Supporting Information

Fabrication of MnSe/SnSe@C Heterostructures for High Performance Li/Na Storage

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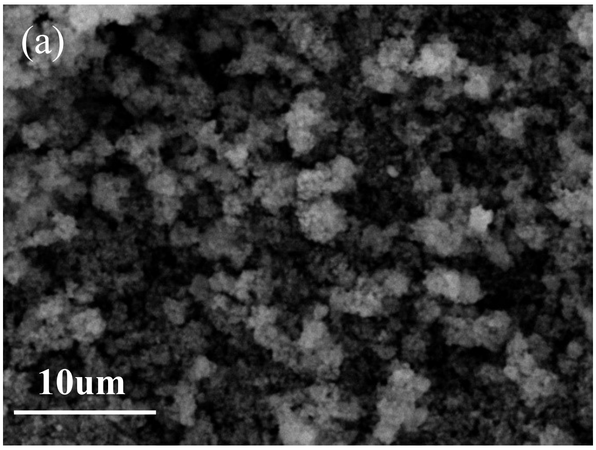

Figure S1. SEM image of the MnSe/SnSe@C-M.

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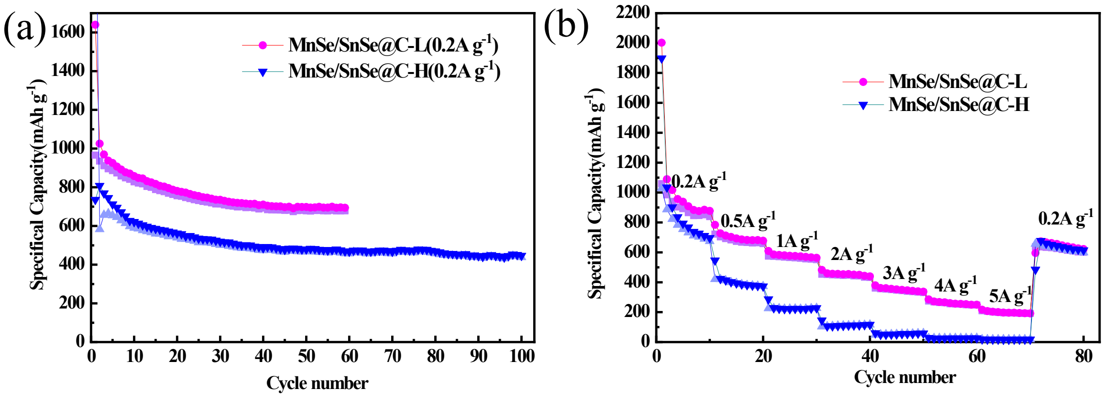

Figure S2. Lithium-ion batteries (a) Cycle performance of the MnSe/SnSe@C-L and MnSe/SnSe@C-M at 0.2 A g^{-1}. (b) Rate performance of the MnSe/SnSe@C-L and MnSe/SnSe@C-H at different current density.

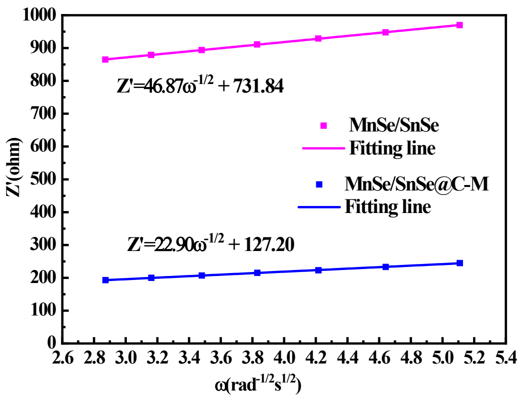

Figure S3. Lithium-ion batteries (a) the D_{Li} of the MnSe/SnSe and MnSe/SnSe@C-M.

