Electronic Supplementary Material (ESI) for RSC Advances.

$Na_{0.4}MnO_2$/MXene nanocomposites as cathodes for high-performance aqueous zinc-ion batteries

Guangquan Si[a]*, Wei Li[b]*, Taijiang Li[b], Caixia Wang[b], Qi Sun[b]

[a] Huaneng Power International, Inc., Beijing 100031, China

[b] Xi'an Thermal Power Research Institute Co., Ltd., Xi'an 710054, China

*Corresponding author.

E-mail address: liwei@tpri.com.cn

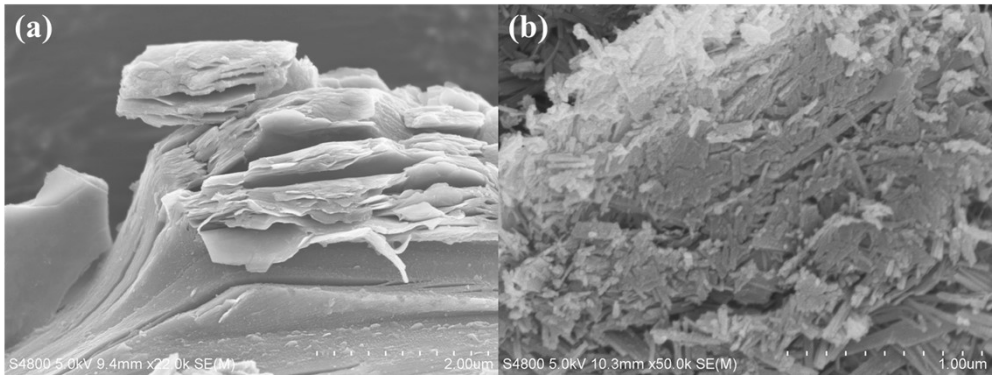

Fig. 1. SEM images of the (a) MXene and (b) MnO_2.

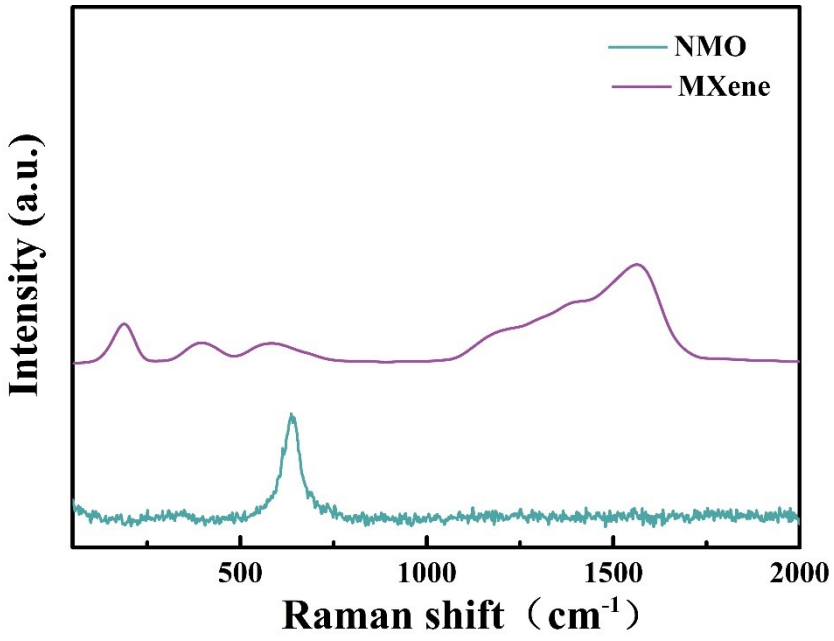

Fig. 2. Raman spectra of the $Na_{0.4}MnO_2$ (NMO) and MXene.

