Supporting Information

Tuning the Local-chemistry of the SPAN to Realize the Development of Room-Temperature Sodium-Sulfur Pouch Cells

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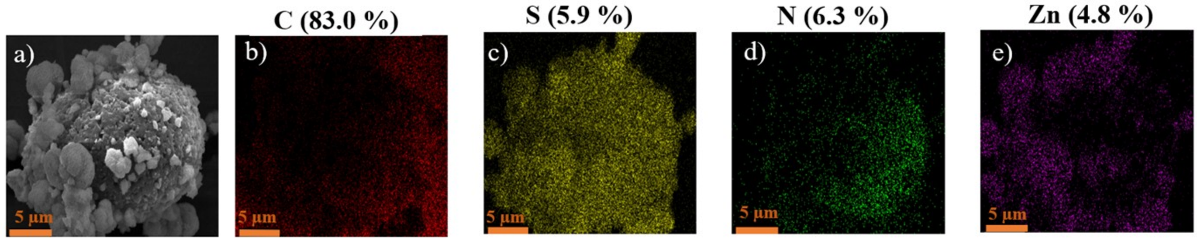

Figure S1. FESEM image of SPAN + 400 mg ZnS (a) and corresponding EDS mapping images (b), (c), (d), and (e)

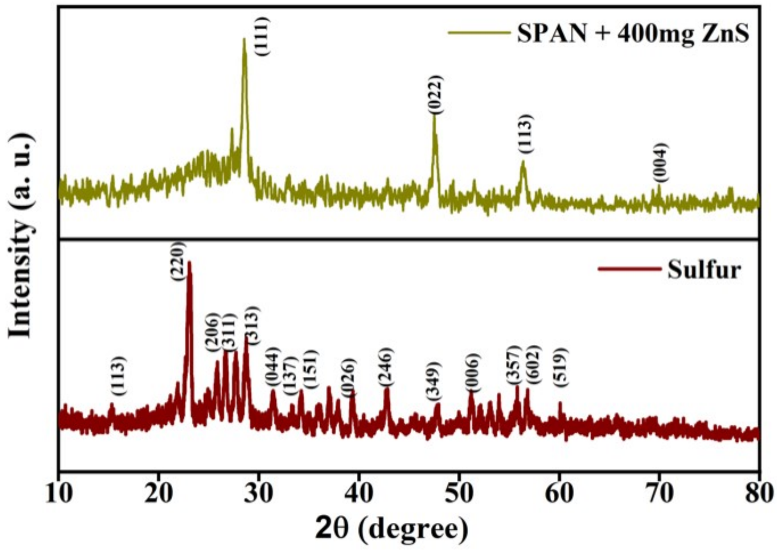

Figure S2. XRD data of Sulfur and SPAN + 400 mg ZnS

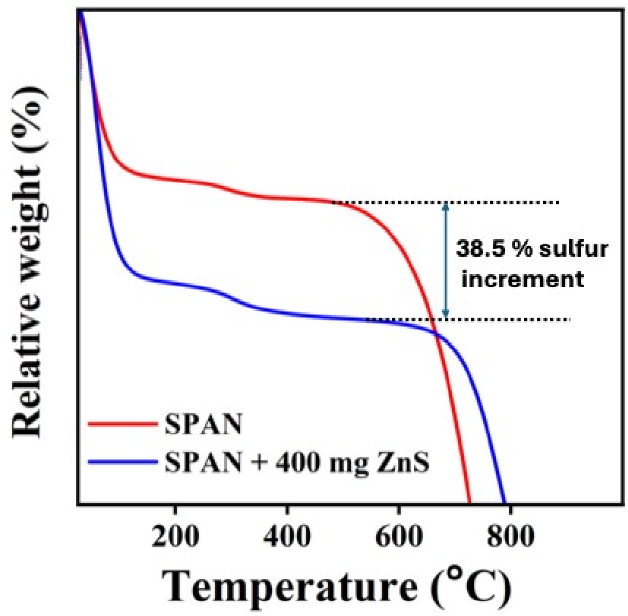

