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ARTICLE

Electronic supplementary information

Ionic Conductivity Promotion of Polymer Electrolyte with Ionic Liquid Grafted Oxides for All-Solid-State Lithium-Sulfur Batteries

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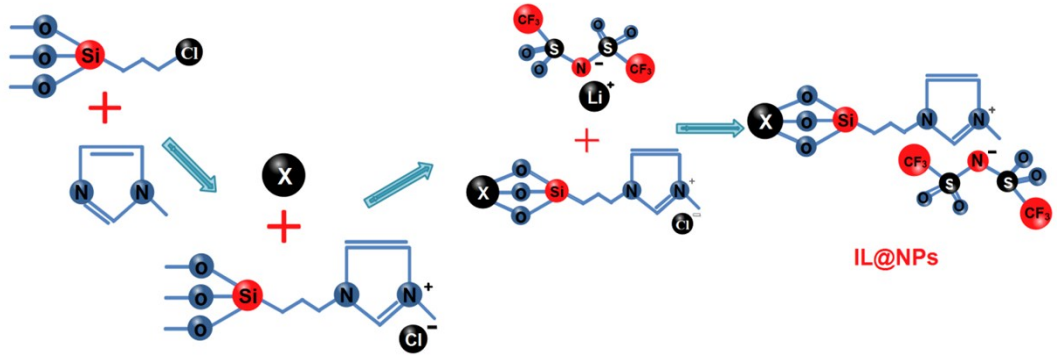


Fig. S1 Schematic illustration of the fabrication process of IL@NPs based on ion exchange method.

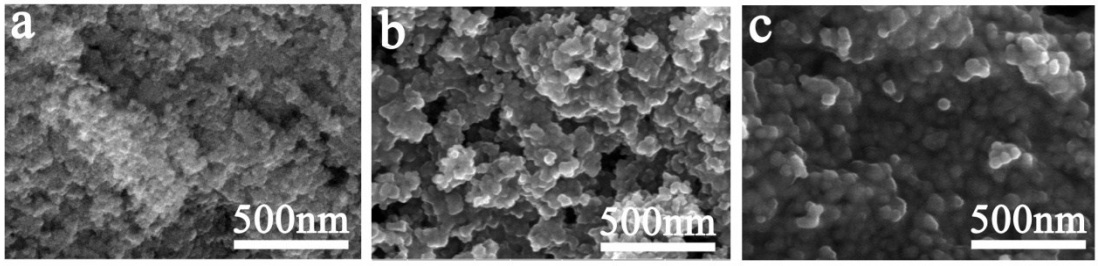


Fig. S2 SEM morphology of (a) IL@SiO_2, (b) IL@TiO_2, (c) IL@ZrO_2.

