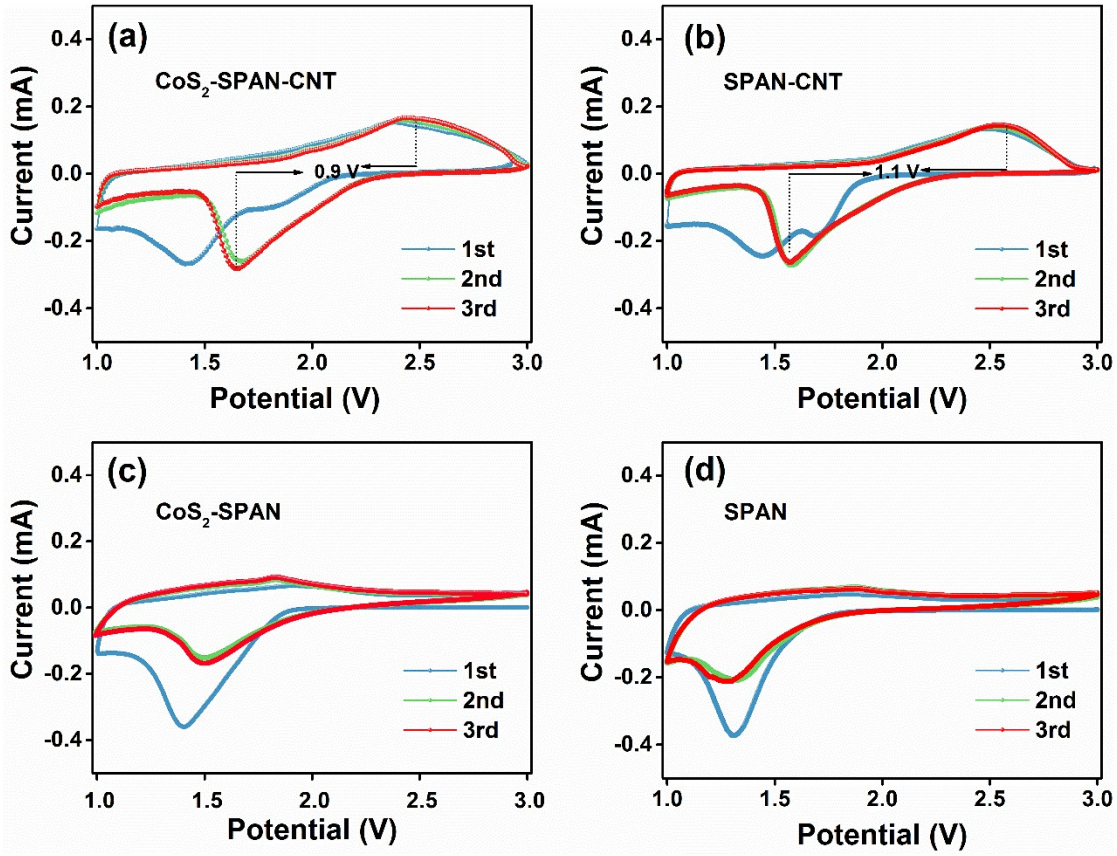

Fig. S6 Cyclic voltammetry profiles of (a) CoS_2-SPAN-CNT, (b) SPAN-CNT, (c) CoS_2-SPAN, and (d) SPAN.

Table S5. Electric conductivity measurements of SPAN, SPAN-CNT, and CoS_2-SPAN-CNT.