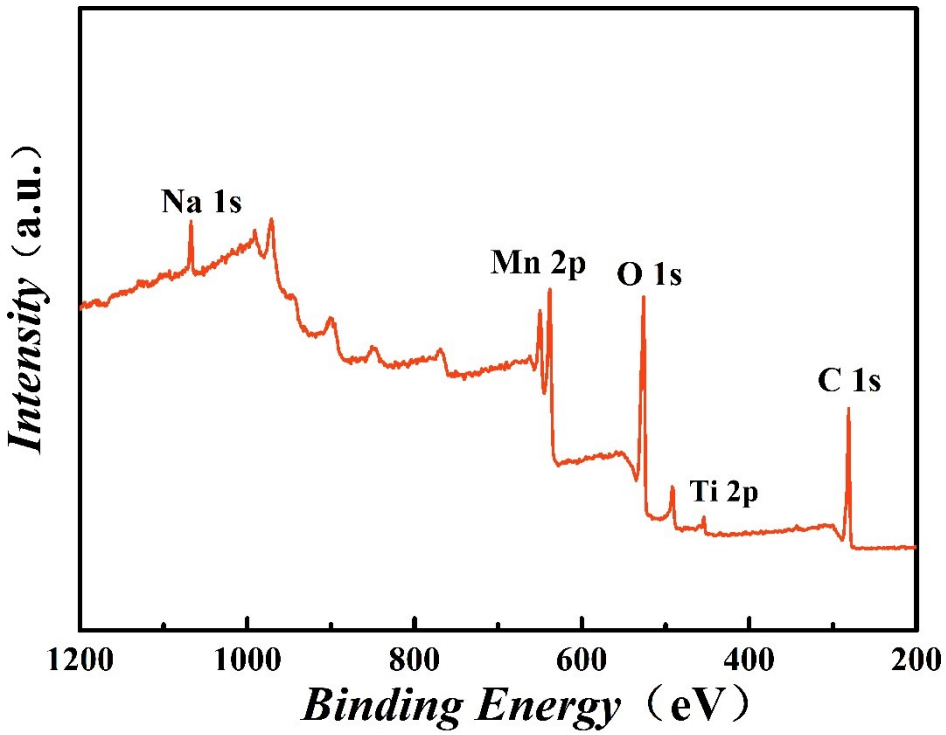

Fig. 3. XPS spectra of the NMO@MXene.

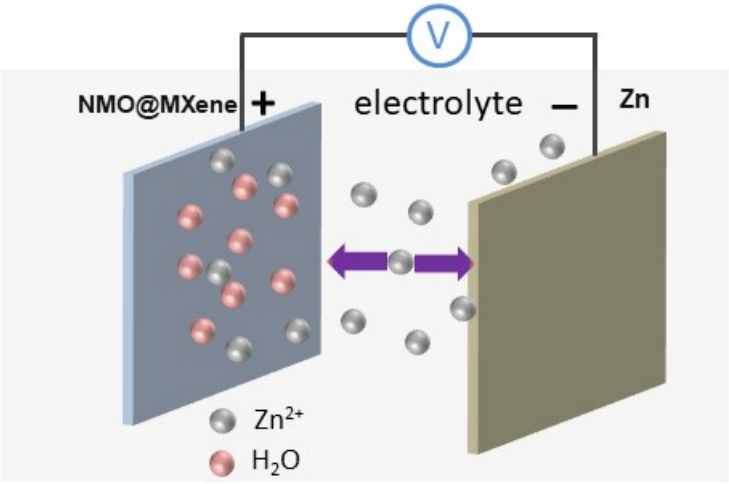

Fig. 4 Schematic illustration of NMO@MXene aqueous rechargeable battery.

