Supplementary Information

TiS_2/Celgard separator as efficient polysulfide shuttling inhibitor for high performance lithium-sulfur batteries

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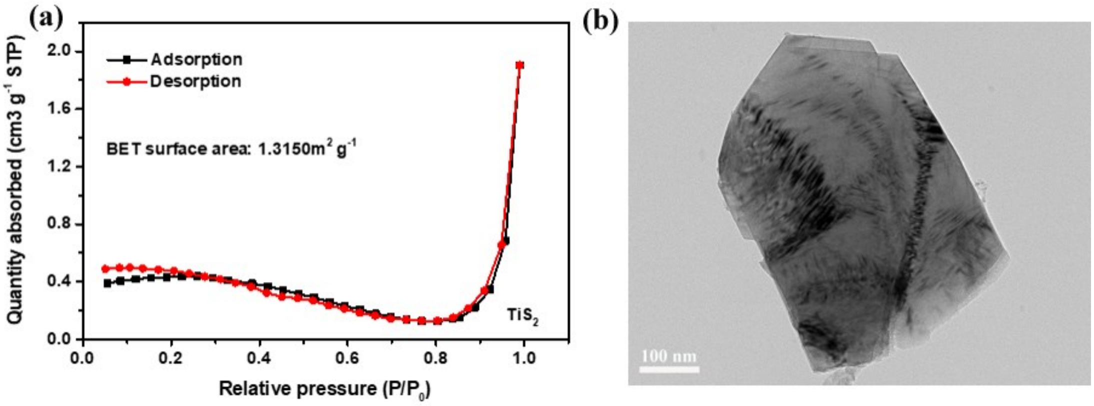

Fig. S1 (a) N_2 adsorption-desorption isotherms of TiS_2. (b)TEM images of TiS_2

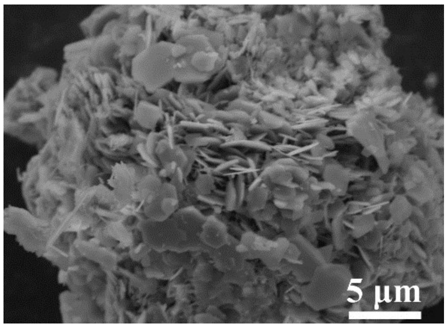

Fig. S2 The low-magnification SEM images of TiS_2

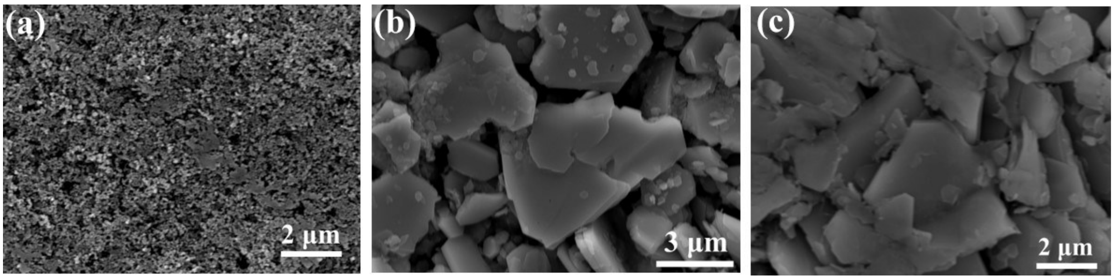

Fig. S3 SEM images of (a) Super P/Celgard, (b)TiS_2-SC/Celgard, and (c) TiS_2-VF/Celgard