Material	Electric conductivity (S/cm)
SPAN	N/A
CoS_2-SPAN	0.4×10^{-4}
SPAN-CNT	1.6×10^{-3}
CoS_2-SPAN-CNT	1.9×10^{-2}

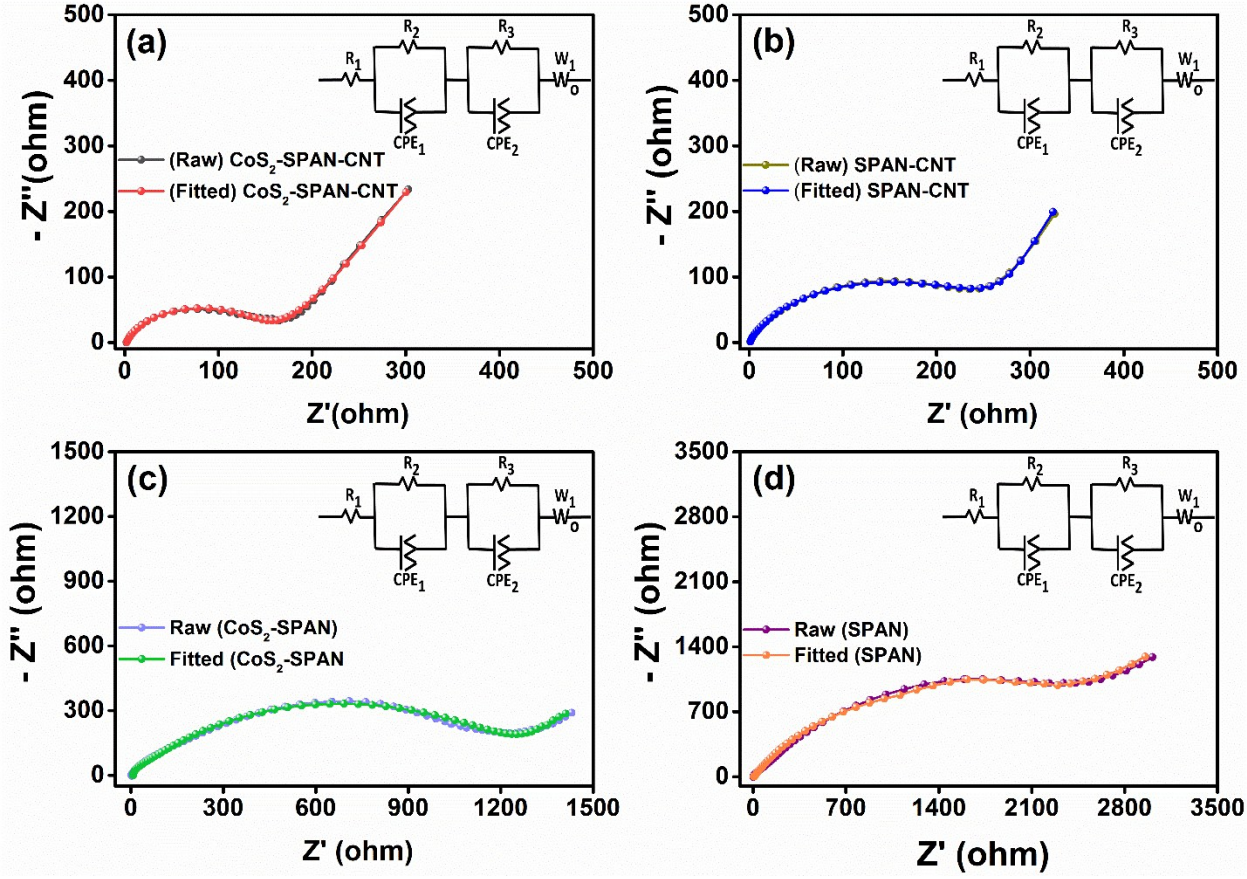

Fig. S7 EIS spectra of (a) CoS_2-SPAN-CNT, (b) SPAN-CNT, (c) CoS_2-SPAN, and (d) SPAN.

Table S6. EIS fitting data of CoS_2-SPAN-CNT, SPAN-CNT, CoS_2-SPAN and SPAN.