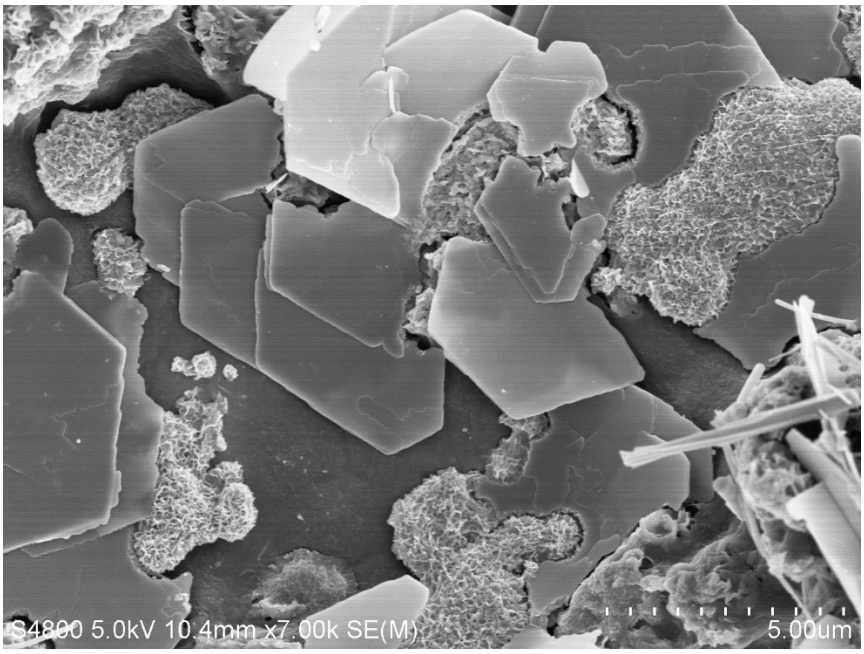

Fig. 5 SEM images of NMO@MXene after 200 cycles.

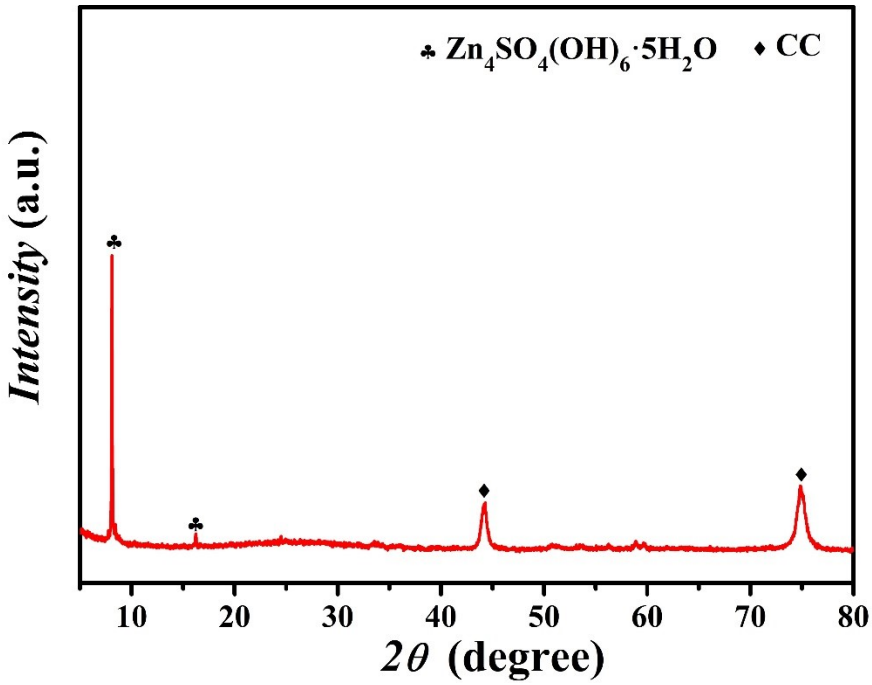

Fig. 6 XRD pattern of NMO@MXene after 200 cycles.

