Electronic Supporting Information

An acetylene black modified gel polymer electrolyte for high performance lithium-sulfur batteries

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Table S1. EIS fitting parameters of the Li-S batteries assembled with (a) CGPE and (b) LE after different cycles at 1C.

(a) CGPE

	$R_b(\Omega)$	$R_{SEI}(\Omega)$	$R_{CT}(\Omega)$
Initial	1.955	13.31	38.46
After 10 cycles	1.767	10.40	5.207
After 50 cycles	1.726	10.06	5.526

(b) LE

	$R_b(\Omega)$	$R_{SEI}(\Omega)$	$R_{CT}(\Omega)$
Initial	1.522	72.67	19.49
After 10 cycles	3.490	62.28	30.24
After 50 cycles	4.676	30.15	70.48

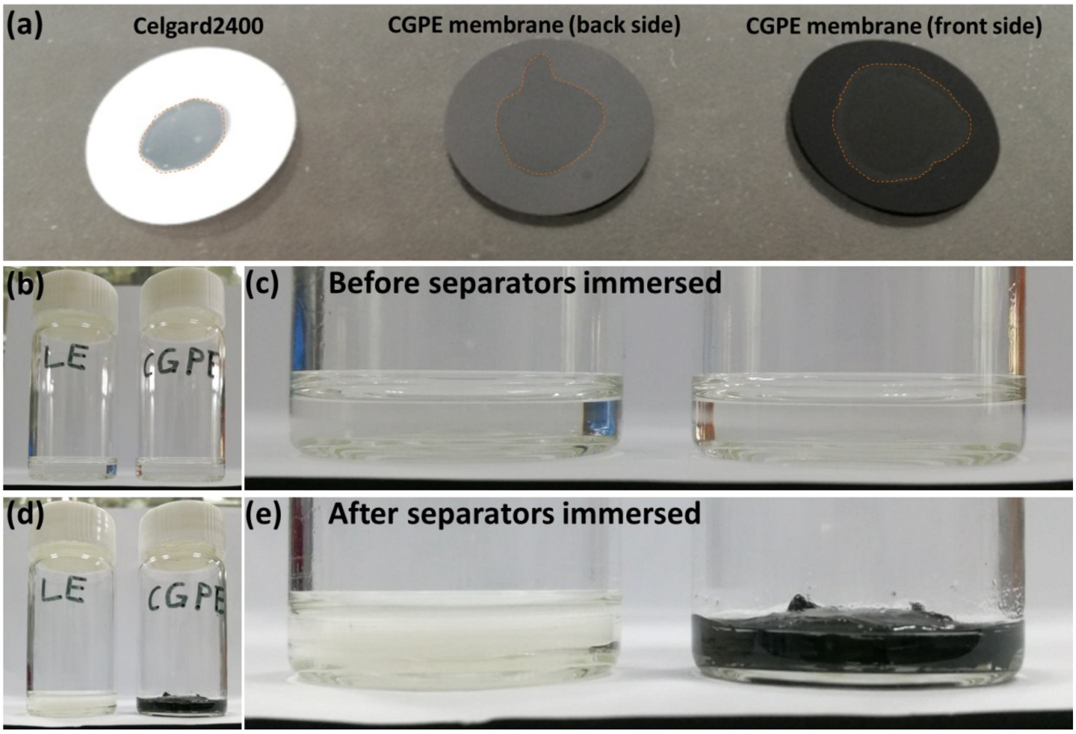

Fig. S1. (a) The photographs of the liquid electrolyte wettability of Celgard2400 and CGPE membrane; (b, c, d and e) observation of the liquid electrolyte uptake ability of the Celgard2400 and CGPE membrane by immersing 0.15 g of Celgard2400 and CGPE membrane into 1ml of liquid electrolyte and putting them standing for 12 h.

