Electronic Supplementary Material (ESI) for Sustainable Energy & Fuels.

Supporting information

Carbon Fiber Reinforced Structural Zn-ion Battery Composite with Enhanced Mechanical Properties and Energy Storage Performance

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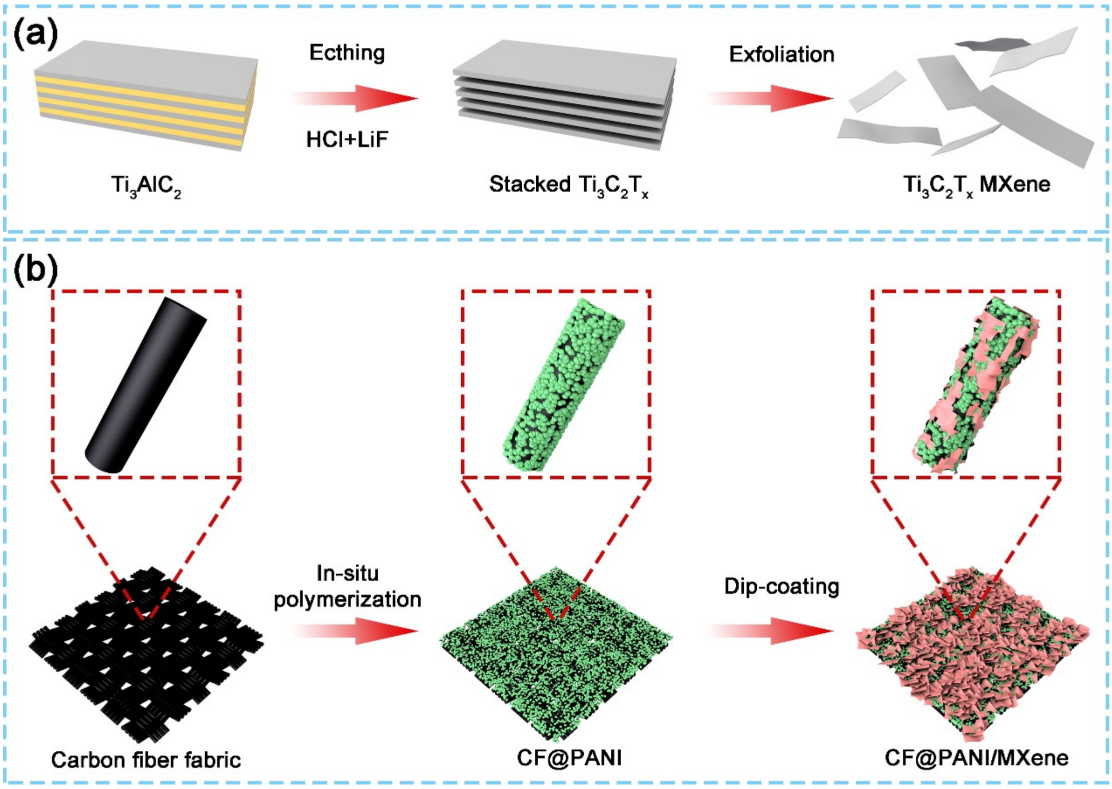

Fig. S1. (a) Schematic illustration of the synthesis of the $Ti_3C_2M_x$-MXene nanosheet. (b) Schematic illustration of the fabrication of the CF@PANI/Mxene structural electrode.

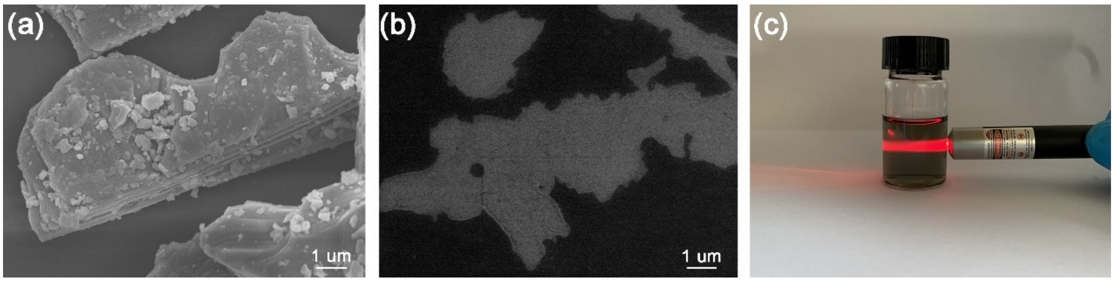

Fig. S2. (a) SEM image of the Ti_3AlC_2. (b) SEM image of Ti_3C_2 MXene. (c) Tyndall effect produced by a few-layer/single-layer MXene solution.

