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Supporting Information

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Multifunctional Sandwich-Structured Electrolyte for High-Performance Lithium–Sulfur Batteries

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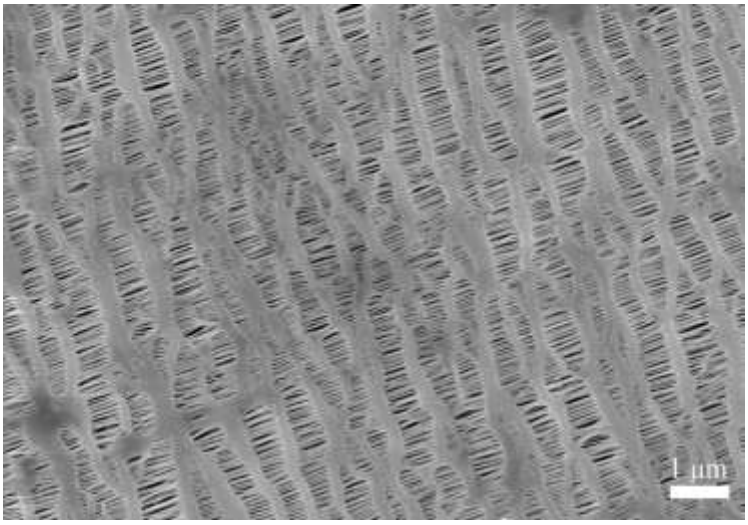

Figure S1. Typical SEM image of PP separator.

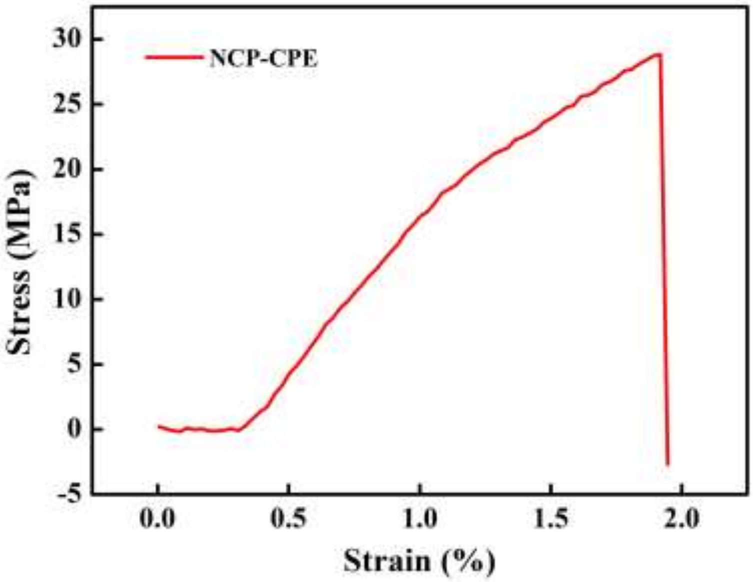

Figure S2. Stress-strain curve of NCP-CPE.

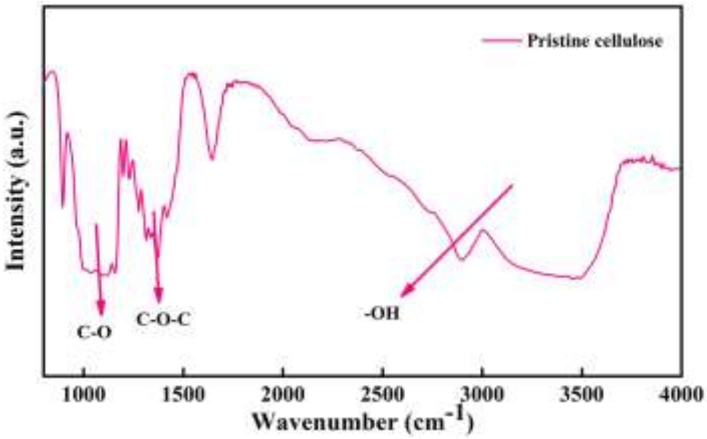

Figure S3. FTIR spectroscopy of cellulose nonwoven.