Calculated Impedance Data	CoS_2-SPAN-CNT	SPAN-CNT	CoS_2-SPAN	SPAN
R_1 (Ω)	2.157	4.723	7.776	8.453
R_2 (Ω)	180.9	277.2	1244	2549
R_3 (Ω)	27.24	75.62	167.3	946.2

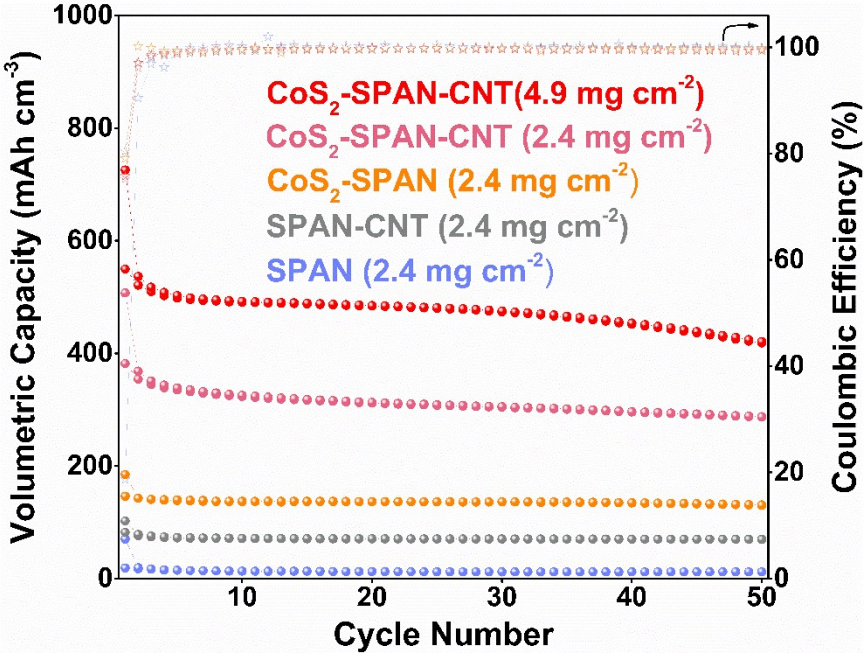

Fig. S8 Volumetric capacities of the CoS_2-SPAN-CNT and control samples at 0.2 C.

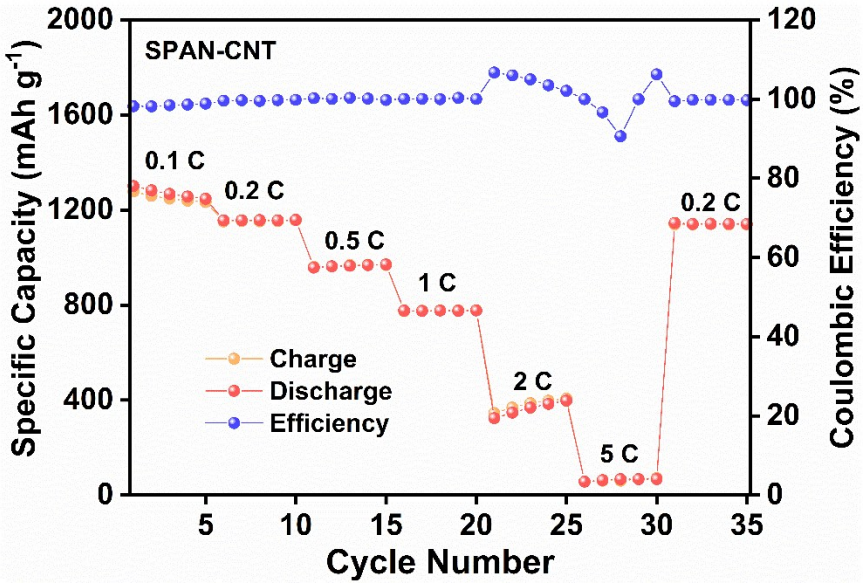

Fig. S9 Rate capability of SPAN-CNT.

