Electronic Supplementary Material (ESI) for Journal of Materials Chemistry A.
This journal is © The Royal Society of Chemistry 2020

Electronic Supplementary Information

Novel Multielement Nanocomposite with Ultrahigh Rate Capacity and Durable Performance for Sodium-Ion Battery Anode

Xiaochuan Ren, ‡[a,b] Yuanxin Zhao, ‡[a] Qingwei Li,[c] Feng Cheng,[b] Wen Wen,[a] Lili Zhang,[a] Yaobo Huang,[a] Xinhui Xia,[d] Xiaolong Li,[a] Daming Zhu,*[a] Kaifu Huo,*[b] and Renzhong Tai[a]

[a] Shanghai Synchrotron Radiation Facility, Shanghai Advanced Research Institute, Chinese Academy of Sciences, Shanghai 201204, China

[b] Wuhan National Laboratory for Optoelectronics (WNLO), Huazhong University of Science and Technology, Luoyu Road 1037, Wuhan 430074, China

[c] Advanced Research Institute for Multidisciplinary Science, Qilu University of Technology (Shandong Academy of Sciences), Jinan 250353, China

[d] State Key Laboratory of Silicon Materials, Key Laboratory of Advanced Materials and Applications for Batteries of Zhejiang Province, Zhejiang University, Hangzhou, 310027, China

* Corresponding author: zhudaming@zjlab.org.cn; kfhuo@hust.edu.cn

[#] These authors contributed equally to this work.

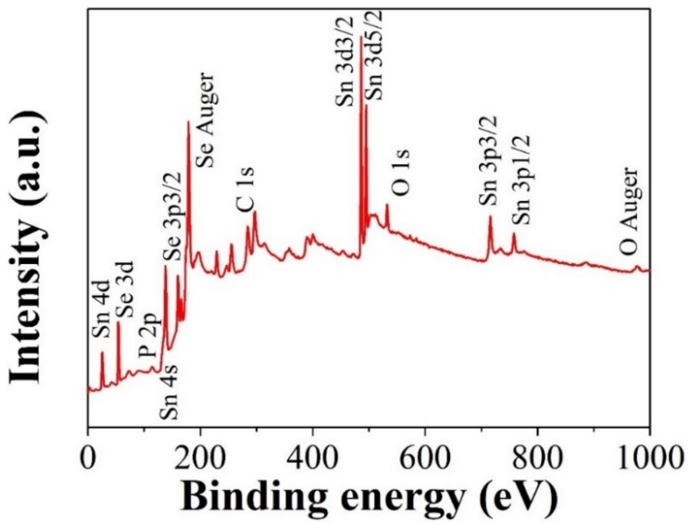

Fig. S1. The survey XPS spectrum of $SnPSe_3$@G.

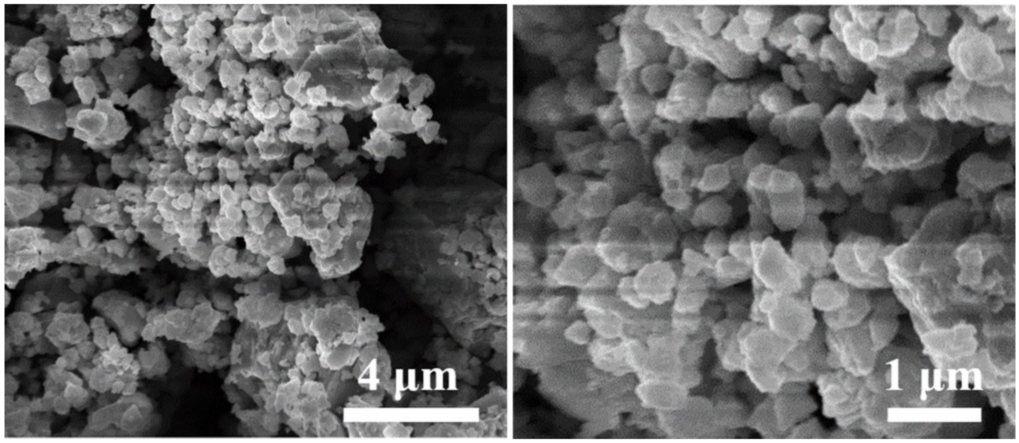

Fig. S2. SEM image of $SnPSe_3$.