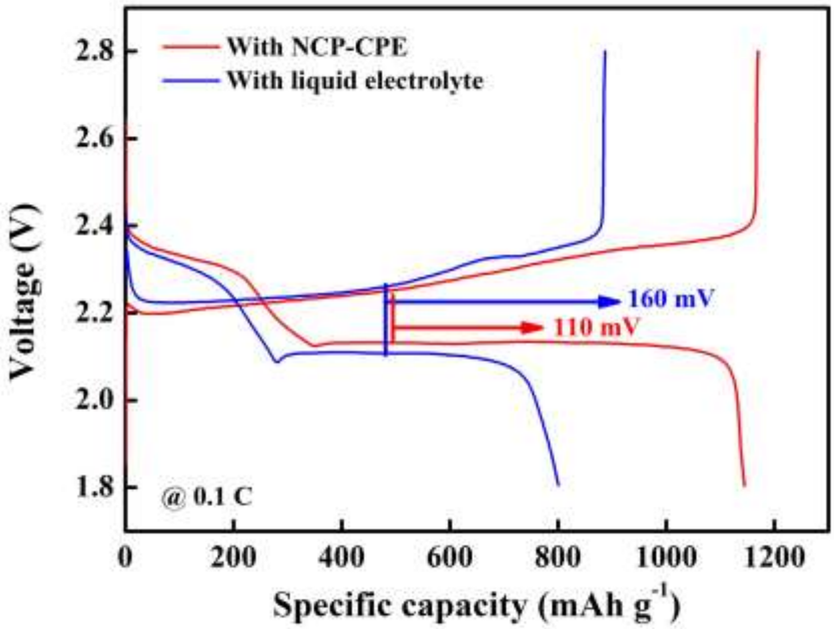

Figure S4. The charge/discharge profiles of Li-S batteries with liquid electrolyte and NCP-CPE at 0.1 C.

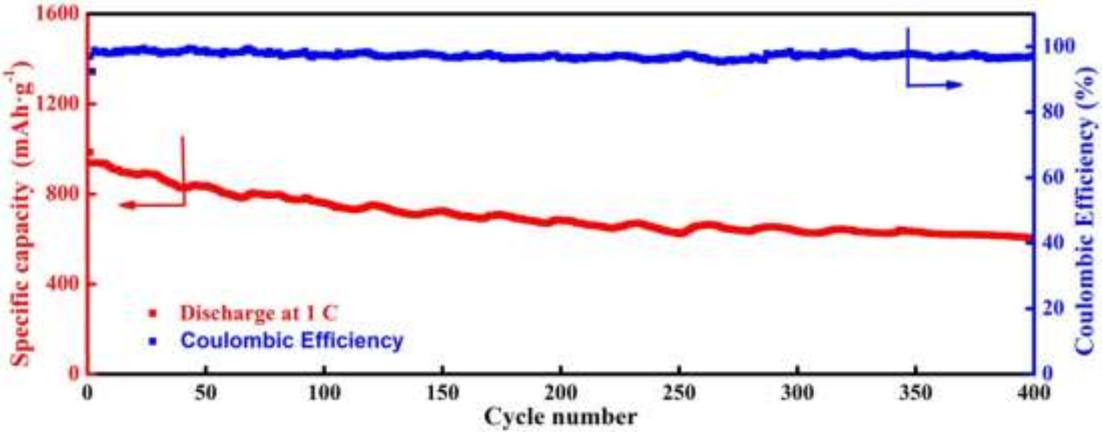

Figure S5. Cycle performance of Li-S battery (60 % sulfur content) with NCP-CPE at 1 C.