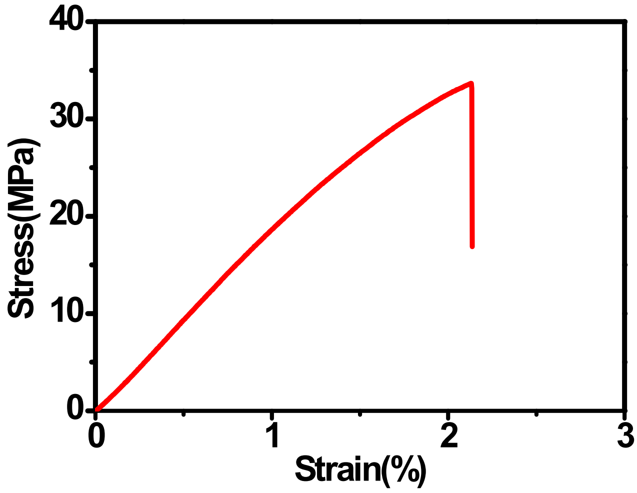

Fig. S2. The stress-strain curve of the CGPE membrane.

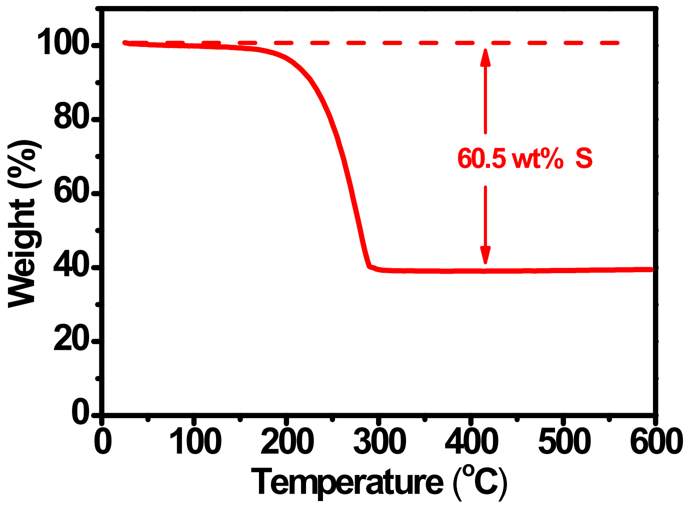

Fig. S3. TG curves of the prepared S-CNTs.

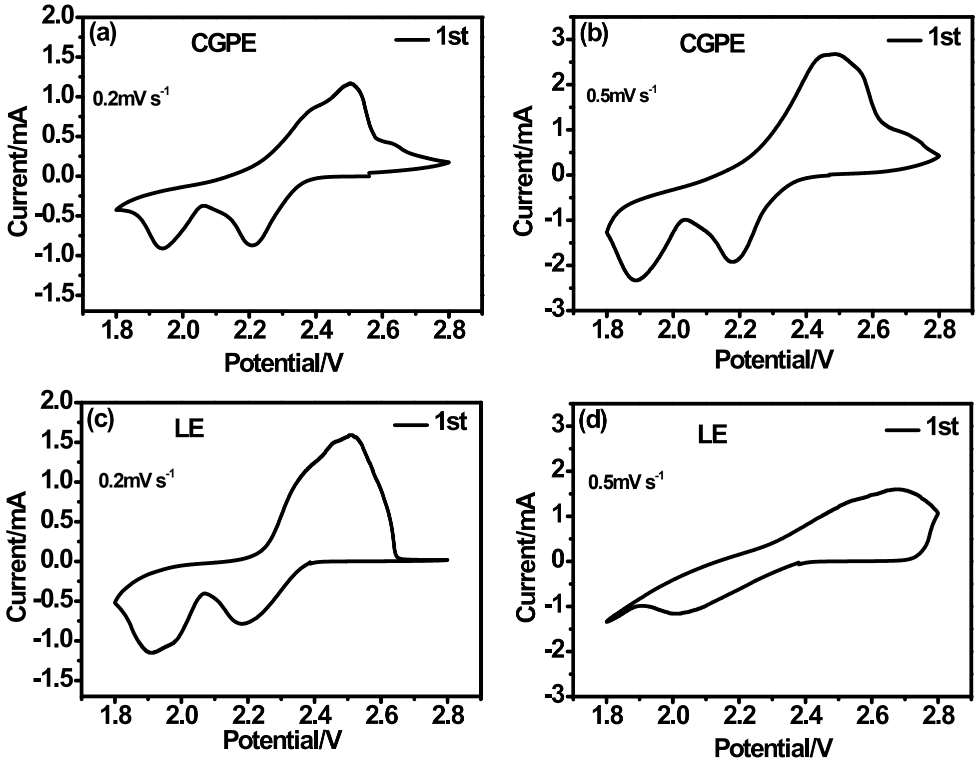

Fig. S4. Cyclic voltammograms of the Li-S batteries assembled with (a, b) CGPE at the scan rate of 0.2 mV s^{-1} and 0.5 mV s^{-1}; (c, d) LE at the scan rate of 0.2 mV s^{-1} and 0.5 mV s^{-1}.