Figure S3 TGA data on SPAN and SPAN + 400 mg ZnS

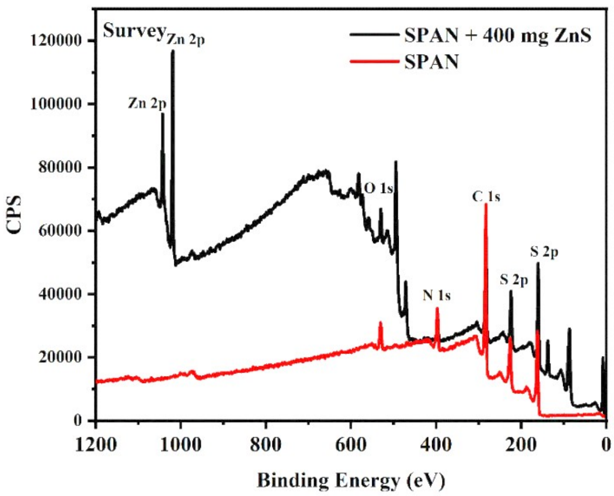

Figure S4. XPS survey spectrum of SPAN and SPAN + 400 mg ZnS

Table S1. Compositional ratio of SPAN composites based on XPS data

S. No	Elements	SPAN + ZnS 400 mg (Wt%)	SPAN (Wt %)
1)	Sulfur	13.1	10
2)	Nitrogen	2.5	61
3)	Carbon	15.4	23.4
4)	Zinc	63	-
5)	Oxygen	5.1	5.3

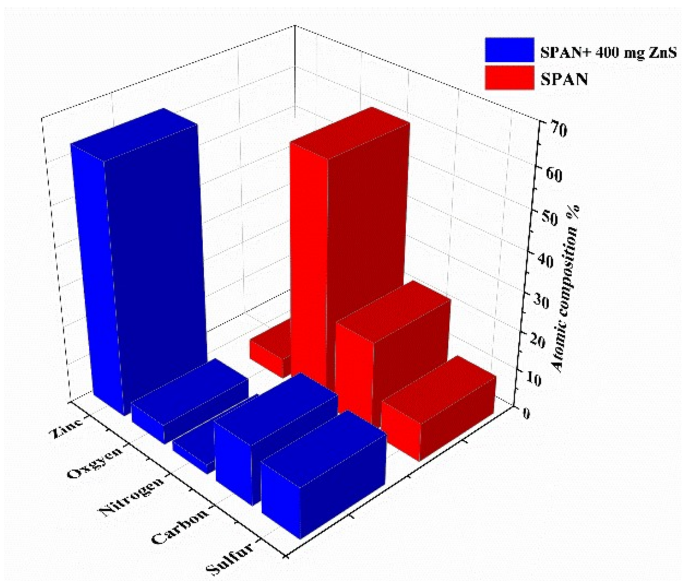

Figure S5. Histogram representation of Zinc, Oxygen, Nitrogen, Carbon and Sulfur in SPAN and SPAN + 400 mg ZnS