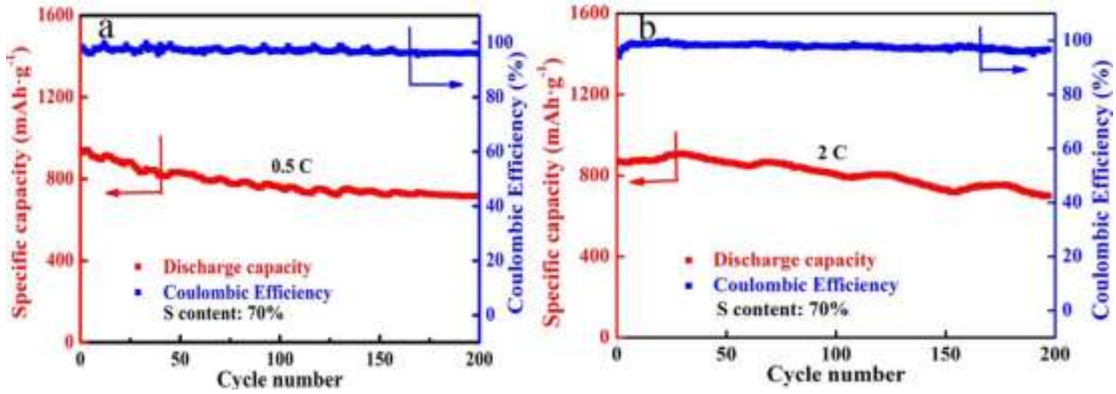

Figure S6. Cycling stability of Li-S battery (70 % sulfur content) with NCP-CPE at a) 0.5 C and b) 1 C.

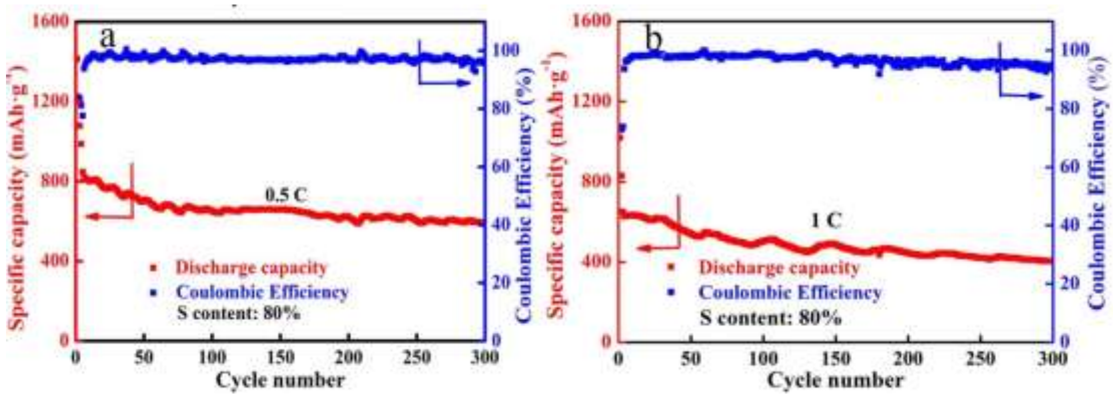

Figure S7. Cycling stability of Li-S battery (80 % sulfur content) with NCP-CPE at a) 0.5 C and b) 1 C.

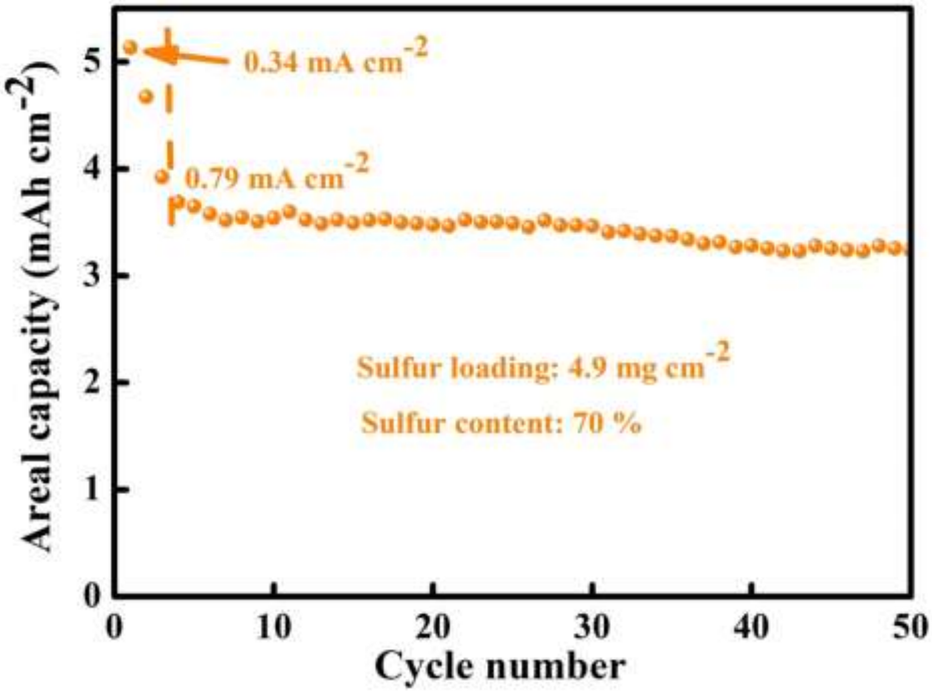

Figure S8. Cycle performance of high sulfur loaded (4.9 mg cm^{-2}) Li-S battery with NCP-CPE.