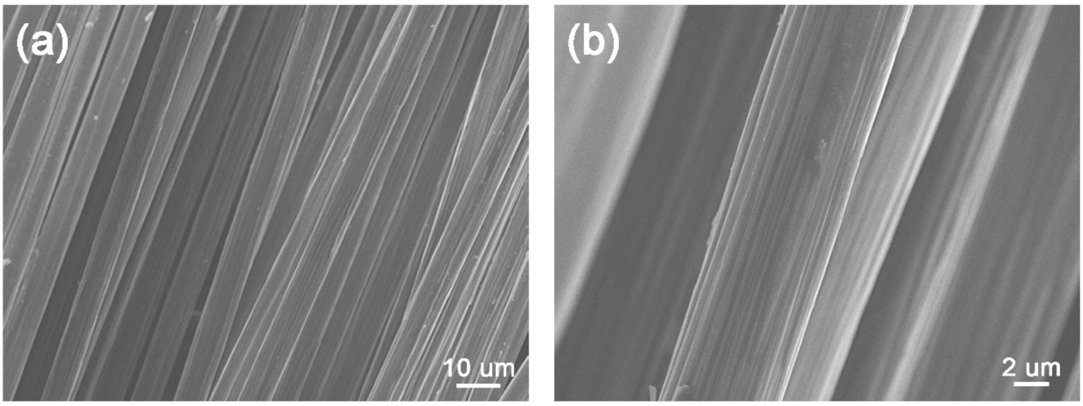

Fig. S3. (a) SEM image of carbon fiber.

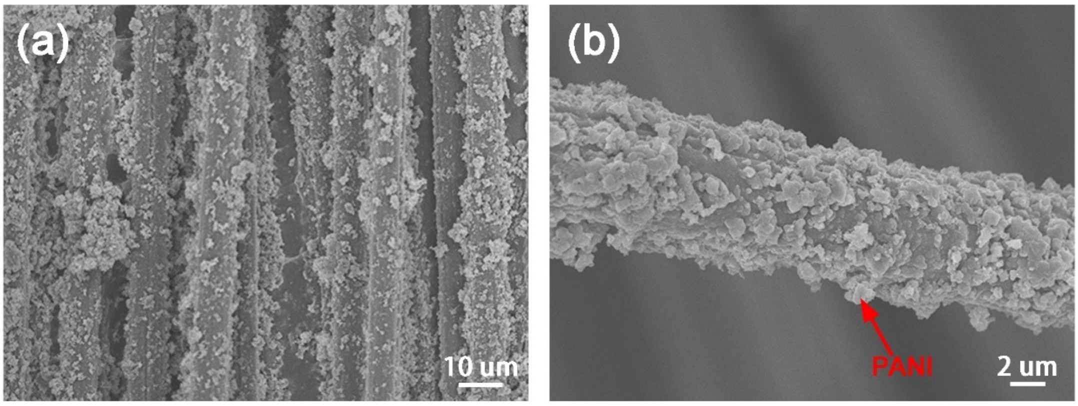

Fig. S4. (a) SEM image of CF@PANI.