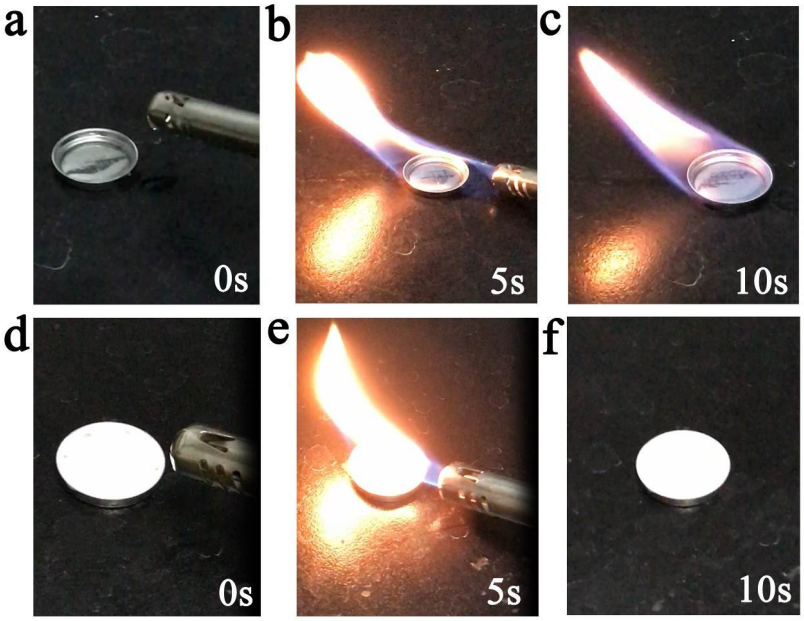


Fig. S3 Flammability tests of (a-c) 1 M LiTFSI and 0.1M $LiNO_3$ dissolved in a mixture of 1,3-dioxolane (DOL) and dimethoxymethane (DME) (v/v=1:1) and (d-f) PEO-Li-Zr electrolytes using a burning torch.

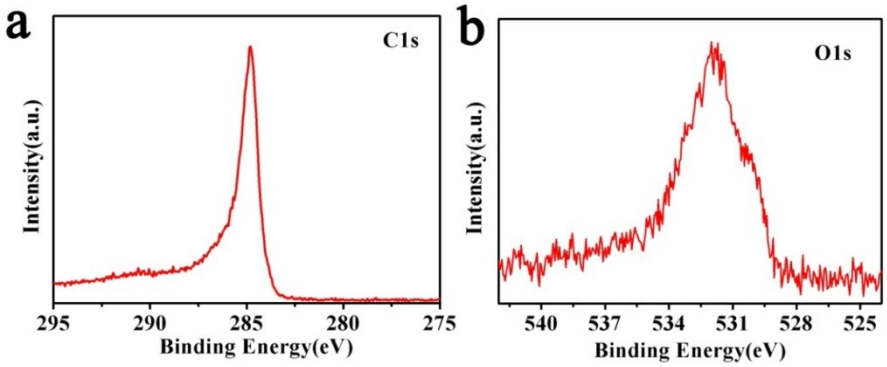
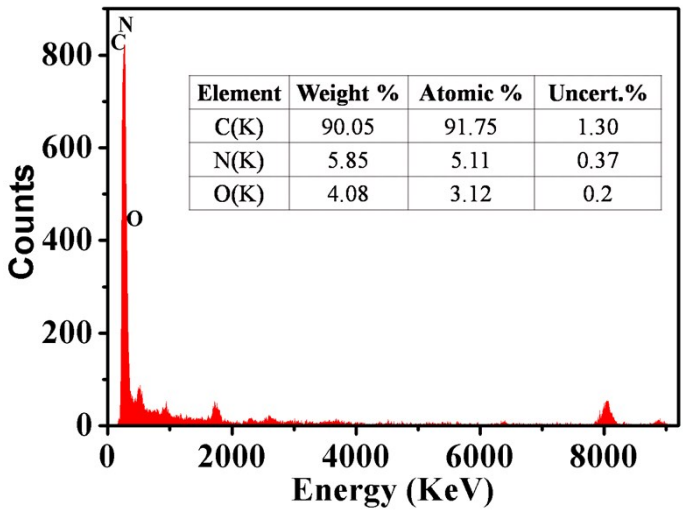


Fig. S4 XPS of (a) C1s and (b) O1s respectively.



Element	Weight %	Atomic %	Uncert.%
C(K)	90.05	91.75	1.30
N(K)	5.85	5.11	0.37
O(K)	4.08	3.12	0.2

Fig. S5 EDX full elements analysis of N-CNs.