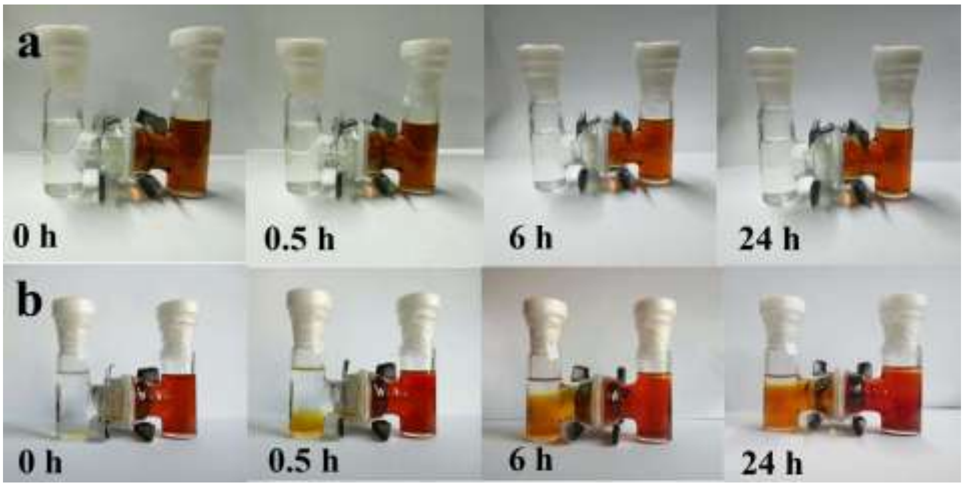

Figure S9. Digital photos of H-type cells separated by NCP-CPE a) and PP separator b).

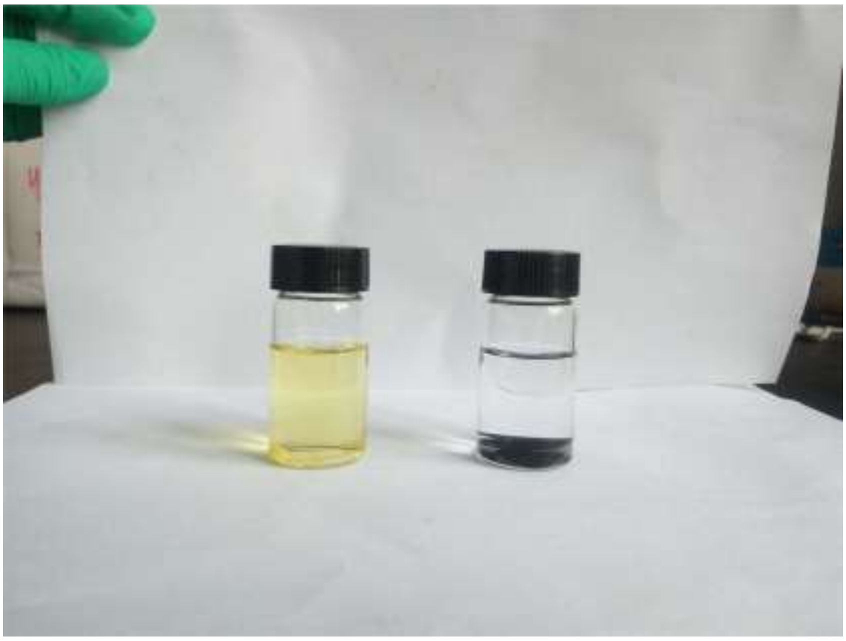

Figure S10. Digital photo of polysulfide adsorption test (50 mM Li_2S_6 dissolved in DME).