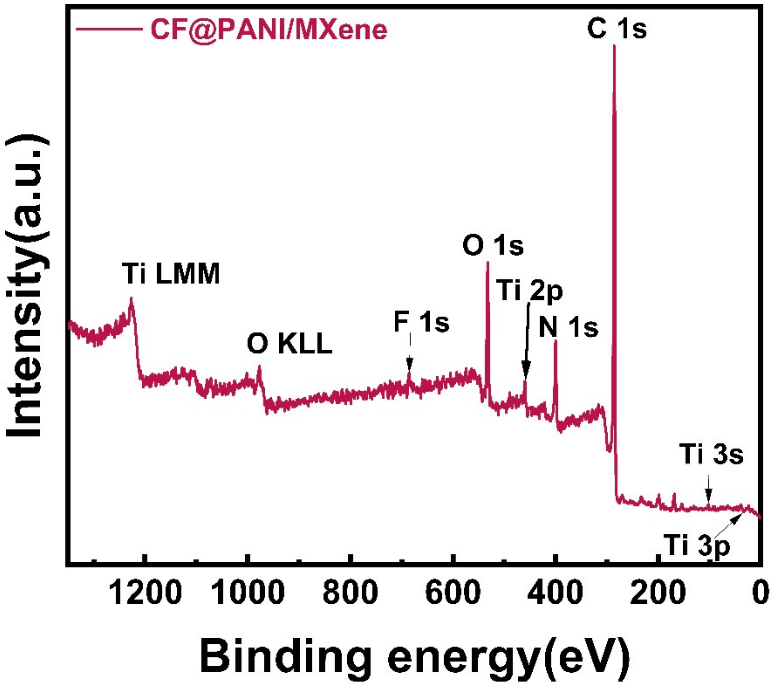

Fig. S5. (a) the XPS spectrums of CF@PANI/MXene.

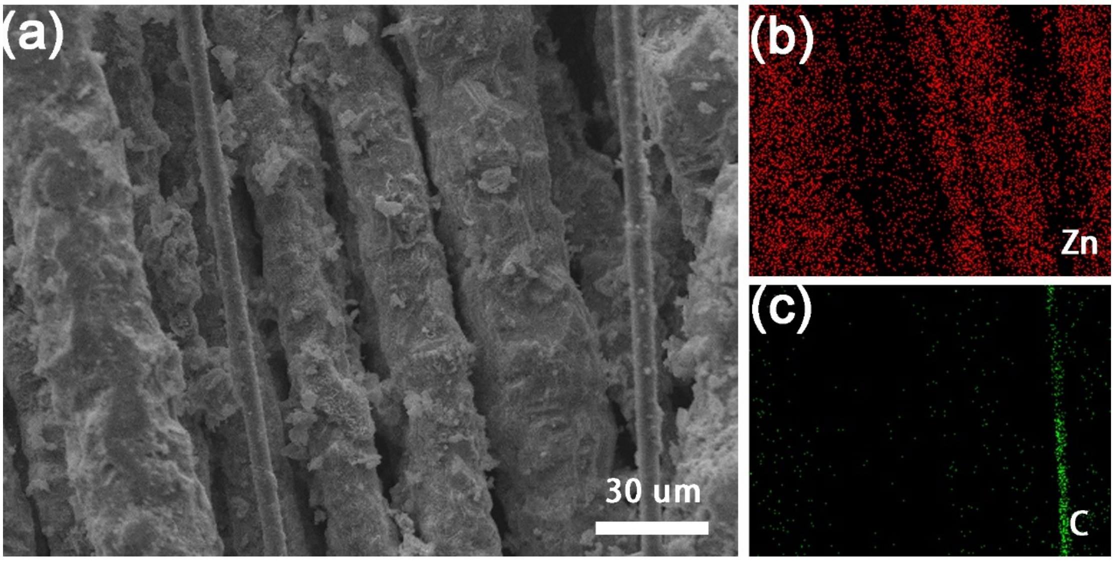

Fig. S6. (a) The SEM image of Zn deposited on carbon fiber. (b) and (c) Corresponding element mapping of Zn and C.