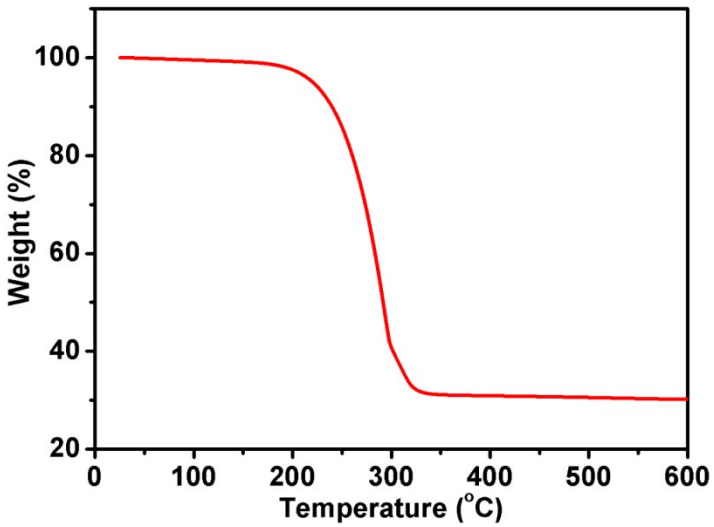


Fig. S6 TG curves of N-CNs/S materials.

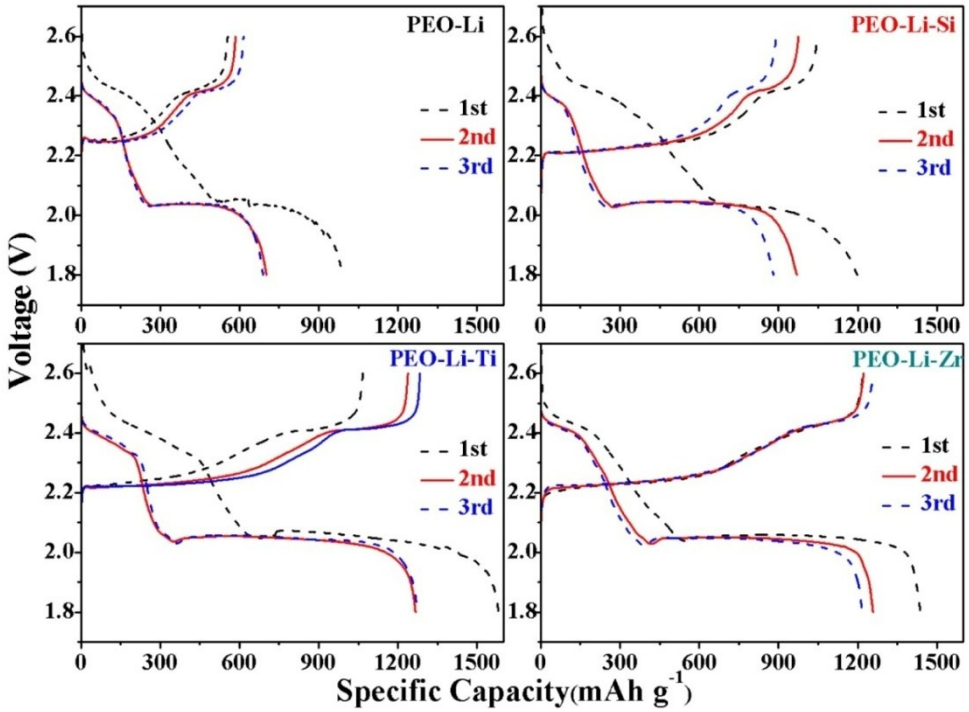


Fig. S7 The discharge/charge curves of the first three cycles for the battery based on PEO-Li, PEO-Li-Si, PEO-Li-Ti, PEO-Li-Zr electrolytes at 50 °C.