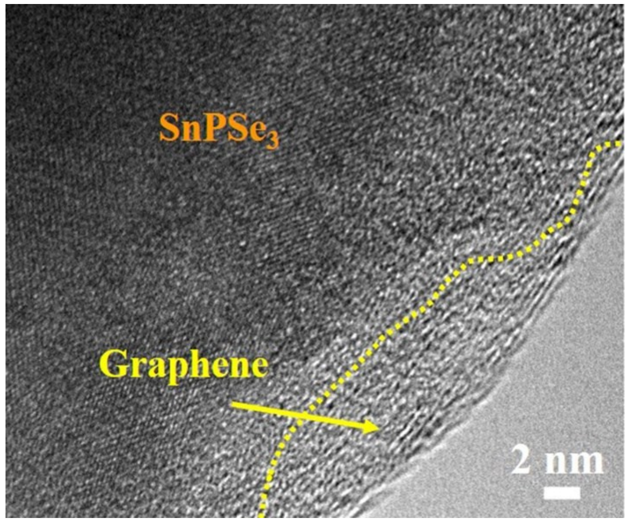

Fig. S3. (a) High-magnification TEM image of $SnPSe_3$@G composite.

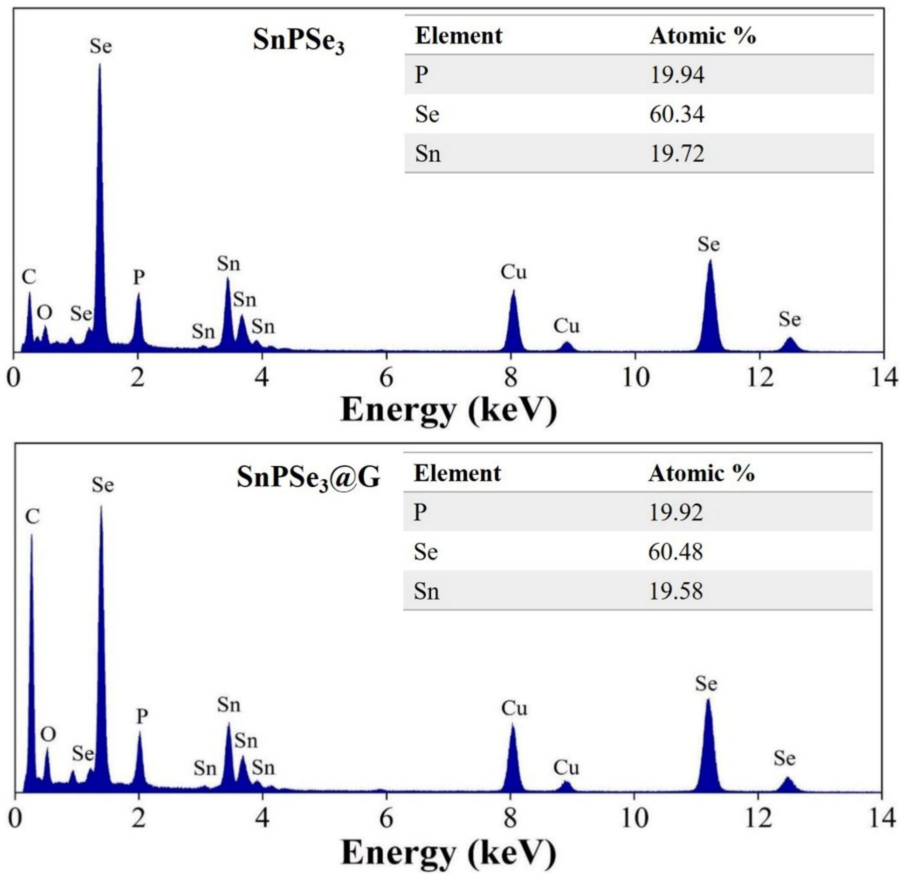

Fig. S4. EDX spectra of $SnPSe_3$ and $SnPSe_3$@G.