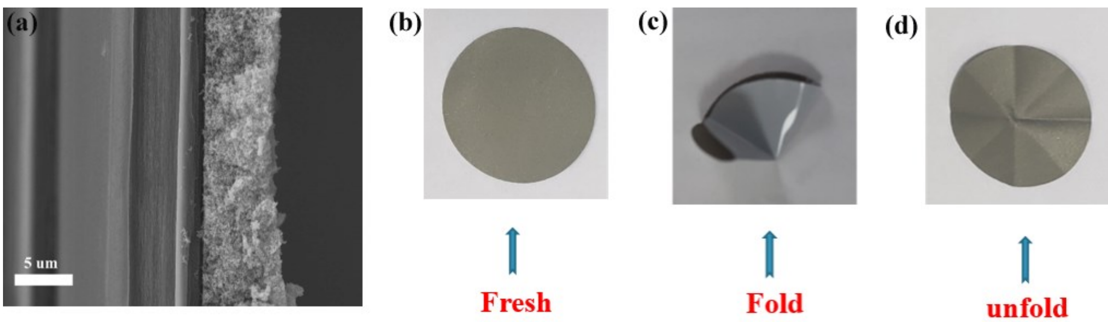

Fig. S4 (a) cross section of Super P layers. Photographs of as prepared TiS_2-VF/Celgard separator. Front side (b), folded (c) and unfolded (d).