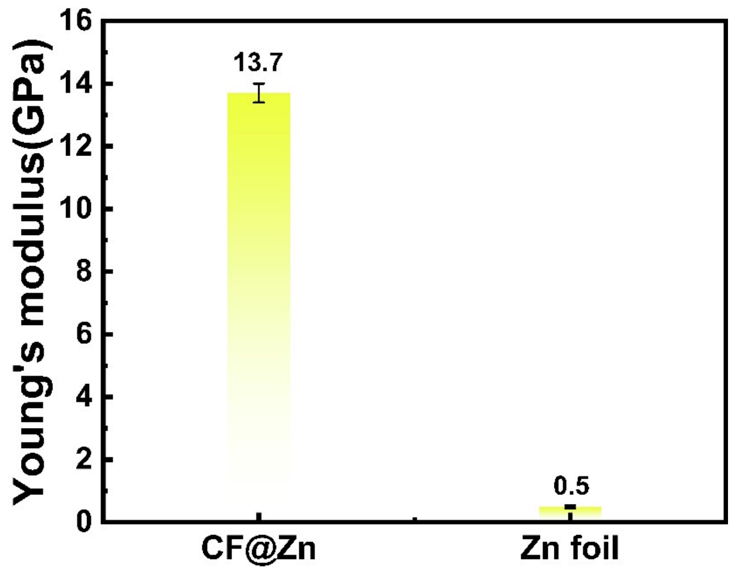

Fig. S7. (a) The Young's modulus of CF@Zn and Zn foil, respectively.

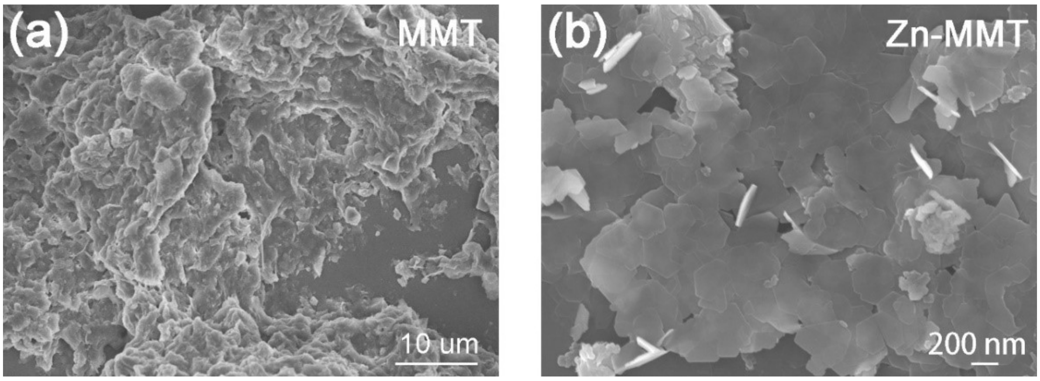

Fig. S8. (a) and (b) The SEM image of MMT and Zn-MMT, respectively.

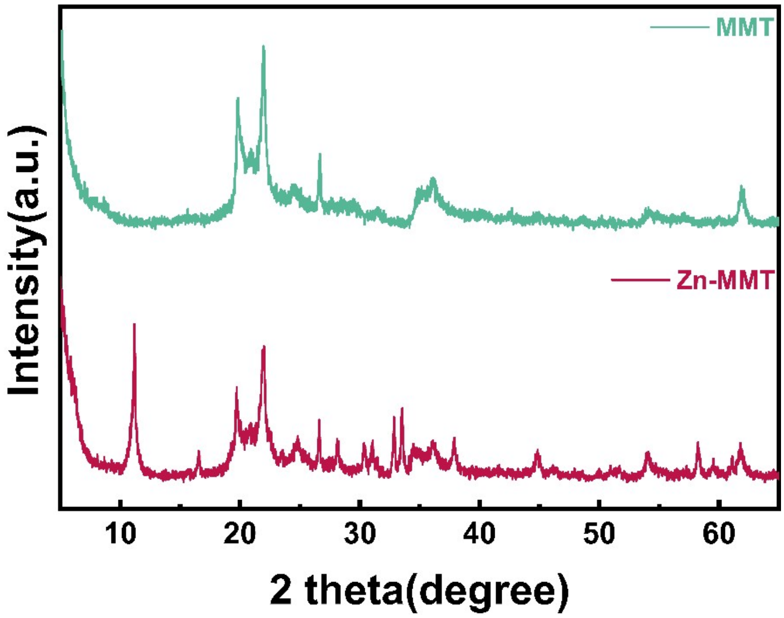

Fig. S9. (a) XRD patterns of MMT and Zn-MMT, respectively.