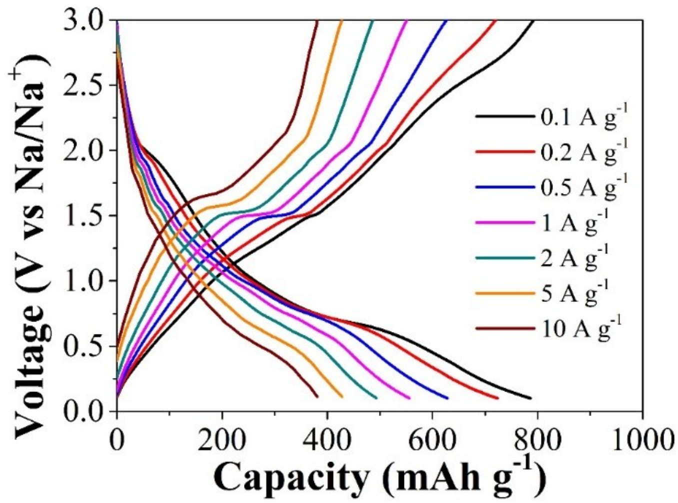

Fig. S5. Corresponding charge-discharge curves of $SnPSe_3$@G in NSF-M electrolyte at various current densities.

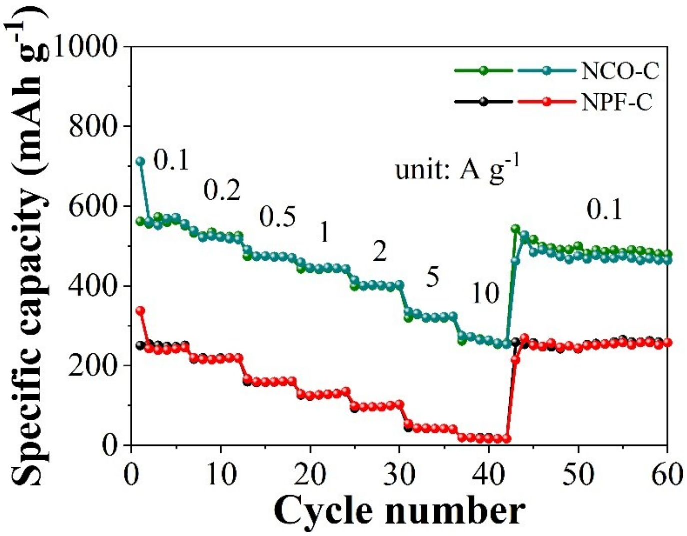

Fig. S6. Rate performance of $SnPSe_3$@G in different electrolytes at a voltage window between 0.1-3.0 V.

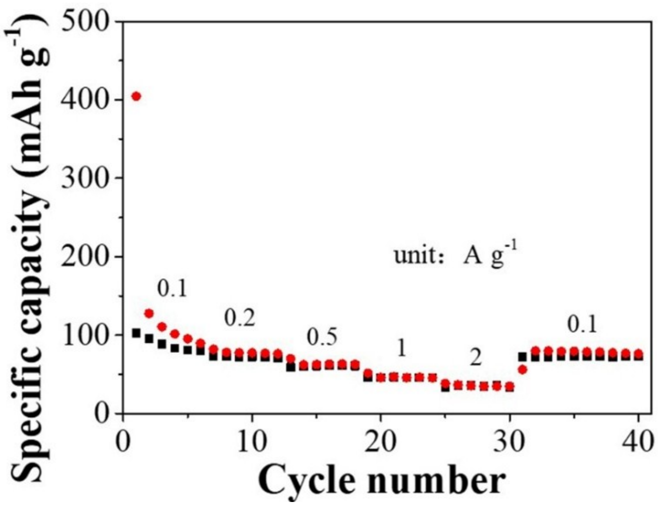

Fig. S7. Rate capability of the graphene electrode.