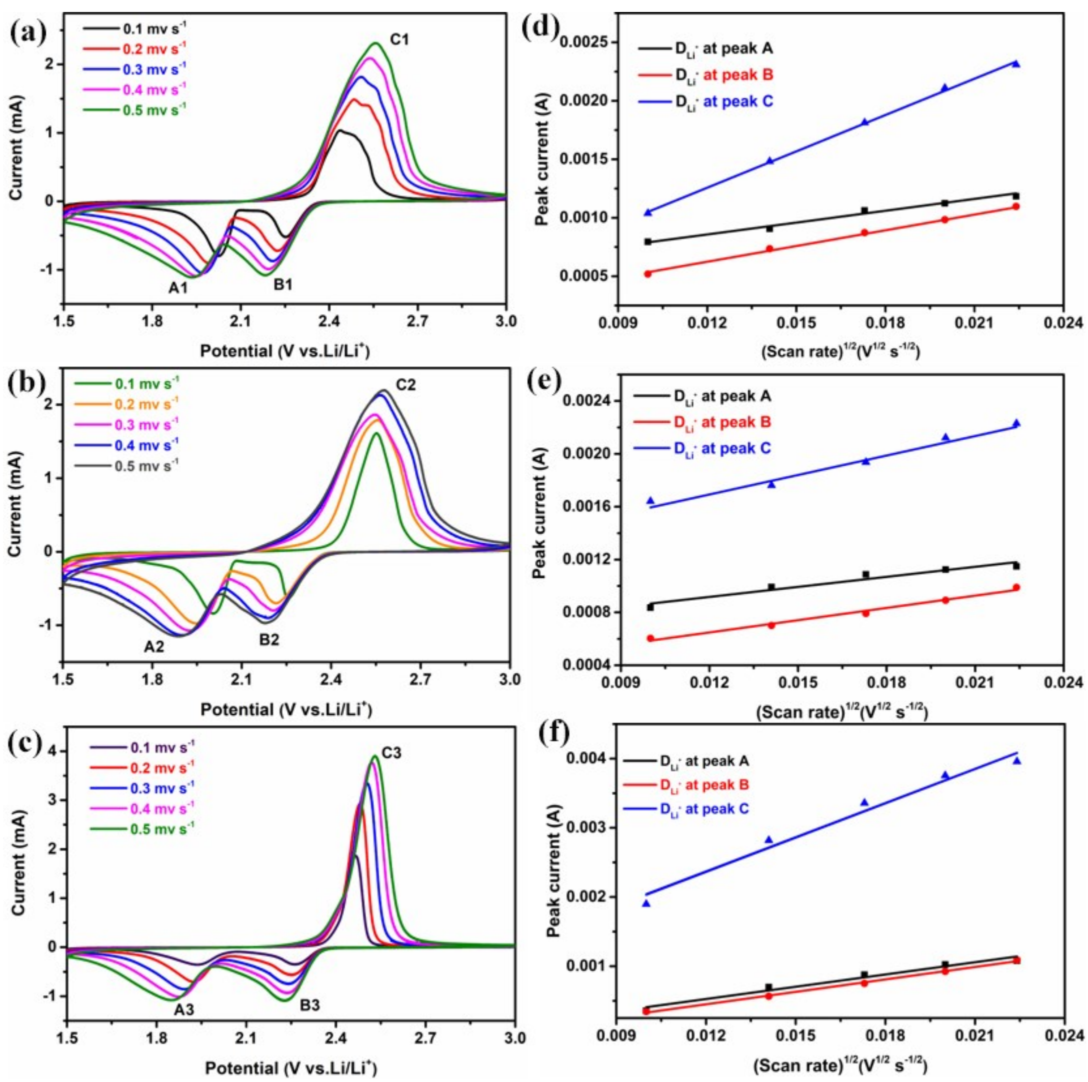

Fig. S5 (a-f) CV curves at various scan rates and corresponding linear fits of the peak currents of the Li-S batteries with a, d) Celgard; b,e) Super P/Celgard; c,f) TiS_2-SC/Celgard.

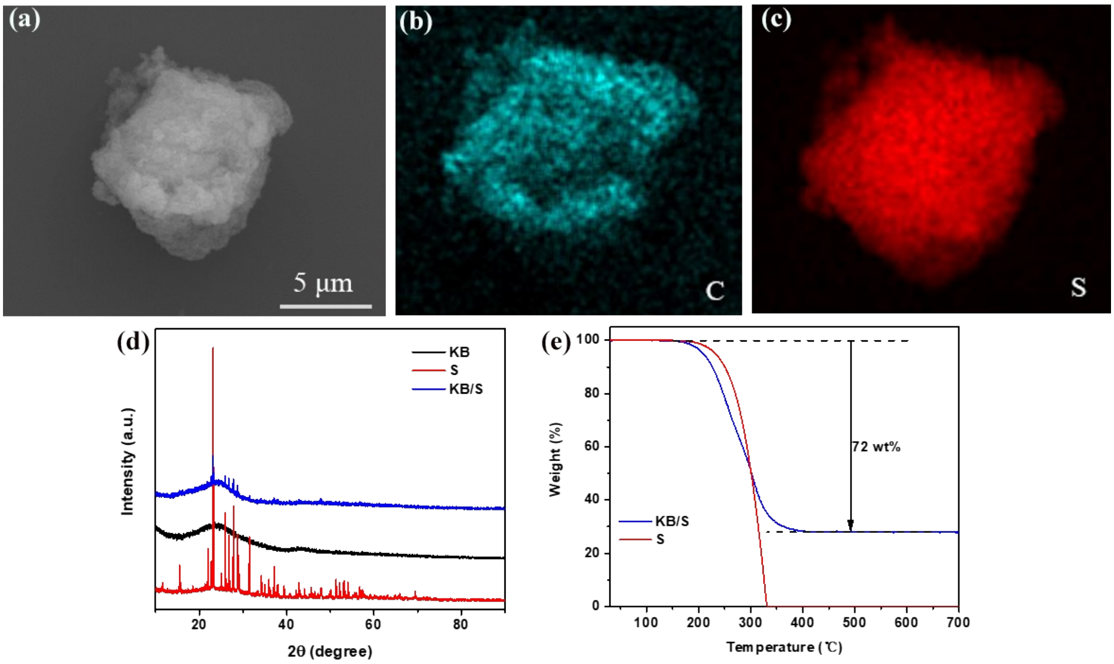

Fig. S6 (a) SEM and (b-c) elemental mapping images of KB/S; (d) XRD patterns for KB, S and KB/S; (e) TGA curve of the prepared S and KB/S composite under N_2 atmosphere.