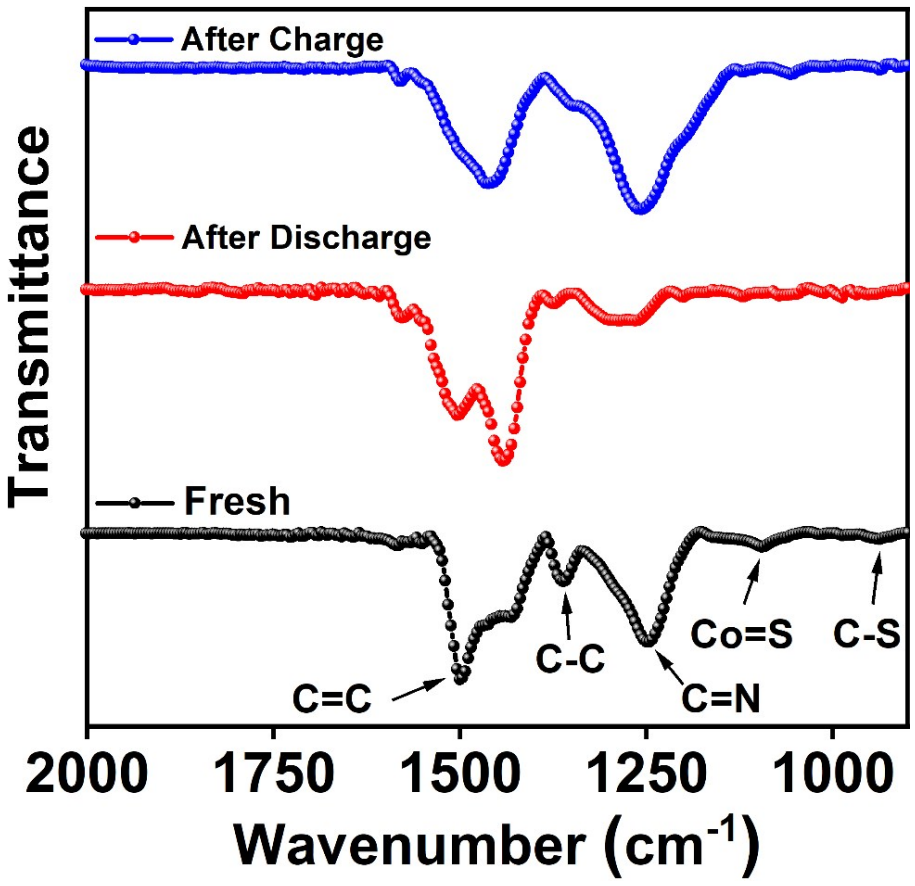

Fig. S10 *Ex-situ* FT-IR plots of the fresh and cycled CoS_2-SPAN-CNT.