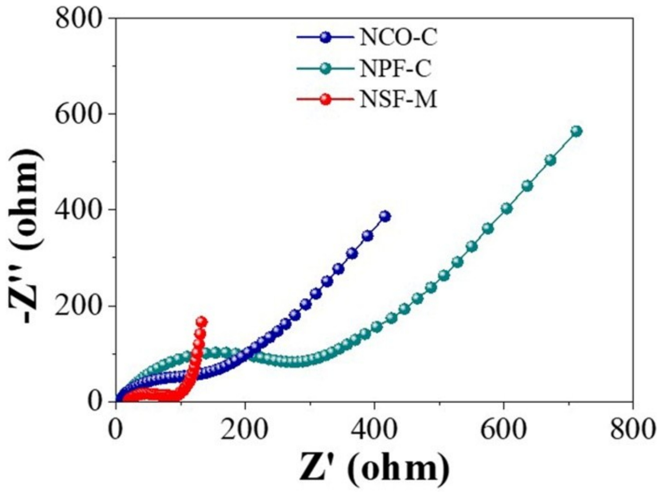

Fig. S8. Nyquist plots of $SnPSe_3$@G in different electrolytes at the voltage window between 0.1-3.0 V

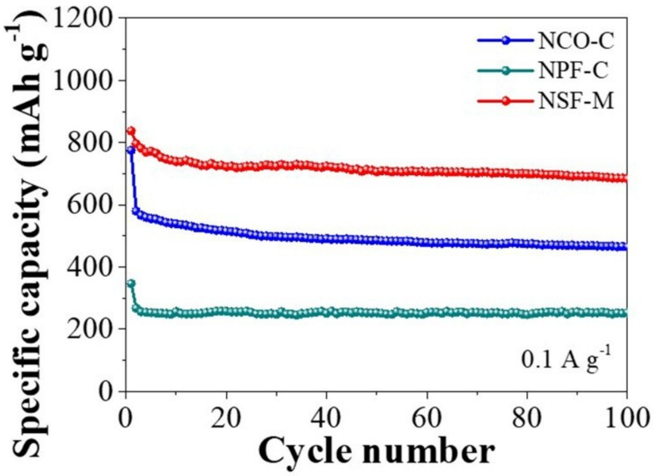

Fig. S9. Cycling stabilities of $SnPSe_3$@G in different electrolytes at 0.1 A g^{-1}.

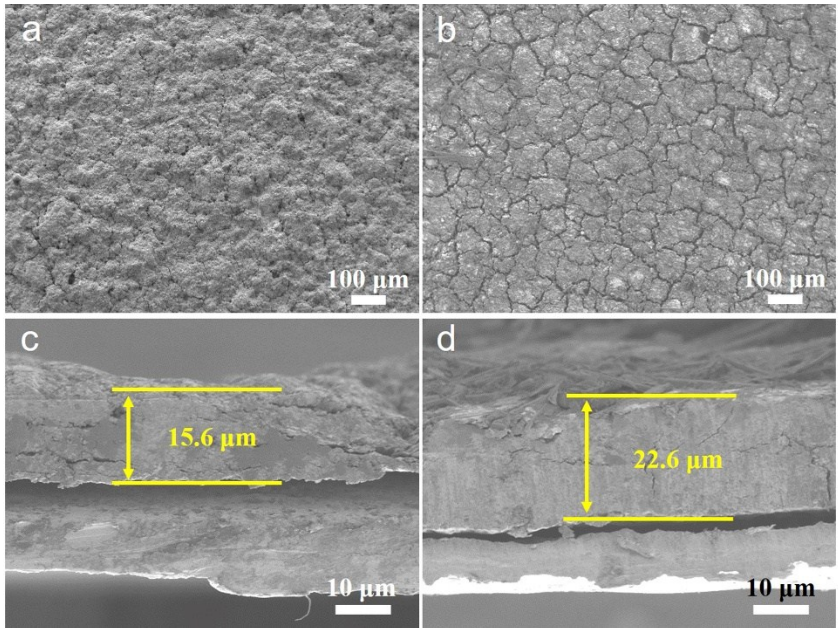

Fig. S10. The SEM images of the surface and cross-section morphology of $SnPSe_3$@G electrode before (a, c) and after (b, d) 100 cycles at 0.1-3 V.