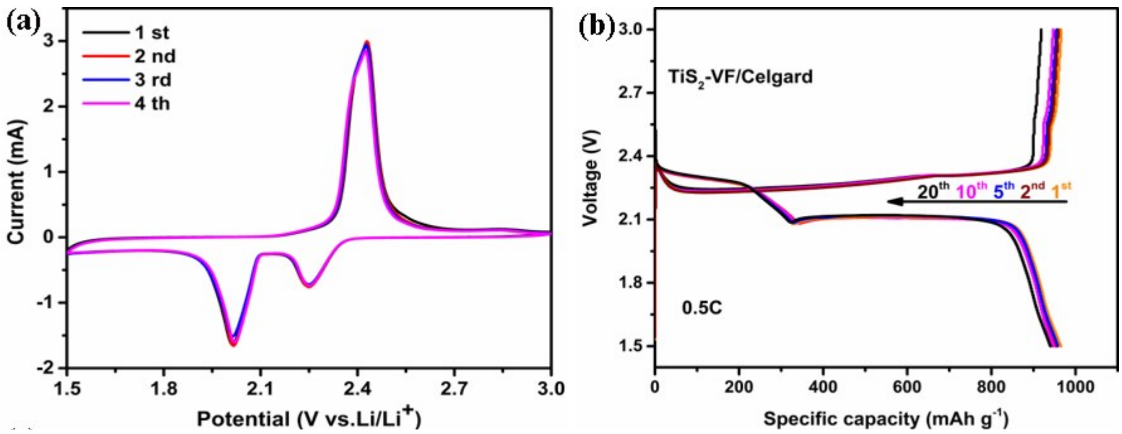

Fig. S7 Electrochemical performance of Li-S batteries with Celgard, Super P/Celgard, TiS_2-SC/Celgard and TiS_2-VF/Celgard separators: (a) Cyclic voltammogram profile for Li-S battery with TiS_2-VF/Celgard separator at scan rate of 0.2 mV s^{-1}. (b) Galvanostatic charge–discharge profiles at 0.5 C.