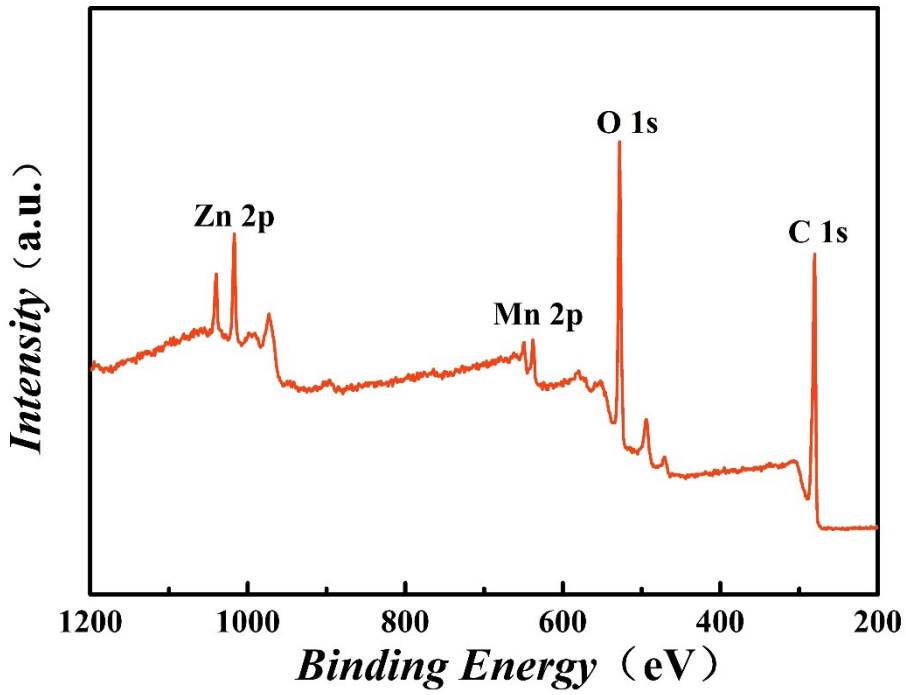

Fig. 7 XPS of NMO@MXene after 200 cycles.

Table S1. Performance comparison of aqueous ZIBs with manganese oxide-based materials as cathodes.

Cathode material	Electrolyte	Specific capacity	Capacity retention	Ref.
NMO@MXene	2 M $ZnSO_4$+ 0.2 M $MnSO_4$	324.6 mA h g^{-1} at 0.2 A g^{-1}	91.4% after 1000 cycles at 2 A g^{-1}	This work
F-MO	2 M $ZnSO_4$+ 0.2 M $MnSO_4$	288 mA h g^{-1} at 0.1 A g^{-1}	96% after 200 cycles at 0.2 A g^{-1}	[1]
MnO_2 @MXene	2 M $ZnSO_4$+ 0.2 M $MnSO_4$	184 mA h g^{-1} at 0.05 A g^{-1}	84.5% after 1000 cycles at 0.1 A g^{-1}	[2]
HCM	2 M $ZnSO_4$+ 0.3 M $MnSO_4$	341 mA h g^{-1} at 0.2 A g^{-1}	87% after 3500 cycles at 2 A g^{-1}	[3]
ε- MnO_2@N	2 M $ZnSO_4$+ 0.5 M $MnSO_4$	183.4 mA h g^{-1} at 0.5 A g^{-1}	83% after 1000 cycles at 5 A g^{-1}	[4]
δ- MnO_2	1 M $ZnSO_4$	252 mA h g^{-1} at 0.083 A g^{-1}	43% after 100 cycles at 0.083 A g^{-1}	[5]
Mn_3O_4/CP	2 M $ZnSO_4$+ 0.2 M $MnSO_4$	201 mA h g^{-1} at 0.3 A g^{-1}	No decreasing after 200 cycles at 1 A g^{-1}	[6]
$ZnMn_2O_4$/NG	1 M $ZnSO_4$+ 0.05 M $MnSO_4$	232 mA h g^{-1} at 0.1 A g^{-1}	97.4% after 2500 cycles at 1 A g^{-1}	[7]
Ocu-Mn_2O_3	3 M $ZnSO_4$+ 0.1 M $MnSO_4$	241 mA h g^{-1} at 0.1 A g^{-1}	88% after 600 cycles at 1 A g^{-1}	[8]
δ-NMOH	2 M $ZnSO_4$+ 0.2 M $MnSO_4$	232 mA h g^{-1} at 2 C	Nearly 100% after 2000 cycles at 10 C	[9]
ZMO/CNTs	1 M $ZnSO_4$+ 0.1 M $MnSO_4$	220.3 mA h g^{-1} at 0.1 A g^{-1}	97.0% after 2000 cycles at 3 A g^{-1}	[10]
Mn_3O_4@HCFs	2 M ZnSO4+ 0.15 M MnSO4	215.8 mA h g^{-1} at 0.3 A g^{-1}	No decreasing after 1300 cycles at 0.4 A g^{-1}	[11]
Fe/α-MnO_2@PPy	2 M $ZnSO_4$+ 0.1 M $MnSO_4$	270 mA h g^{-1} at 0.1 A g^{-1}	71.4.% after 100 cycles at 0.1 A g^{-1}	[12]
α-MnO_2/CNT HMs	2 M $ZnSO_4$+ 0.1 M $MnSO_4$	296 mA h g^{-1} at 0.2 A g^{-1}	No decreasing after 100 cycles at 0.2 A g^{-1}	[13]
Ti-MnO_2	3 M $Zn(CF_3SO_3)_2$ + 0.1 M	259 mA h g^{-1} at	80% after 4000 cycles at	[14]