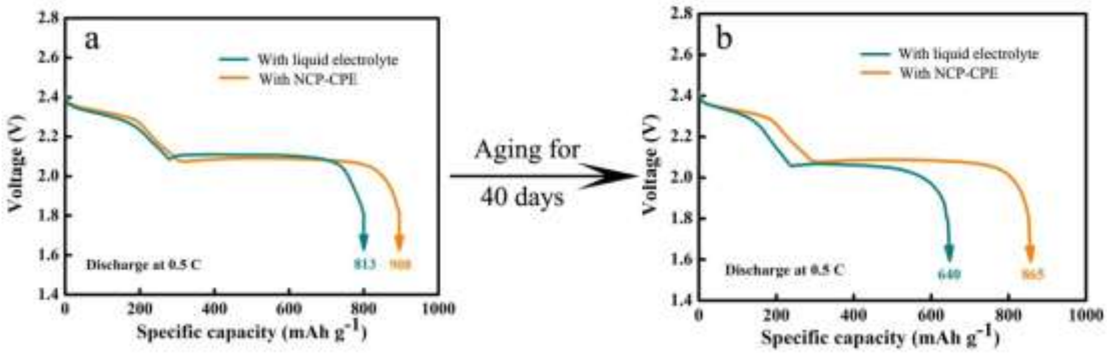

Figure S11. The 1st discharge profiles of Li-S battery at 0.5 C: a) fresh cell, b) aging for 40 days. (Fresh cell: The newly assembled Li-S battery was aged for 4 hrs to ensure the cathode completely infiltrated and then discharged at 0.5 C. For anti-self-discharge measurement, Li-S battery was also assembled and stored for 40 days, then discharged at 0.5 C).

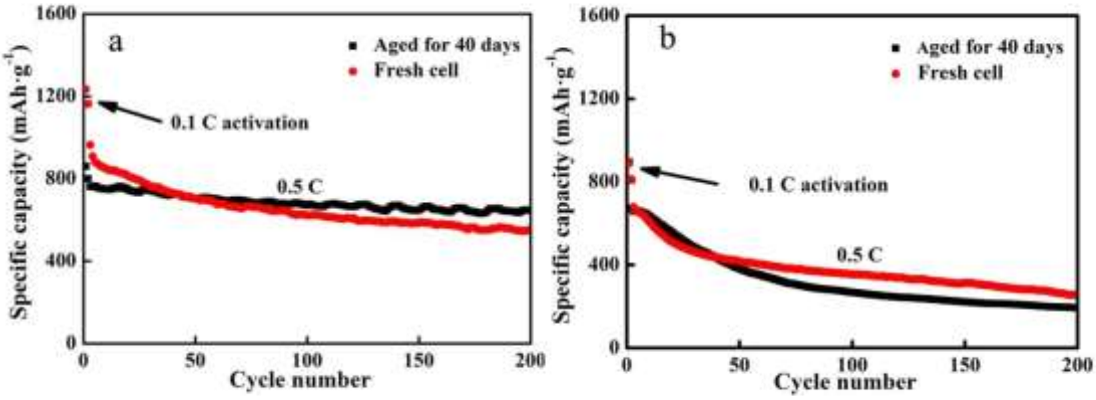

Figure S12. Comparison of cycle performance of Li-S battery before/after aging for 40 days with a) NCP-CPE and b) liquid electrolyte.

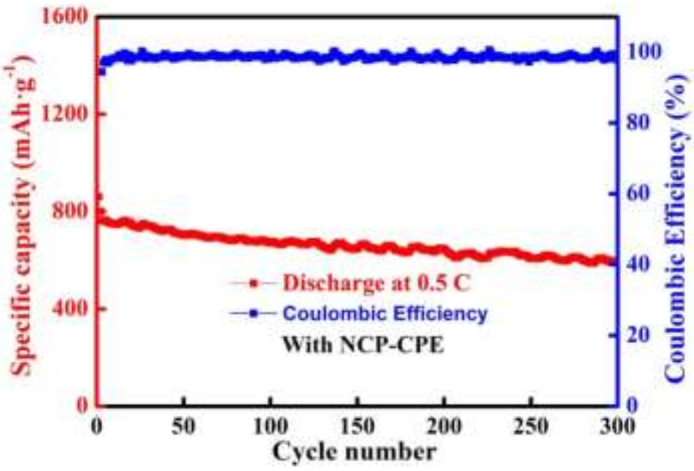

Figure S13. Cycle performance of Li-S battery with NCP-CPE after aging for 40 days.