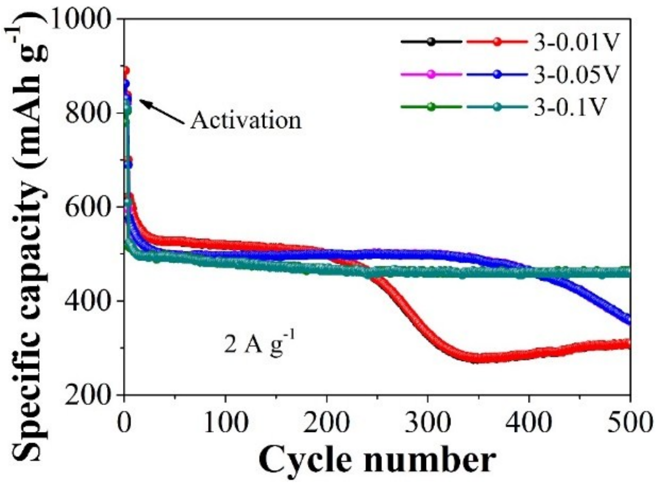

Fig. S11. The cycling performance of the $SnPSe_3$@G electrode at 2 A g^{-1} with the different cut-off voltages in NSF-M electrolyte.

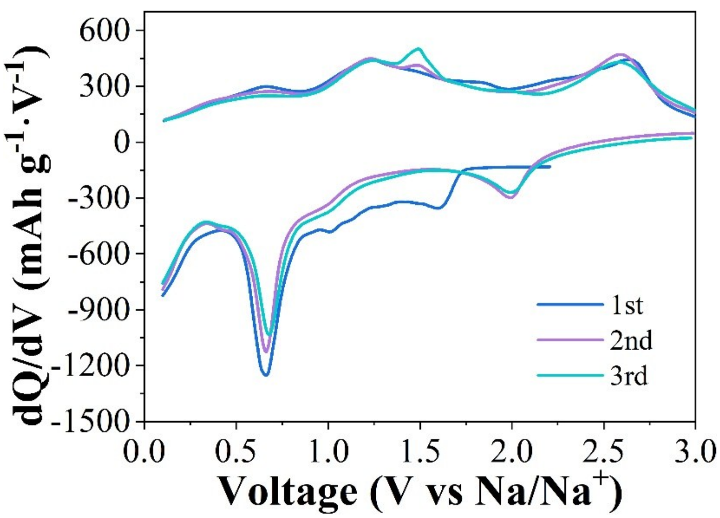

Fig. S12. Di□erential capacity (dQ/dV) *vs.* voltage plots of $SnPSe_3$@G electrode for the initial three cycles in NSF-M electrolyte.

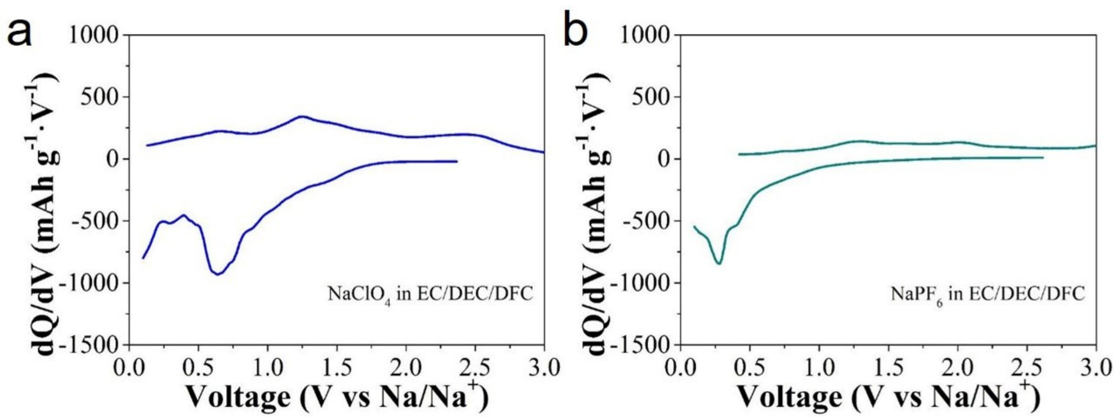

Fig. S13. Di□erential capacity (dQ/dV) *vs.* voltage plots in NCO-C (a) and NPF-C (b) electrolytes.