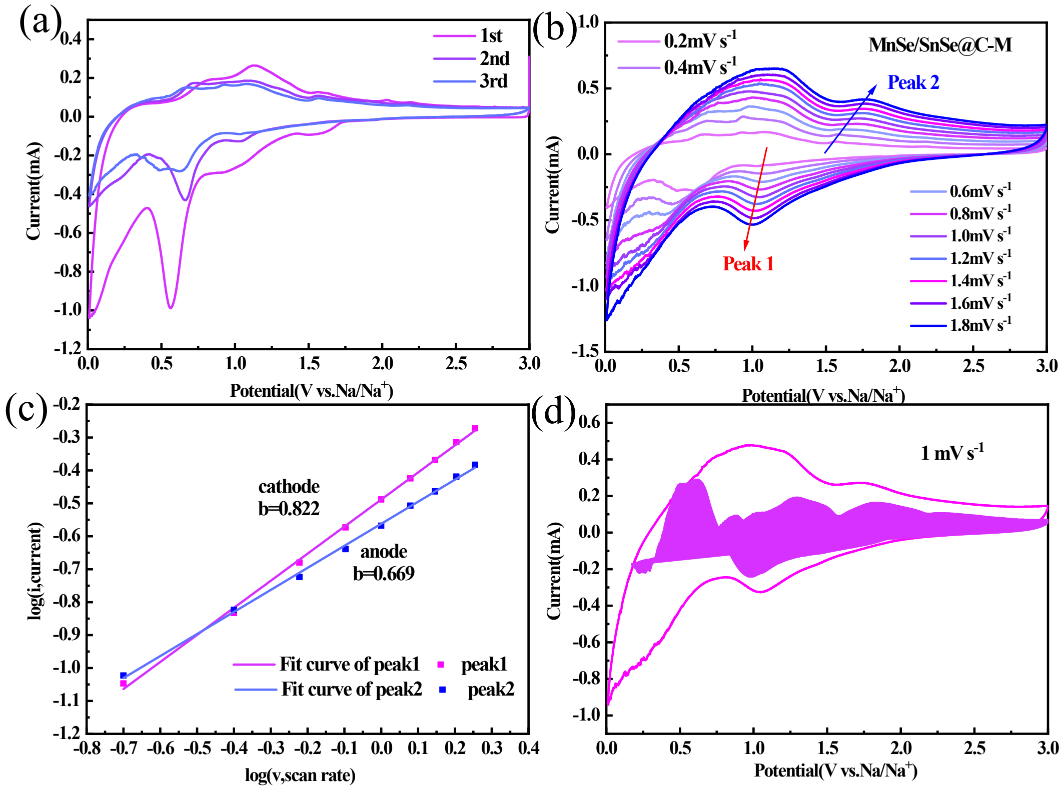

Figure S4. Kinetics investigation of the MnSe/SnSe@C-M as anode material for NIBs (a) CV curves of the MnSe/SnSe@C-M at 0.2 mV s^{-1} for the initial three cycles. (b) CV curves of the MnSe/SnSe@C-M at different scan rate (0.2-1.8 mV s^{-1}). (c) Log (i) versus Log (v) curves for anode/cathode peaks. (d) the proportion of pseudo-capacitance at 1 mV s^{-1}.

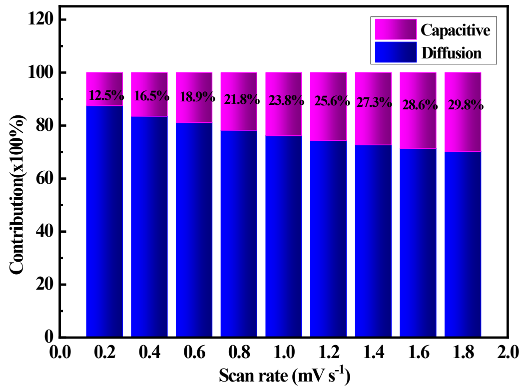

Figure S5. The proportion of pseudo capacitance of the MnSe/SnSe@C-M at different scan rate for NIBs (0.2-1.8 mV s^{-1}).

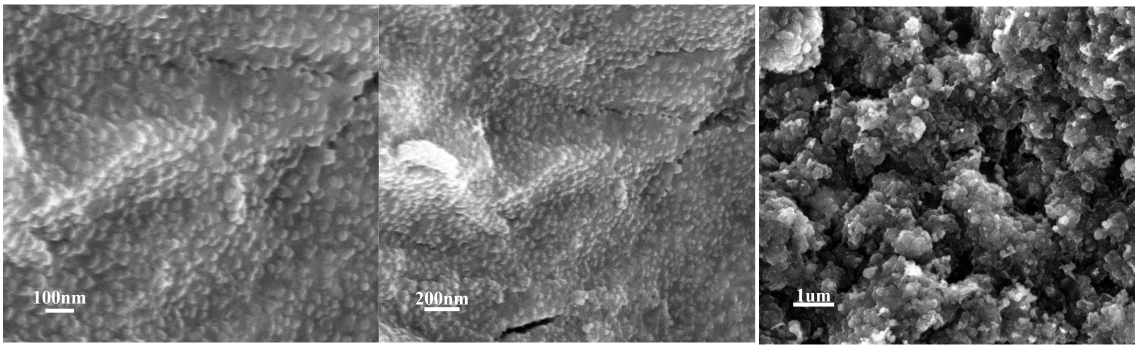

Figure S6. SEM images of the MnSe/SnSe@C-M nanoboxes after 600 cycles at 1A g^{-1} (MnSe/SnSe@C-M//LFP Li-ion full cell).

Table S1. Electrochemical performance of MnSe/SnSe@C for lithium ion half cell and other Sn-based materials for lithium ion half cell.