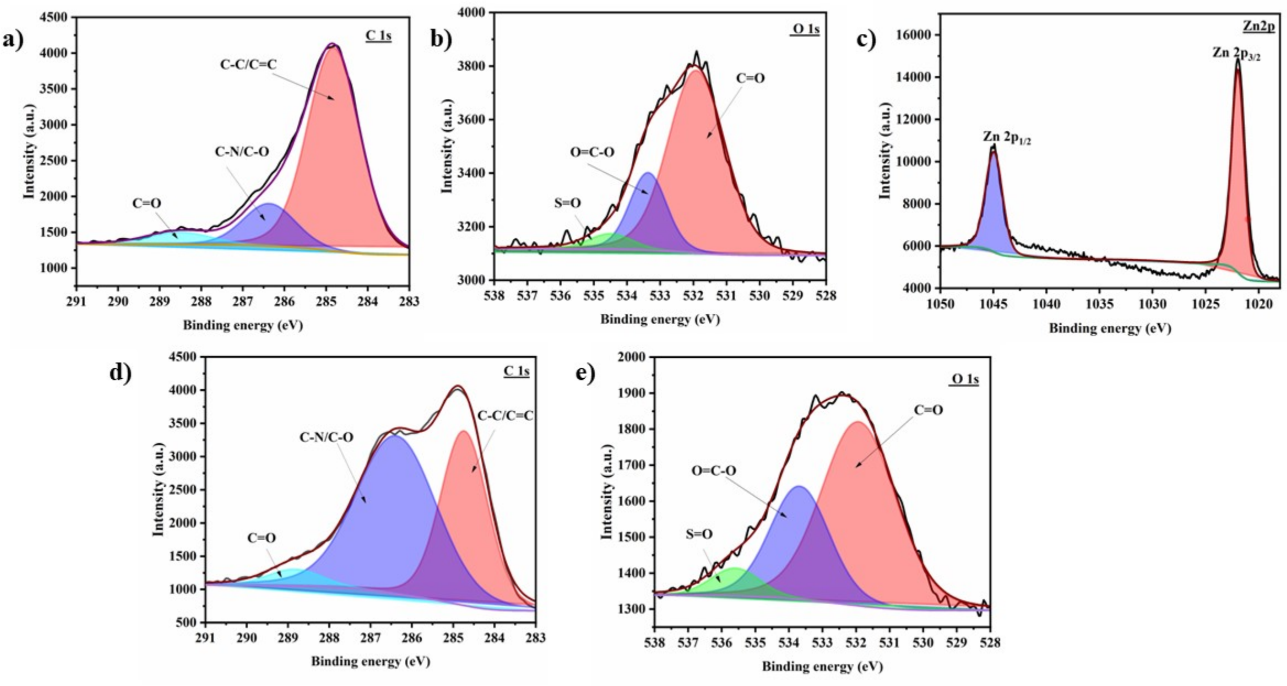

Figure S6. XPS spectra of SPAN + 400 mg ZnS (a) C 1s, (b) O 1s (c) Zn 2p and SPAN (d) C 1s, (e) O 1s

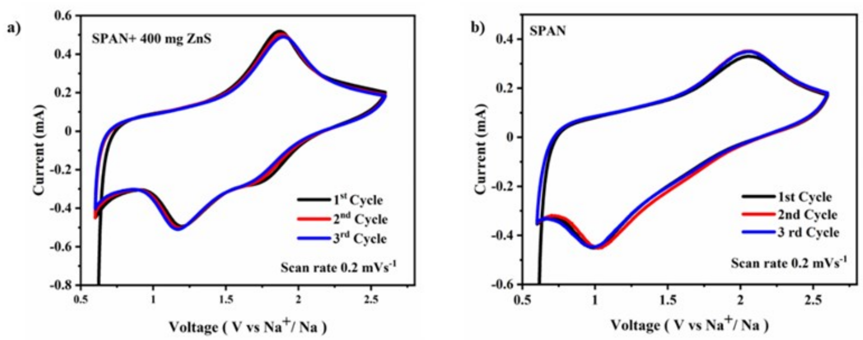

Figure S7. CV curves at 0.2 mV s^{-1} of a) SPAN + 400 mg ZnS and b) SPAN in ether electrolyte.