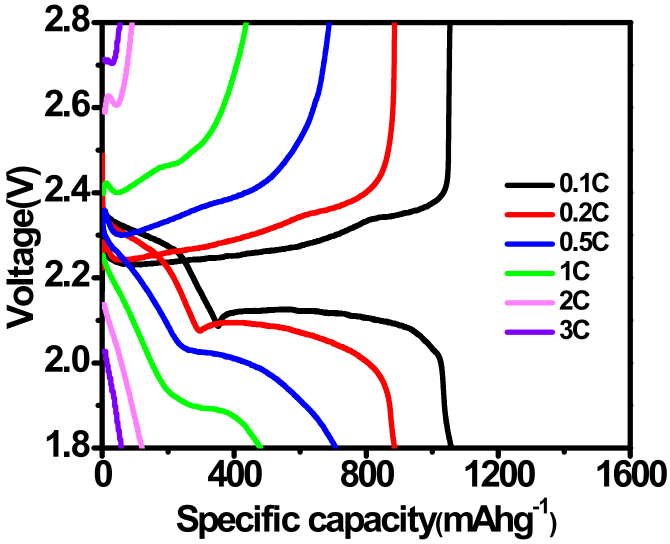

Fig. S5. Discharge/charge profiles of the Li-S batteries assembled with LE at different current densities.

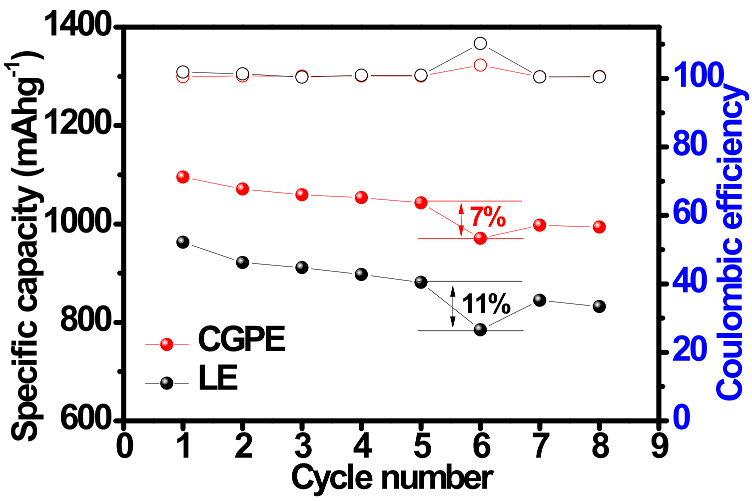

Fig. S6. Cycling performance of the Li-S batteries assembled with CGPE and LE at 0.2C, in which the resting time between the fifth cycle and sixth cycle was 24 h.

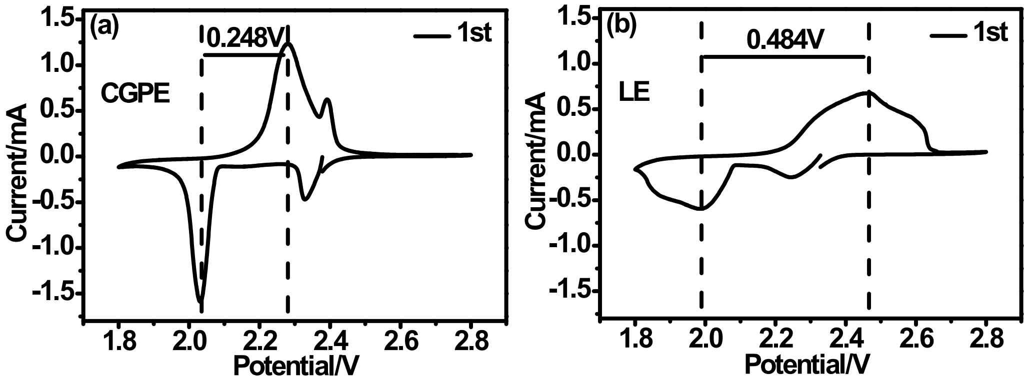

Fig. S7. Cyclic voltammograms of the Li-S batteries assembled with (a) CGPE and (b) LE at a scan rate of 0.1 mV s^{-1}, with the condition that the tested batteries were cycled at 1C for 50 times beforehand.