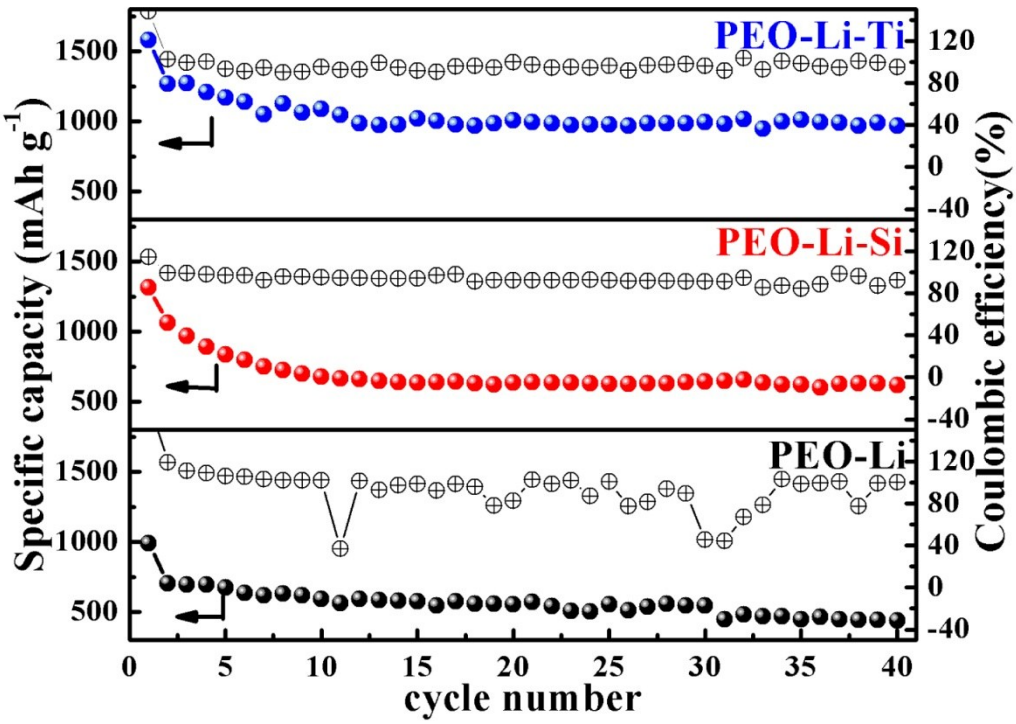


Fig.S8 Discharge capacity and Coulombic efficiencies of PEO-Li, PEO-Li-Si, PEO-Li-Ti battery at 50 ^{o}C.

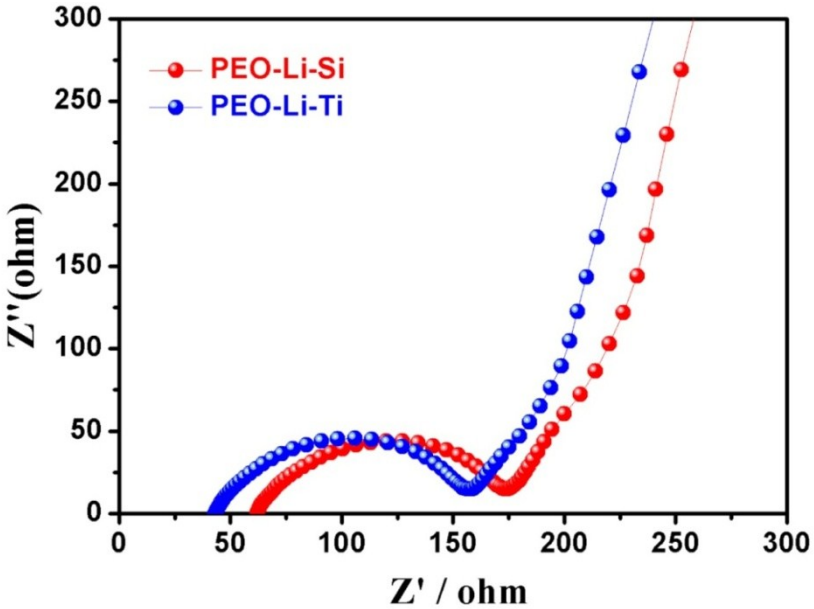


Fig. S9 Electrochemical impedance spectroscopy (EIS) of PEO-Li-Si, PEO-Li-Ti battery at 50 ^{o}C.