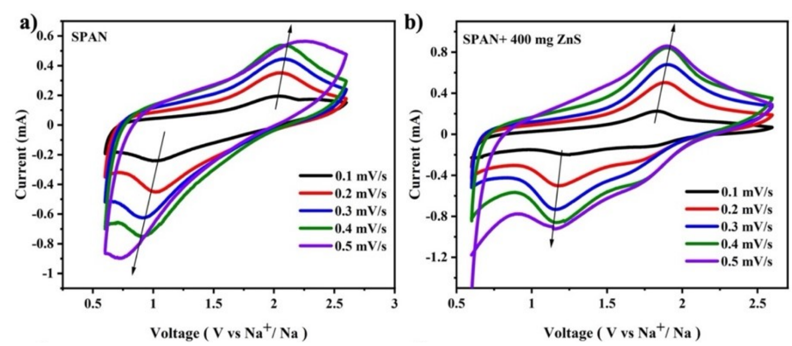

Figure S8. CV curves at various scan rates ranging from 0.1 to 0.5 mV s^{-1} of a) SPAN and b) SPAN + 400 mg ZnS in ether electrolyte.

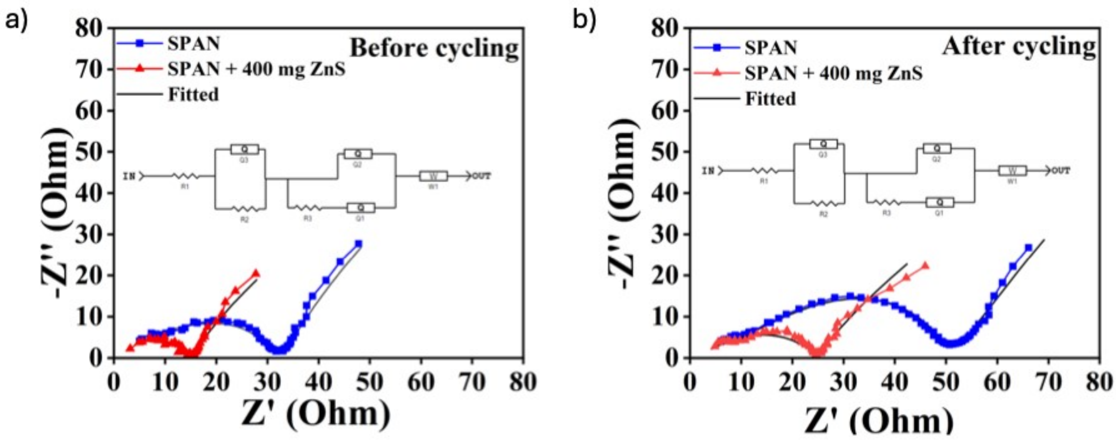

Figure S9. EIS data of SPAN and SPAN + 400 mg ZnS a) before cycling and b) after cycling

Table S2 Values obtained from EIS data fitting

SPAN						**SPAN + 400 mg ZnS**					
Before cycling			After cycling			Before cycling			After cycling		
R1	R2	R3	R1	R2	R3	R1	R2	R3	R1	R2	R3
10 mΩ	2.41 Ω	29.66 Ω	10 mΩ	40.34 Ω	9.82 Ω	46 mΩ	2.01 Ω	12.01 Ω	1.15 Ω	23.88 Ω	8.12 Ω
R_{ct} =31.9 Ω			R_{ct} = 50.16 Ω			R_{ct} = 14.02 Ω			R_{ct} = 32 Ω		