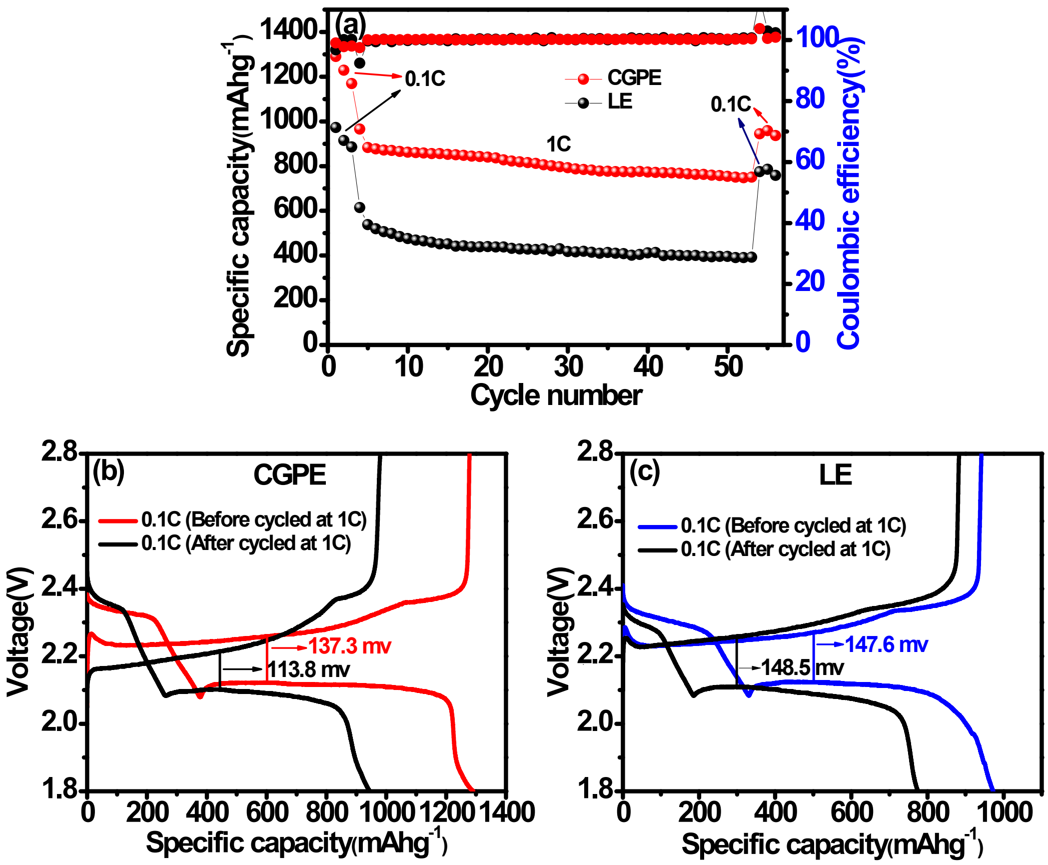

Fig. S8. (a) Cycling performance of the Li-S batteries assembled with CGPE and LE at different current densities (0.1C, 1C, 0.1C); (b) discharge/charge profiles of the first cycle at 0.1C before and after 1C rate for the Li-S batteries equipped with CGPE; (c) discharge/charge profiles of the first cycle at 0.1C before and after 1C rate for the Li-S batteries equipped with LE.