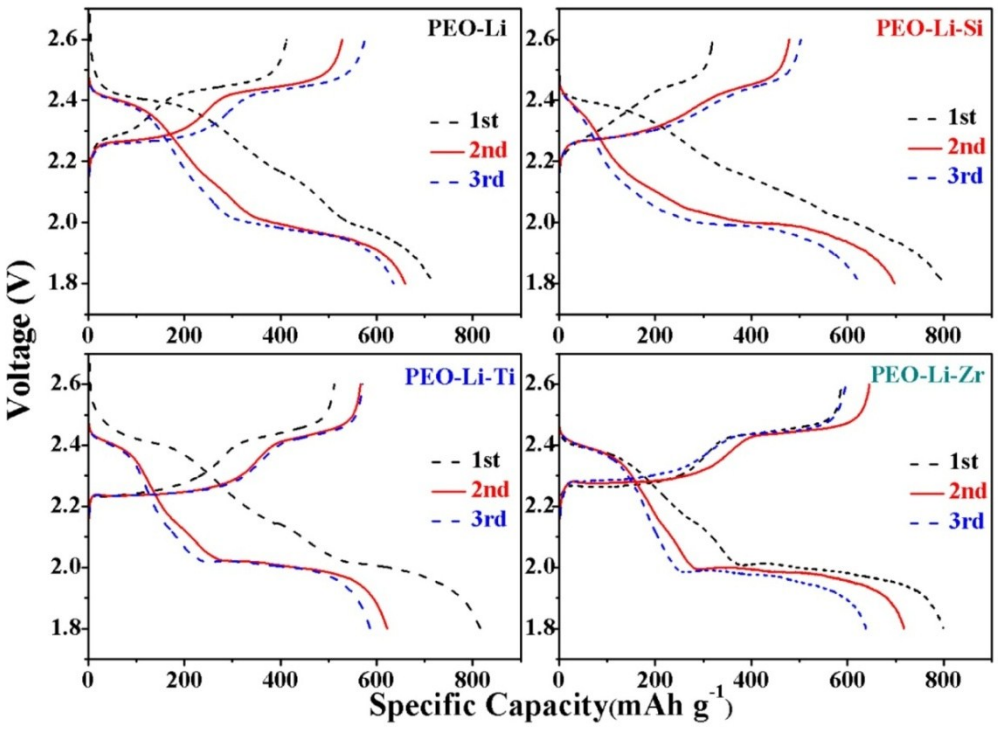


Fig. S10 The discharge/charge curves of the first three cycles for the battery based on PEO-Li, PEO-Li-Si, PEO-Li-Ti, PEO-Li-Zr electrolytes at 37 °C.