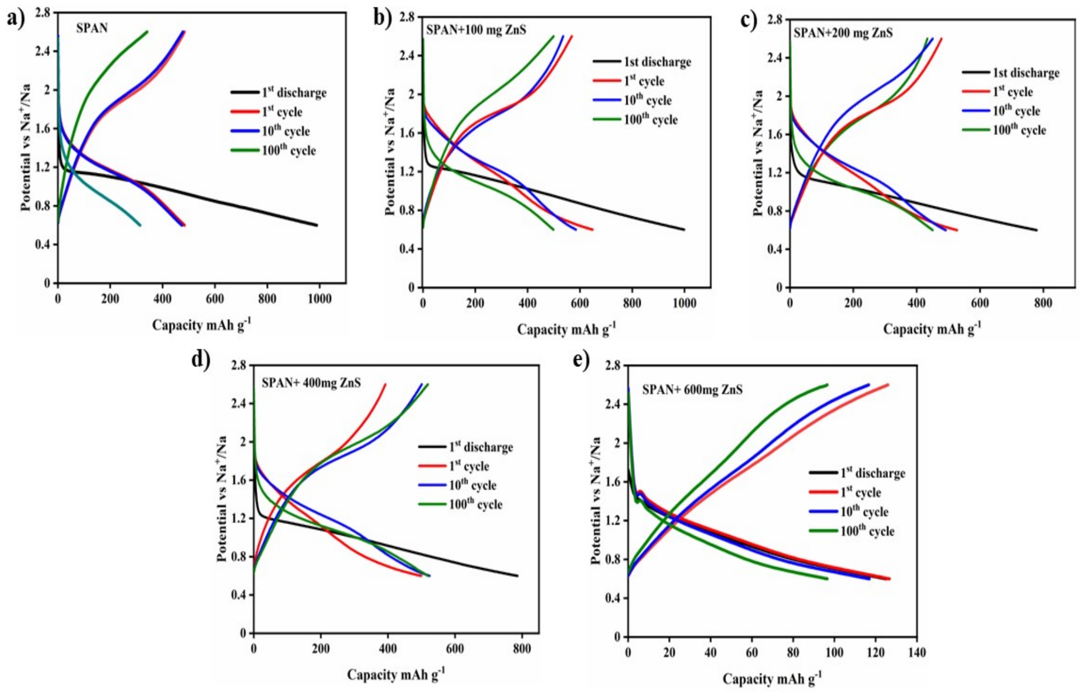

Figure S10. Voltage profile of SPAN (a), SPAN + 100 mg ZnS (b), SPAN + 200 mg ZnS (c), SPAN SPAN + 400 mg ZnS (d), SPAN +600 mg ZnS (e) in ether electrolyte at 0.14 C.

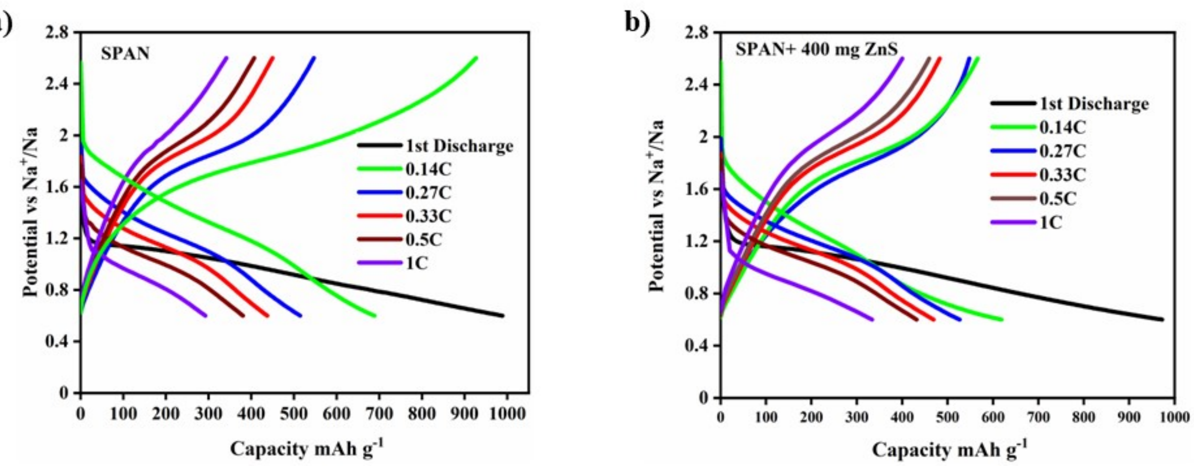

Figure S11. Voltage profile of SPAN (a), SPAN + 400 mg ZnS (b), composite in ether-based electrolyte.