Morphology of materials	**Voltage Range (V vs. Li^+ /Li)**	**Cycles (times)**	**Current density (A g^{-1})**	**Cs(mA hg^{-1})**	**Reference**
SnSe/carbon	0.01-3	100	0.5A g^{-1}	633.1 mAh g^{-1}	1
SnSe-amorphous carbon	0.01-3	200	0.1 A g^{-1}	626 mAh/g	2
Mn_2SnO_4/Sn/C Cubes	0.01-3	100	0.5A g^{-1}	908 mAh g^{-1}	3
Se-doped SnS@carbon nanofibers	0.01-3	50	0.2 A g^{-1}	742 mAh/g	4
SnS-SnSe Nanocomposite	0.01-3	50	3μA/cm^{-2} ;	613 mAh/g	5
SnO_2/N-C Nanoflowers	0.01-3	100	1.0A g^{-1}	750 mAh g^{-1}	6
SnO_2/Sn-RGO	0.01-2.5	400	1.6A g^{-1}	449 mAh g^{-1}	7
SnO_2 Nanorod/Carbon Nanofiber	0.05-3	850	0.1A g^{-1}	485 mAh g^{-1}	8
SnSe/C nanofibers	0.01-2.5	500	1.0A g^{-1}	405 mAh g^{-1}	9
SnSe/SnO_2@Gr	0.01-3	200	0.2 A g^{-1}	810 mAh g^{-1}	10
SnSe/CNT	0.01-3	200	0.2A g^{-1}	772 mAh g^{-1}	11
SnSe/rGO	0.01-3	200	0.1A g^{-1}	620 mA h g^{-1}	12
SnSe N/S-doped rGO	0.01-3	100	0.2A g^{-1}	785 mA h g^{-1}	13
$SnSe_2$ Quantum Dot/rGO	0.01-3	500	0.05A g^{-1}	778.5 mA h g^{-1}	14
Carambola-shaped SnO_2/CNT	0.01-3	500	1.0A g^{-1}	452 mAh g^{-1}	15
MnSe/SnSe@C	0.01-3	240	0.2A g^{-1}	**965 mAh g^{-1}**	**This work**
	0.01-3	900	0.5A g^{-1}	**557 mAh g^{-1}**	

References

1. L. Cui, X. Li, C. Yin, J. Wang, S. Li, Q. Zhang and S. Kang, Dalton Trans, 2019, 48, 504-511.
2. W. u. Rehman, Y. Xu, X. Sun, I. Ullah, Y. Zhang and L. Li, ACS Applied Materials & Interfaces, 2018, 10, 17963-17972.
3. K. Liang, T. Y. Cheang, T. Wen, X. Xie, X. Zhou, Z. W. Zhao, C. C. Shen, N. Jiang and A. W. Xu, The Journal of Physical Chemistry C, 2016, 120, 3669-3676.
4. G. Ali, S. Mehboob, M. Ahmad, M. Akbar, S.-O. Kim, H. Y. Ha and K. Y. Chung, Journal of Alloys and Compounds, 2020, 823.
5. X. Shi, X. Lin, S. Liu, A. Li, X. Chen, J. Zhou, Z. Ma and H. Song, Chemical Engineering Journal, 2019, 372, 269-276.
6. J. Liang, C. Yuan, H. Li, K. Fan, Z. Wei, H. Sun and J. Ma, Nano-micro letters, 2018, 10, 21.
7. X. Sui, X. Huang, Y. Wu, R. Ren, H. Pu, J. Chang, G. Zhou, S. Mao and J. Chen, ACS applied materials & interfaces, 2018, 10, 26170-26177.
8. J. Abe, K. Takahashi, K. Kawase, Y. Kobayashi and S. Shiratori, ACS Applied Nano Materials, 2018, 1, 2982-2989.
9. D. Liu, Z. Kong, X. Liu, A. Fu, Y. Wang, Y. G. Guo, P. Guo, H. Li and X. S. Zhao, ACS Appl Mater Interfaces, 2018, 10, 2515-2525.
10. X. Zhou, L. Yu and X. W. D. Lou, Advanced Energy Materials, 2016, 6.

11. X. Zhao, M. Luo, W. Zhao, R. Xu, Y. Liu and H. Shen, ACS Appl Mater Interfaces, 2018, 10, 38006-38014.

12. L. Pan, Y. Zhang, F. Lu, Y. Du, Z. Lu, Y. Yang, T. Ye, Q. Liang, Y. Bando and X. Wang, Energy Storage Materials, 2019, 19, 39-47.

13. M. Liu, S. Zhang, H. Dong, X. Chen, S. Gao, Y. Sun, W. Li, J. Xu, L. Chen, A. Yuan and W. Lu, ACS Sustainable Chemistry & Engineering, 2019, 7, 4195-4203.

14. F. Li, G. Luo, W. Chen, Y. Chen, Y. Fang, M. Zheng and X. Yu, ACS Appl Mater Interfaces, 2019, 11, 36949-36959.

15. H. Kim, H. Kim, S. Muhammad, J. H. Um, M. S. A. Sher Shah, P. J. Yoo and W.-S. Yoon, Journal of Power Sources, 2020, 446.