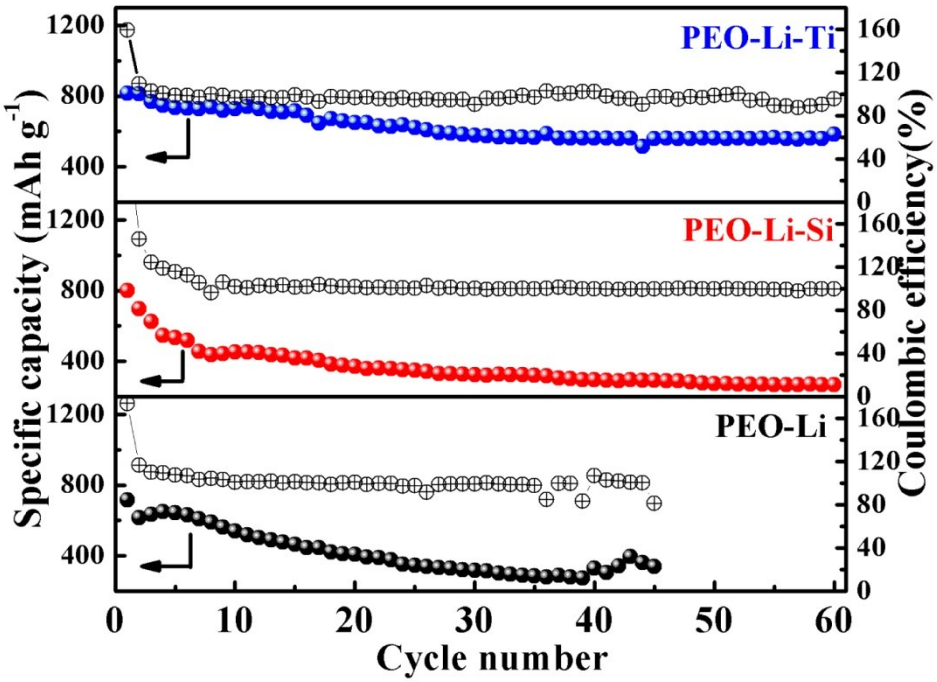


Fig. S11 Discharge capacity and Coulombic efficiencies of PEO-Li, PEO-Li-Si, PEO-Li-Ti battery at 37 °C.

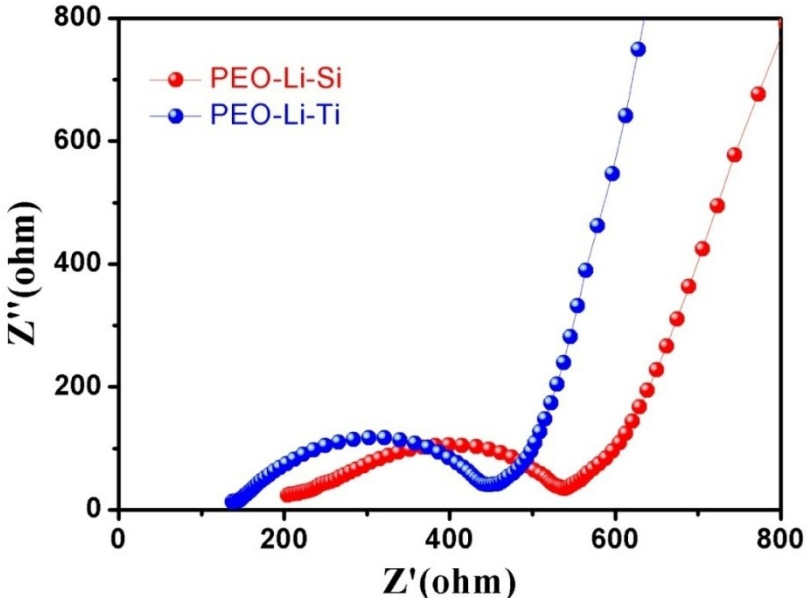


Fig. S12 Electrochemical impedance spectroscopy (EIS) of PEO-Li-Si, PEO-Li-Ti battery at 37 ^{o}C.