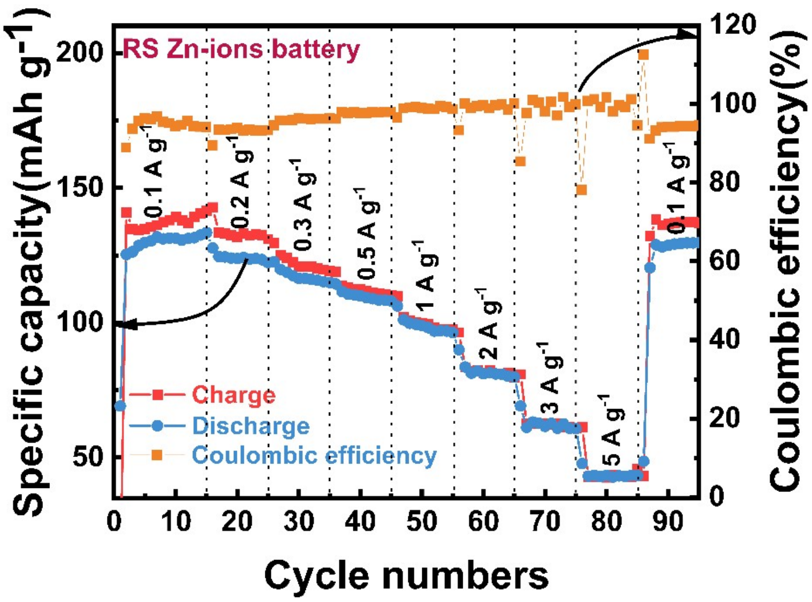

Fig. S10. The rate performance of regular structural Zn-ion battery.

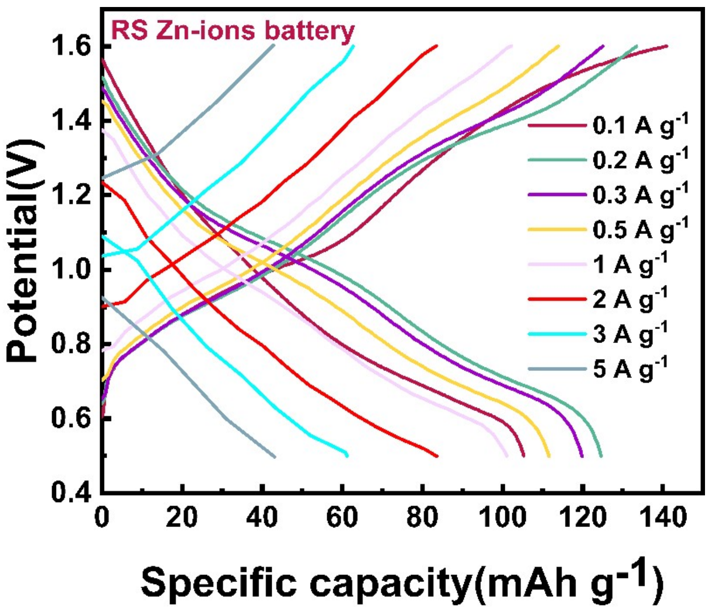

Fig. S11. Galvanostatic charge-discharge test at different current densities.

Table S1. The comparison of electrochemical performance between PC@Cu electrode and previously reported electrodes

Materials	Electrochemical performance		Mechanical properties		Reference
	Energy storage (Wh kg^{-1})	Cycling performance	Tensile strength and Young's modulus	Bending strength and modulus	
C1-100/0 (Li^{+})	0.320±0.08	/	71.7±2.87 MPa and 14.7 GPa	/	Mater. Res. Express 5 (2018) 055701[1]
Zn/PZB-931/γ-MnO2	123.4 $mAhg^{-1}$	90% after 100 cycles	/	/	ACS Nano 2019, 13, 1107−1115[2]
PANI/BANF/CNT	128 ± 5 $mAhg^{-1}$	90% after 1000 cycles	40 ± 4 MPa and 4 ± 0.5 GPa	/	Nanoscale, 2020, 12, 16840–16850[3]
CF GR|LiTFSI in EMIMBF4|CF LFP	~30 mAh g^{-1}(36 Wh kg^{-1})	/	213 MPa and ~1.8 MPa	/	Energy Storage Materials 24 (2020) 676–681[4]
PAN GR|LFP	52 W h kg^{-1}	68% after 1000 cycles	/	/	DOI: 10.1039/d0se00263a[5]
LSB	16 mAh g^{-1}	8% after 100 cycles	270.13 MPa and 28.54 GPa	55.18 MPa and 9.19 GPa	Polymer Composites. 2020;1–11.[6]