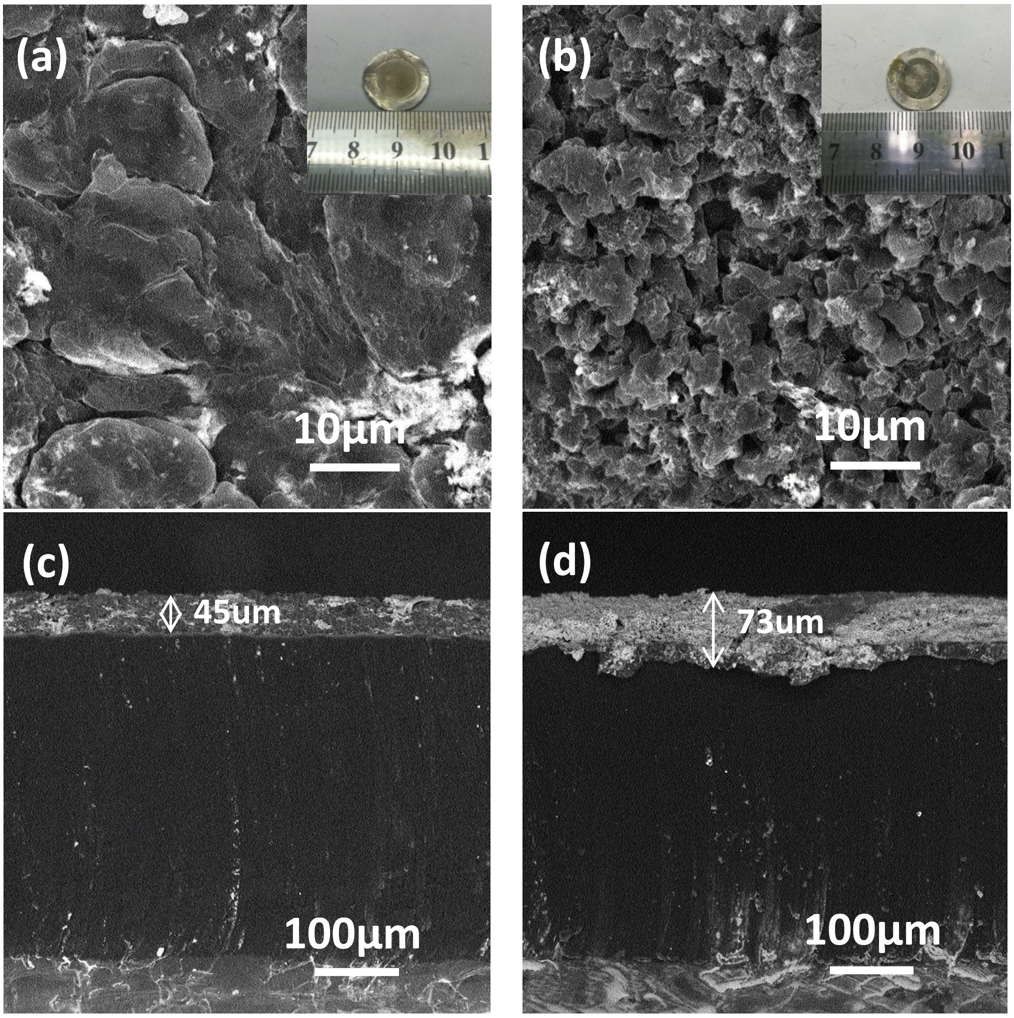

Fig. S9. Surface SEM images of the cycled lithium anodes and their corresponding cross-sectional morphology for Li-S batteries assembled with (a, c) CGPE and (b, d) LE.

Table S2. A comparison in rate performance of this work to other previous reports.

	GPE materials	S loading (mg cm^{-2})	Rate (1C=1675 mA g^{-1})	Capacity (mAh g^{-1})
This work	**PMMA/Acetylene black**	**1.0-1.3**	**3 C**	**657**
[22]	Carbon black/Nonwoven/PEG-PPG-PEG	1.5	3 C	641
[23]	PETEA	1.0-1.2	1 C	325
[42]	PVDF-HFP/PETT-Ester	1.2	2 C	243
[43]	PVDF-HFP/CNF	1.7	2 C	< 600
[44]	PVDF-HFP/LATP	1.7-2	0.2 C	459
[45]	ETPTA/CNF	1	2 C	330
[46]	PMMA/PAN	1.5-1.8	3 C	645
[47]	Lignocellulose	-	0.19 C	< 600
[48]	PVDF/CNF	1.18	2 C	500
[49]	PEO/LiTFSI	-	1 C	554