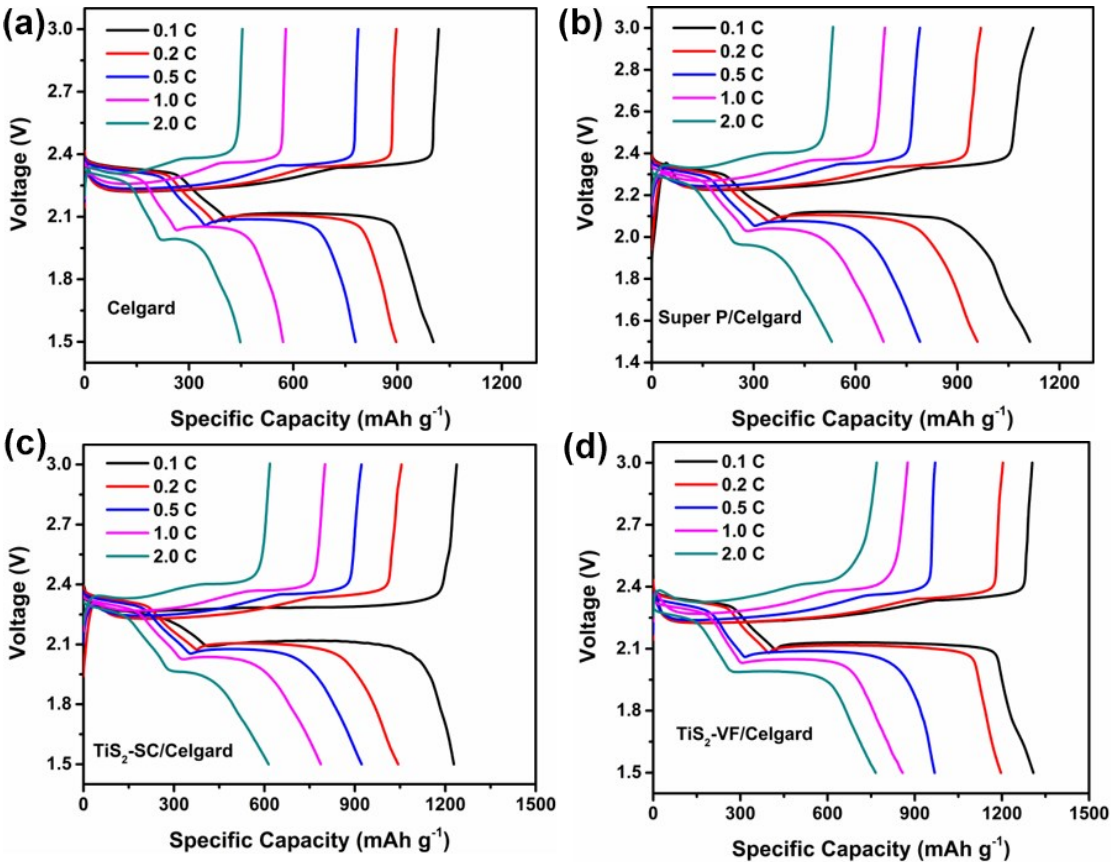

Fig. S8 Galvanostatic charge–discharge profiles of Li-S batteries with Celgard, Super P/Celgard, TiS_2-SC/Celgard and TiS_2-VF/Celgard separators at different rate.

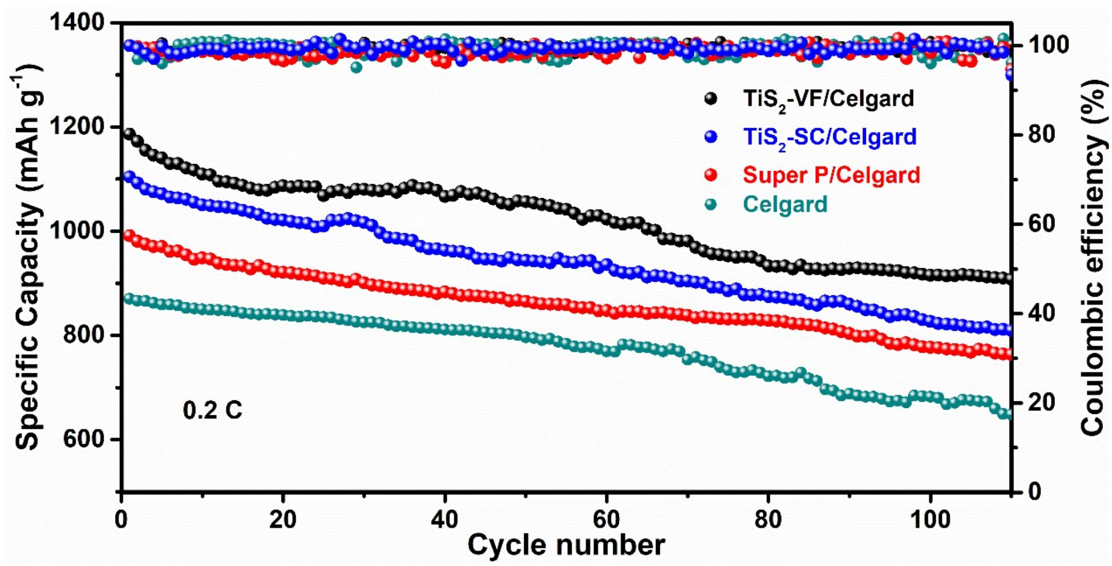

Fig. S9 Electrochemical performance of Li-S batteries with Celgard, Super P/Celgard, TiS_2-SC/Celgard and TiS_2-VF/Celgard separators: long-time cycling performance at 0.2 C.