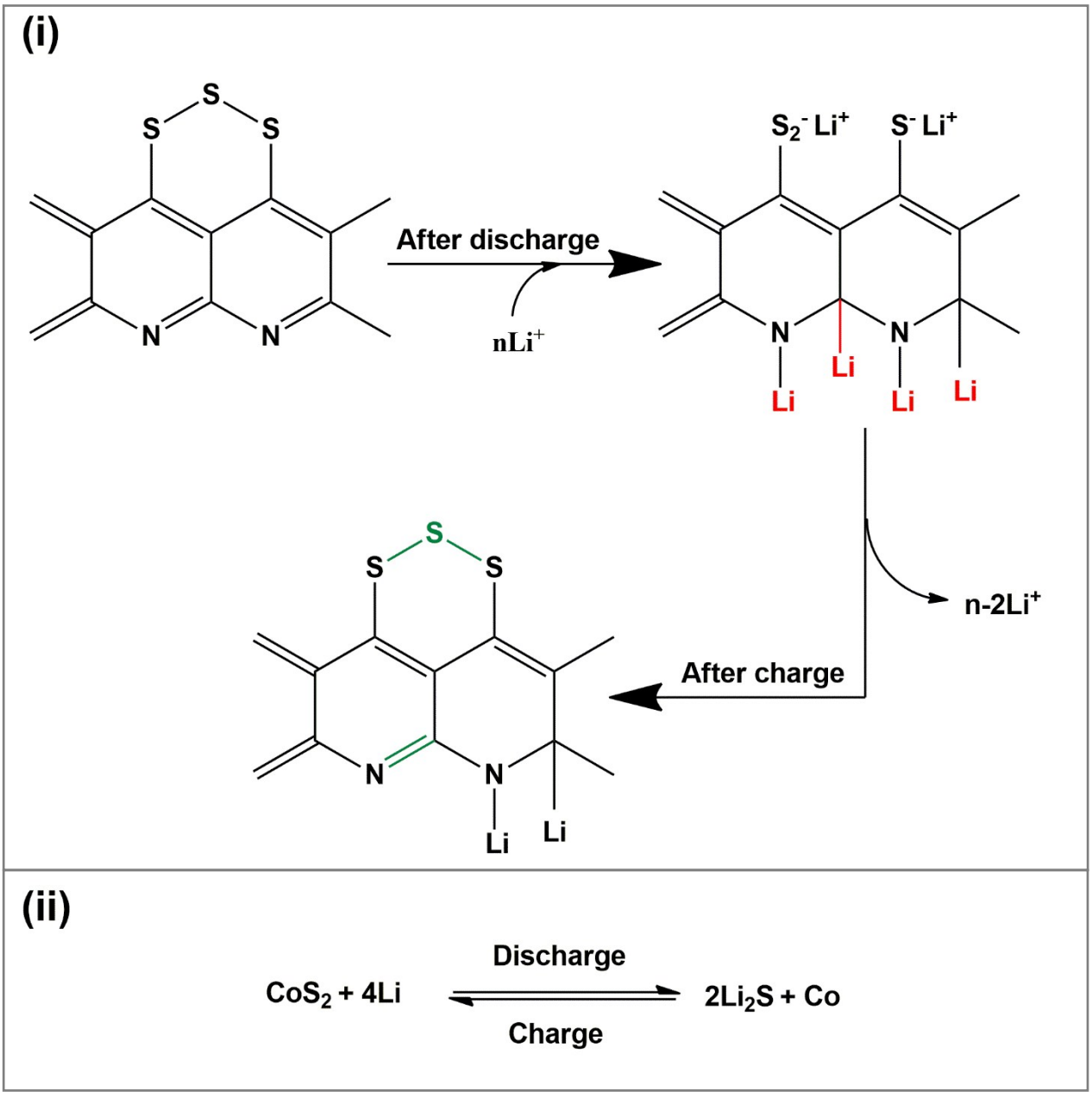

Fig. S11 The proposed overall electrochemical lithiation/delithiation processes for CoS_2-SPAN-CNT.

Table S7. Comparison of CoS_2-SPAN-CNT with previously reported SPAN cathodes in terms of sulfur loading and areal capacity.

Material	Current Collector	Free-standing	Sulfur loading (mg cm^{-2})	Areal Capacity (mA h cm^{-2})	Ref
SPAN4	Al foil	None	0.4	-	[1]
S/PAN/KB	Carbon fiber paper	None	4.4	-	[2]
SPAN	Al foil	None	0.7	1.0	[3]
S/Microporous carbon polyhedrons/PAN	Al foil	None	1.0	-	[4]
CMK-3/S@PAN	Al foil	None	2.1	-	[5]
S@pPAN	Al foil	None	2.5	-	[6]
pPAN/SeS_2	Al foil	None	7.9	4.5	[7]
$Te_{0.04}S_{0.96}$@pPAN	Al foil	None	3.1	-	[8]
$Se_{0.06}$SPAN	Al foil	None	3.1	-	[9]
S/PAN/MWCNT	None	flexible	3.0	-	[10]
S/PAN/GO	None	flexible	2.5	-	[11]
SPAN-CNT20	None	flexible	1.1	-	[12]
S/DPAN/KB	None	flexible	1.5	1.7	[13]
SPAN/CNT-12	None	flexible	2.0	-	[14]
CoS_2-SPAN-CNT	**None**	**flexible**	**4.6** **5.9**	**6.5** **8.1**	**This Work**

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