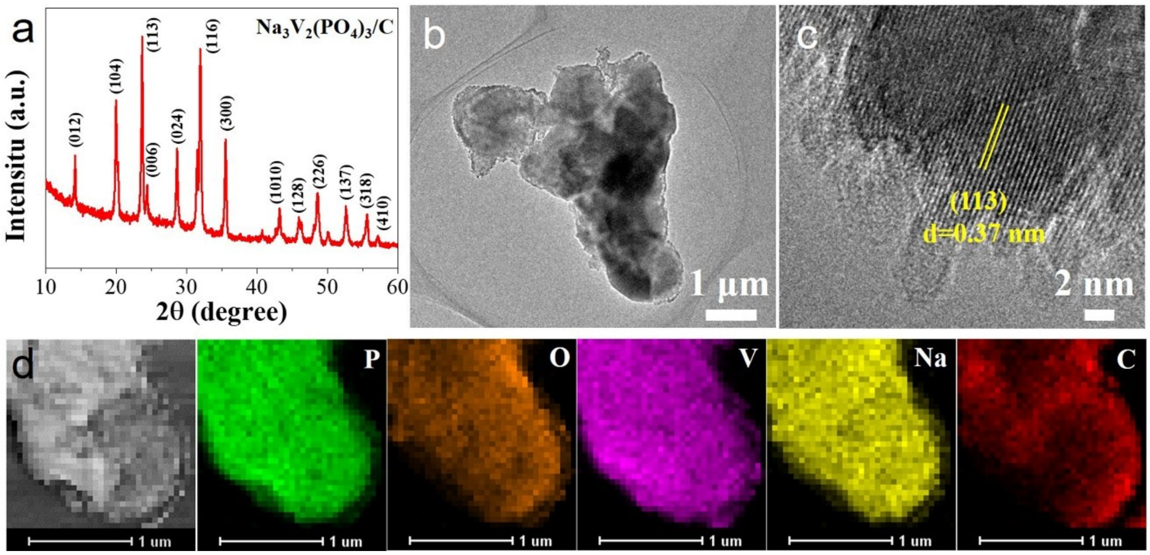

Fig. S14. (a) XRD, (b) TEM, (c) HRTEM and (d) EDX mapping of $Na_3V_2(PO_4)_3/C$ used as the cathode for sodium full-cell.