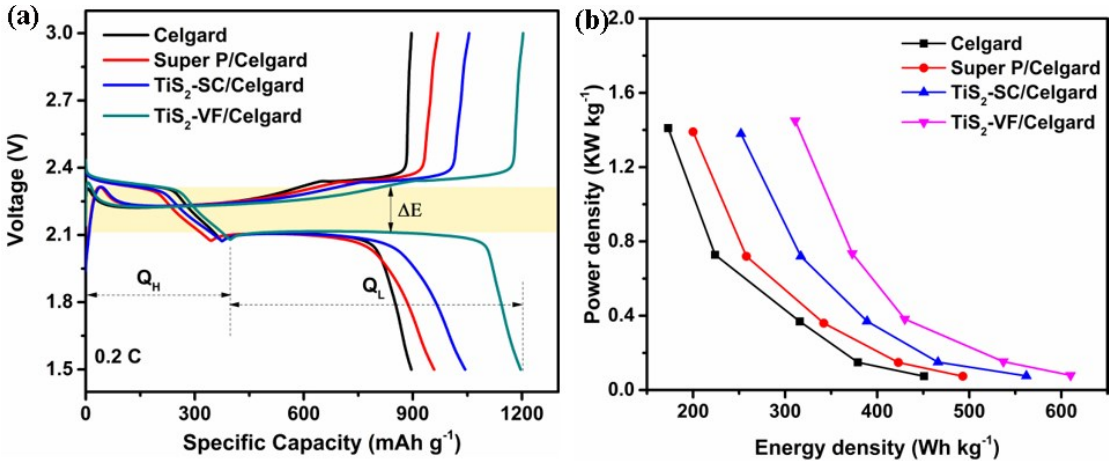

Fig. S10 (a) charge/discharge curves of Li-S batteries with Celgard, Super P/Celgard, TiS_2-SC/Celgard and TiS_2-VF/Celgard separators at 0.2 C; (b) Ragone plot. calculated from rate performances of Li-S batteries with Celgard, Super P/Celgard, TiS_2-SC/Celgard and TiS_2-VF/Celgard separators in Fig. 6c; The power and energy densities are calculated based on the total device mass.

Table S1. The specific data derived from simulation equivalent circuits diagram of the Li-S batteries with Celgard, Super P/Celgard, TiS_2-SC/Celgard and TiS_2-VF/Celgard separators.

Parameters	Celgard		Super P/Celgard		TiS_2-SC/Celgard		TiS_2-VF/Celgard	
	before	after	before	after	before	after	before	after
R0 (Ω)	6.55	10.87	7.14	13.96	18.62	4.39	3.675	7.77
Rct (Ω)	110.25	38.37	117.66	31.64	52.46	46.12	57.01	38.23
Rsf (Ω)	-	56.02	-	20.33	-	-	-	-

Table S2. The comparisons of the TiS_2-VF/Celgard and TiS_2-SC/Celgard-based Li-S batteries with the recent reports of Li-S batteries with modified separations.

Separator	**Host**	**Sulfur loading (mg cm^{-2})**	**Sulfur content (wt%)**	**Initial capacity (mAh g^{-1})**	**Rate (C)**	**Cycles**	**Capacity deacy (%)**	**Ref.**
Ketjen Black/PP	Super P	1.5-2	60	1350	0.5	500	0.09	1
GO/PP	CNT	1.0	63	920	0.1	500	0.23	2
Nafion/PP	CNT	0.53	50	800	1	500	0.08	3
Co_9S_8/Celgard	Super P	2	70	869	1	1000	0.039	4
Super P/Celgard	active carbon	0.7	70	1008	0.5	200	0.185	5
$Ni_3(HITP)_2$/PP	Carbon black	3.5	64	1244	0.2	100	0.085	6
Graphene/PP	CNT	1.8	63	1165	0.5	150	0.16	7
TiN/Celgard	Super P	1.3	70	1032	0.2	400	0.091	8
MoS_2/Celgard	Carbon black	-	65	808	0.5	600	0.083	9
SnS_2/Celgard	Ketjen black	3.1	70	1300	0.2	150	0.2	10
$Ti_3C_2T_x$/Celgard	Ti_3C_2	0.7-1	49	899	0.5	50	0.64	11
SnO_2@rGO/Celgard	Carbon black	2.87	55	~990	1	200	0.13	12
$BaTiO_3$/Celgard	Ketjen black	3.0	60	1122.1	0.1	50	0.34	13
MOF/Celgard	carbon black	0.6-0.8	70	1126	0.5	500	0.058	14
TiS_2-SC/Celgard	Ketjen black	1.8	50	811.2	1	500	0.056	This work
TiS_2-VF/Celgard	Ketjen black	1.8	50	887.3	1	500	0.024	This work

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