	$Mn(CF_3SO_3)_2$	0.1 A g^{-1}	1 A g^{-1}

References

1. D. Wang, Z. Liu, X.-W. Gao, Q. Gu, L. Zhao and W.-B. Luo, *Journal of Energy Storage*, 2023, **72**, 108740.
2. L. Wu, Y. Mei, Y. Liu, W. Xu, M. Zhang, Y. Dong and Z.-S. Wu, *Chemical Engineering Journal*, 2023, **459**, 141662.
3. S. Luo, J. Xu, B. Yuan, L. Chen, L. Xu, R. Zheng, Y. Wang, M. Zhang, Y. Lu and Y. Luo, *Carbon*, 2023, **214**, 118334.
4. Y. Zhang, Y. Liu, Z. Liu, X. Wu, Y. Wen, H. Chen, X. Ni, G. Liu, J. Huang and S. Peng, *Journal of Energy Chemistry*, 2022, **64**, 23-32.
5. M. H. Alfaruqi, J. Gim, S. Kim, J. Song, D. T. Pham, J. Jo, Z. Xiu, V. Mathew and J. Kim, *Electrochemistry Communications*, 2015, **60**, 121-125.
6. A. Dhiman and D. G. Ivey, *Batteries & Supercaps*, 2020, **3**, 293-305.
7. L. Chen, Z. Yang, H. Qin, X. Zeng and J. Meng, *Journal of power sources*, 2019, **425**, 162-169.
8. N. Liu, X. Wu, Y. Yin, A. Chen, C. Zhao, Z. Guo, L. Fan and N. Zhang, *ACS applied materials & interfaces*, 2020, **12**, 28199-28205.
9. D. Wang, L. Wang, G. Liang, H. Li, Z. Liu, Z. Tang, J. Liang and C. Zhi, *ACS nano*, 2019, **13**, 10643-10652.
10. F. Gao, B. Mei, X. Xu, J. Ren, D. Zhao, Z. Zhang, Z. Wang, Y. Wu, X. Liu and Y. Zhang, *Chemical Engineering Journal*, 2022, **448**, 137742.
11. J. Long, Z. Yang, F. Yang, J. Cuan and J. Wu, *Electrochimica Acta*, 2020, **344**,

136155.

12. J.-W. Xu, Q.-L. Gao, Y.-M. Xia, X.-S. Lin, W.-L. Liu, M.-M. Ren, F.-G. Kong, S.-J. Wang and C. Lin, *Journal of Colloid and Interface Science*, 2021, **598**, 419-429.

13. Y. Liu, X. Chi, Q. Han, Y. Du, J. Huang, Y. Liu and J. Yang, *Journal of Power Sources*, 2019, **443**, 227244.

14. S. Lian, C. Sun, W. Xu, W. Huo, Y. Luo, K. Zhao, G. Yao, W. Xu, Y. Zhang and Z. Li, *Nano Energy*, 2019, **62**, 79-84.