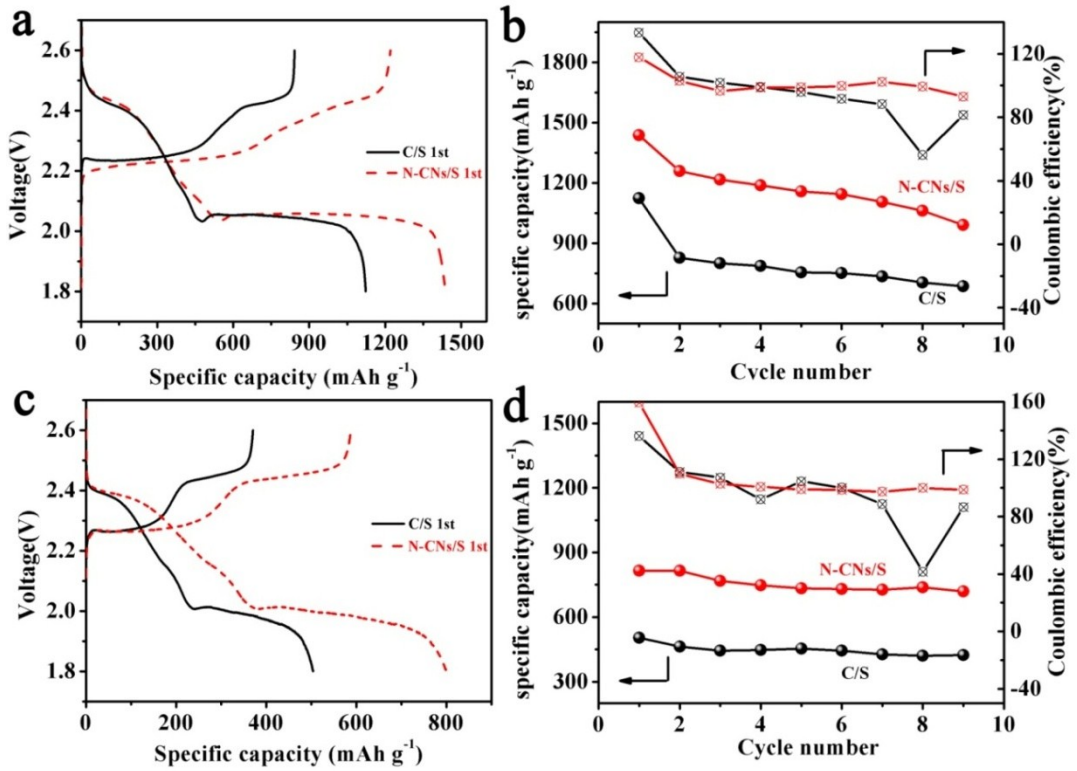


Fig. S13 Typical discharge/charge curves of Carbon black/S cathode and N-CNs/S cathode using PEO-Li-Zr electrolyte at 50 °C. b) Discharge/charge capacity and Coulombic efficiencies of the battery with Carbon black/S cathode or N-CNs/S cathode at 50 °C**.** c) Typical discharge/charge curves of Carbon black/S cathode and N-CNs/S cathode using PEO-Li-Zr electrolyte at 37 °C. d) Discharge/charge capacity and coulombic efficiencies of the battery with Carbon black/S cathode or N-CNs/S cathode at 37 °C.

Table S1. Comparison of the electrochemical performance of different all-solid-state batteries

Electrolyte	Cathode/ Anode	Working Voltage (V)	Working Temp(°C)	Capacity (mAh g^{-1})	Year	Ref
PEO-LiTFSI -Pyr_{14}TFSI	$LiFePO_4$/Li	3.0-4.0	40	160 (After 100cycles)	2014	[1]
PEO-LiTFSI -HMOP	$LiFePO_4$/Li	2.9-3.8	65	120 (After 100cycles)	2016	[2]
PEO-$LiClO_4$ -SiO_2	$LiFePO_4$/Li	2.5-4.1	90	105 (After 80cycles)	2016	[3]
PEO-$LiClO_4$ -LLZTO	$LiFePO_4$/Li	2.6-3.8	60	105 (After 200cycles)	2016	[4]
PEO-$LiCF_3SO_3$ -Li_2S-ZrO_2	Li_2S-C /Li	1.5-3.2	70	600 (After 50cycles)	2010	[5]
PEO-LiTFSI -MIL-53(Al)	PANI@C/S-280/Li	1.0-3.0	80	876 (After 60cycles)	2015	[6]
PEO-LiTNFSI	CMK-3/S /Li	1.5-3.0	60	450 (After 200cycles)	2016	[7]
PEO-LiTFSI -IL@ZrO_2	**N-CNs/S/Li**	**1.8-2.6**	**37** **50**	**600 (After 80cycles)** **986 (After 40cycles)**	**Our work**	

References

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