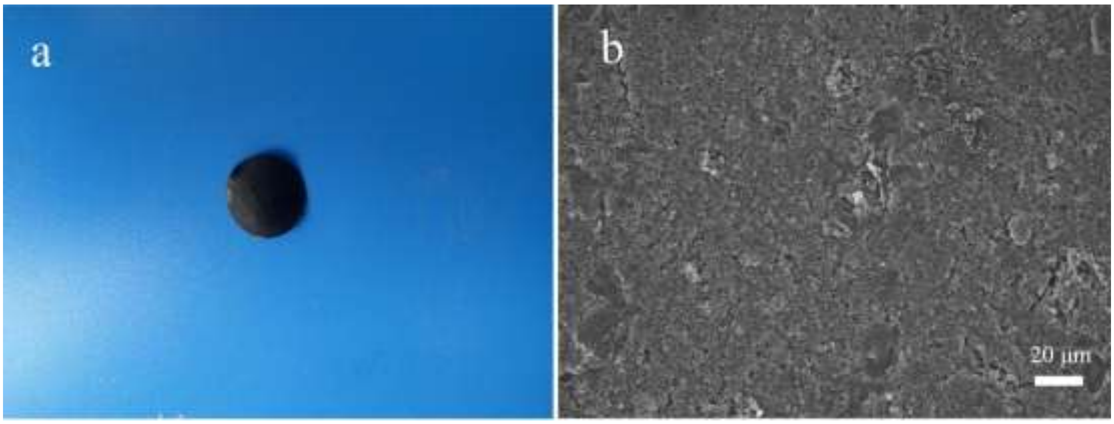

Figure S14. a) Digital photo and b) typical SEM image of NCP-CPE which was disassembled from Li-S cell after 1100 cycles.

Table S1. Electrochemical performance comparisons of previously reported Li-S battery and our presented case.

Separator/ Polymer electrolyte	Cathode	S content/ wt %	Cycle performance			Rate performance		Refs
			Cycle number	C-rate	Capacity decay per cycle / %	C-rate	Reversible capacity / mAh·g^{-1}	
PP/Ketjen black	KB/S	64	100	1	0.14	2	900	[49]
PP/Super P	Bare S	60	100	0.5	0.28	2	700	[50]
PP/MC	Bare S	70	500	0.5	0.081	2	850	[51]
PP/Super P/Nafion	Bare S	70	200	0.5	0.2	1	302	[52]
PP/AB-SO_3^-	C-PANI/S	72	100	0.1	0.24	1.5	800	[43]
PP/MoS_2	Bare S	65	600	0.5	0.083	1	500	[53]
PP/Black phosphorus	Bare S	80	100	0.2	0.14	2	600	[54]
GO/MOF	CMK-3/S	48	1500	1	0.019	3	500	[55]
PP/RGO	Bare S	70	100	0.2C	0.18	2	710	[56]
PP/$Li_3Ti_5O_{12}$/Graphene	Bare S	70	500	1	0.0286	2	700	[57]
PP-AB&CNT&LAGP	C/S	56	150	0.5	0.224	1	852	[58]

PETEA	Bare S	60	400	0.5	0.047	1	601.2	[28]
PP/$BaTO_3$	Bare S	60	50	0.1	0.34	~	~	[59]
Py_{14}TFSI/DOL/DME	KB/S	64	120	0.1	0.185			[60]
PVDF-HFP	KB/S	53	40	0.3	0.5			[61]
PVDF-HFP/ PMI_mTFSI	Bare S	60	30	0.1	0.49	1	311	[29]
Nafion	S catholyte		500	0.5	0.11	0.5	900	[62]
PAN/GO	Bare S	70	100	0.2	0.395	2	337	[63]
		60	**1500/400**	**0.5/1**	**0.039/0.047**	**4**	**594**	
NCP-CPE	**Bare S**	**70**	**200/200**	**0.5/2**	**0.106/0.097**	**2**	**871**	**Our work**
		80	**300/300**	**0.5/1**	**0.104/0.119**	**2**	**441**	

Table S2. The binding energy of Li_2S_4 to different oxygen sites in cellulose.

Oxygen site	a	b	c	d
Binding Energy (eV)	-0.778	-0.863	-0.496	-0.879