Table S3. Pouch Cell parameters

Electrode size (Anode)	56 mm*53 mm
Electrode size (Cathode)	56 mm*43 mm
Anode	Sodium metal
Anode loading	15 mg cm^{-2}
Cathode	SPAN+ 400 mg ZnS

Cathode loading	4 mg cm^{-2}
Binder	PVDF
Current Collector	Al foil
Electrolyte	1M NaOTF in Diglyme

Table S4. Na–S battery systems based on different sulfur composites

S. no	Cathodes	Electrolyte	Initial capacity	Final capacity	Capacity decay	Cycle life	Ref.
1)	HPCM/S composite	1 M NaOTF in diglyme	617 mA h g^{-1} (0.7 C)	311 mA h g^{-1} (0.7 C)	-	60	[1]
2)	Polysulfide catholyte in rGO-CNT-CMC sponge	1 M NaOTF in diglyme	755 mAh g^{-1} (0.2 C)	755 mA h g^{-1} (0.2 C)	-	200	[2]
3)	CS90-rGO	1 M $NaClO_4$ + 0.2 M $NaNO_3$ in tetraglyme	542 mA h g^{-1} (0.2 A g^{-1})	335 mA h g^{-1} (0.2 A g^{-1})	0.76% per cycle	50	[3]
4)	(S@iMCHS)	1.0 M $NaClO_4$ in PC: EC (1:1, v/v) with 5 wt. % FEC of additive	418.75 mAh g^{-1} (0.2 A g^{-1})	292 mAh g^{-1} (0.2 A g^{-1})	-	200	[4]
5)	c-PANS NF	0.8 M $NaClO_4$ in EC: DEC	796 mAh/g^{-1} (0.1 C)	219 mAh/g^{-1} (1 C)	-	500	[5]
6)	$S_{0.6}Se_{0.4}$@C NFs	1 M $NaClO_4$ in EC: PC (1:1, v/v))	417 mAh g^{-1} (0.1 A g^{-1})	375 mAh g^{-1} 0.1 A g^{-1})	-	100	[6]
7)	SeS-PAN particles	1.0 M $NaClO_4$ in EC: DEC: PC (1:1:1,	721 mAh g^{-1} (0.2 A g^{-1})	550 mAh g^{-1} (0.2 A g^{-1})	-	150	[7]

		v/v) with 5.0 vol. % FEC					
8)	Sulfurized polyacrylonitrile nanofiber (SPAN) web	1 M of $NaPF_6$ in EC: DEC (1:1, v/v)	342 mAh g^{-1} (0.1 C)	266 mAh g^{-1} (0.1 C)	-	200	8
9)	Multi-channel sulfurized polyacrylonitrile	1 M NaOTF in diglyme	523 mAh g^{-1} (0.1 A g^{-1})	437 mAh g^{-1} (0.1 A g^{-1})	-	100	9
10)	H-SPAN	1.0 M NaClO4 in EC: PC (1:1, v/v)	599.2 mAh g-1 (0.05 C)	717 mAh g-1 (0.1 C)	-	200	10
11)	$Te_{0.04}S_{0.96}$@ pPAN	1 M $NaClO_4$ in EC: DMC (1:1, v:v) with 10% FEC	503 mA h g-1 (0.5 A g^{-1})	463 mA h g-1 (0.5 A g^{-1})	0.015% decay per cycle	600	11
12)	$Se_{0.08}S_{0.92}$@ pPAN	1.0 M $NaClO_4$ in PC: EC (1: 1, v/v)	1185 mA h g^{-1} (0.4 A g^{-1})	770 mA h g^{-1} (0.4 A g^{-1})	0.045% decay per cycle	500	12
13)	SPAN@ TiO_2	1 M $NaClO_4$ in EC: PC (1:1, v:v)	1100 mAh g^{-1} (0.2 C)	400 mAh g^{-1} (0.2 C)	0.13 mAh g^{-1} per cycle	1000	13

14)	**SPAN@ ZnS composite**	**1 M NaOTF in diglyme**	**500 mAh g^{-1} (1 C)**	**227 mAh g^{-1} (1 C)**	**0.07 % decay per cycle**	**450**	**Our work**

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