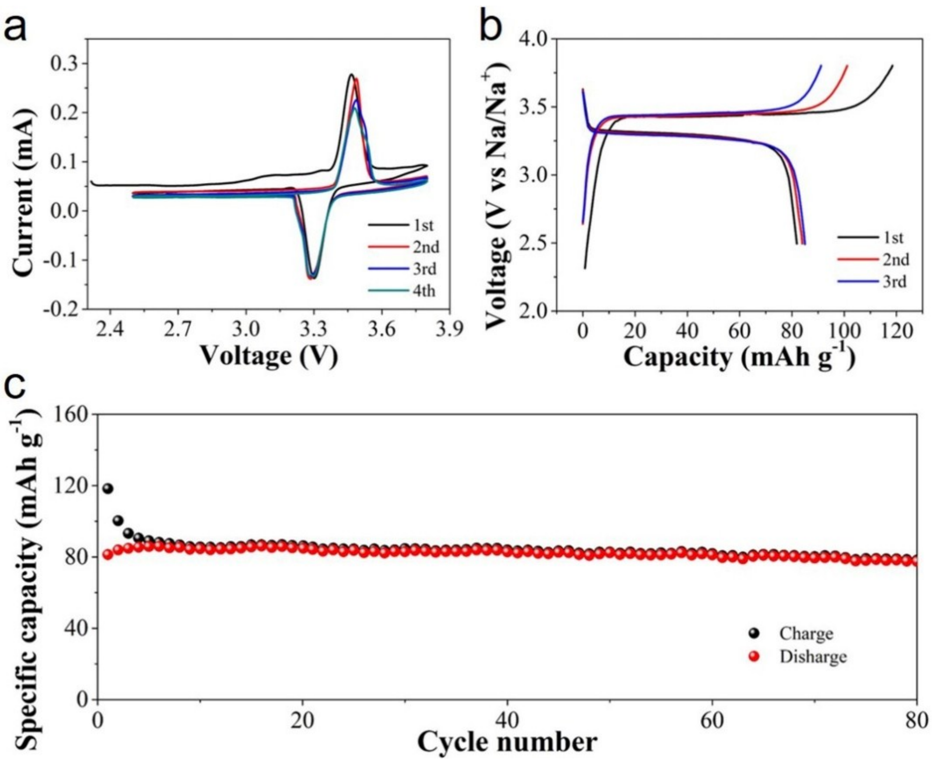

Fig. S15. Electrochemical performance of $Na_3V_2(PO_4)_3$/C (NVP/C) as a cathode for sodium full-cell. (a) CV curves of the first four cycles at 0.2 mV s^{-1} in 2.5-3.8 V. (b) charge/discharge profiles and (c) cycling performance at 0.2 A g^{-1} between 2.5-3.8 V.

Table S1. The initial coulombic efficiency (ICE) comparisons of $SnPSe_3$@G electrode with the reported Sn-, Se- or P-based anodes for SIBs.[a]

Electrode	Electrolyte	Initial coulombic efficiency	Ref.
Sn_4P_3@C	1 M $NaPF_6$ in DME	90.7%	1
FeP/C	1 M NaPF6 in EC/DEC with 2% FEC	68.4%	2
Sandwich-like Ni_2P	1 M $NaCF_3SO_3$ in TGM	69%	3
SnS_2@CNTs	1 M $NaClO_4$ in EC/DEC with 5% FEC.	74.3%	4
$FeSe_2$@N-doped Carbon	$NaCF_3SO_3$ in diglyme	97%	5
$MoSe_2$@C	1 M $NaClO_4$ in PC with 5% FEC	75.7%	6
Sn_4P_3@porous carbon	1 M $NaPF_6$ in EC/DMC with 10% FEC	72.5%	7
$CoSe_2$@B and N co-doped graphene	1 M $NaCF_3SO_3$ in DEG/DME	68.5%	8
SnS_2/CNT	1 M $NaPF_6$ in PC with 2% FEC	54%	9
$SnPSe_3$@G	**1 M $NaCF_3SO_3$ in diglyme**	**95%**	**This work**

[a] DME: 1,2-Dimethoxyethane. EC: ethylene carbonate. DEC: diethylene carbonate. FEC: fluoroethylene carbonate. TGM: tetraethylene glycol dimethyl ether. PC: propylene carbonate. DMC: dimethyl carbonate. DEG: diethylene glycol.

References

1. X. Fan, T. Gao, C. Luo, F. Wang, J. Hu and C. Wang, *Nano Energy*, 2017, **38**, 350-357.
2. Y. Von Lim, S. Huang, Y. Zhang, D. Kong, Y. Wang, L. Guo, J. Zhang, Y. Shi, T. P. Chen, L. K. Ang and H. Y. Yang, *Energy Storage Mater.*, 2018, **15**, 98-107.
3. C. Dong, L. Guo, Y. He, C. Chen, Y. Qian, Y. Chen and L. Xu, *Energy Storage Mater.*, 2018, **15**, 234-241.
4. Y. Liu, X.-Y. Yu, Y. Fang, X. Zhu, J. Bao, X. Zhou and X. W. Lou, *Joule*, 2018, **2**, 725-735.
5. P. Ge, H. Hou, S. Li, L. Yang and X. Ji, *Adv. Funct. Mater.*, 2018, **28**, 1801765.
6. P. Ge, H. Hou, C. E. Banks, C. W. Foster, S. Li, Y. Zhang, J. He, C. Zhang and X. Ji, *Energy Storage Mater.*, 2018, **12**, 310-323.
7. L. Ran, I. Gentle, T. Lin, B. Luo, N. Mo, M. Rana, M. Li, L. Wang and R. Knibbe, *J. Power Sources*, 2020, **461**, 228116.
8. H. Tabassum, C. Zhi, T. Hussain, T. Qiu, W. Aftab and R. Zou, *Adv. Energy Mater.*, 2019, **9**, 1901778.
9. Z. Liu, A. Daali, G. L. Xu, M. Zhuang, X. Zuo, C. J. Sun, Y. Liu, Y. Cai, M. D. Hossain, H. Liu, K. Amine and Z. Luo, *Nano Lett.*, 2020, DOI: 10.1021/acs.nanolett.0c00964.