Li/0.4 M LiBoB/0.6 M LiTf/LiFePO4	23.6 W h kg^{-1}	35 cycles	163 MPa	/	Adv. Energy Sustainability Res.2021,2, 2000093[7]
graphite/LiNi0.5Mn0.3Co0.2O2	148.6 mAh g^{-1}	95.5% after 500 cycles	/	Bending modulus is 3.1 GP	Adv. Energy Mater. 2021, 2100997[8]
Zn–MnO2	145.9 mAh g^{-1}	88.3% after 500 cycles	293 MPa and 12.8 GPa	180.8 MPa and 4.4 GPa	Composites Science and Technology 209 (2021) 108787[9]
LiFePO4/Graphene oxide	93.3 mAh.g^{-1} (222.14 Wh·kg^{-1})	88.1% after 500 cycles	/	/	Composites Science and Technology 208 (2021) 108768[10]
ACF|LATP-GF/PEO-LiTFSI|Li	1.45 mAh cm^{-2}	68% after 500 cycles	124.2 MPa	110 MPa	ACS Appl. Energy Mater. 2021, 4, 4038−4049[11]
LFP/WCF	114 $mAhg^{-1}$	82% after 500 cycles	/	/	Composite Structures 256 (2021) 112999
LFP/Carbon Fiber	1.05 Wh L^{-1}	10 cycles	145 MPa and 0.289 GPa	/	Manufacturing Letters 24 (2020) 1–5 [12]
Ni Hydroxide / Iron	1.4 Wh kg^{-1}	/	270 MPa and 7 GPa	/	Nano Lett. 18, 7761–7768

Hydroxide					267 (2018)[13]
RS Zn-ion batteries	336.1 mAh g^{-1} (235.6 Wh kg^{-1})	95.5% after 500 cycles	194.6 ± 8.0 MPa and 9.6 ± 0.4 GPa	268.0 MPa and 8.6 GPa	This work

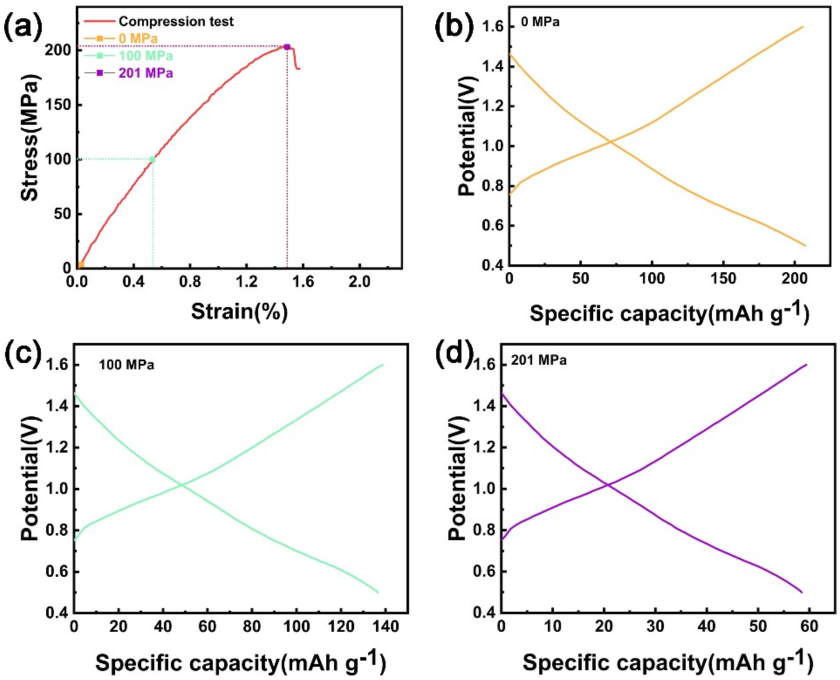

Fig. S12 (a) The compression curve of in-situ electrochemical-mechanical performance of OS ZIB. (b) The voltage profiles at 0 MPa. (c)The voltage profiles at 100 MPa. (d)The voltage profiles at 201 MPa.

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