Supplementary Material

Zn/Ti/F synergetic-doped $Na_{0.67}Ni_{0.33}Mn_{0.67}O_2$ for high energy density sodium ion batteries

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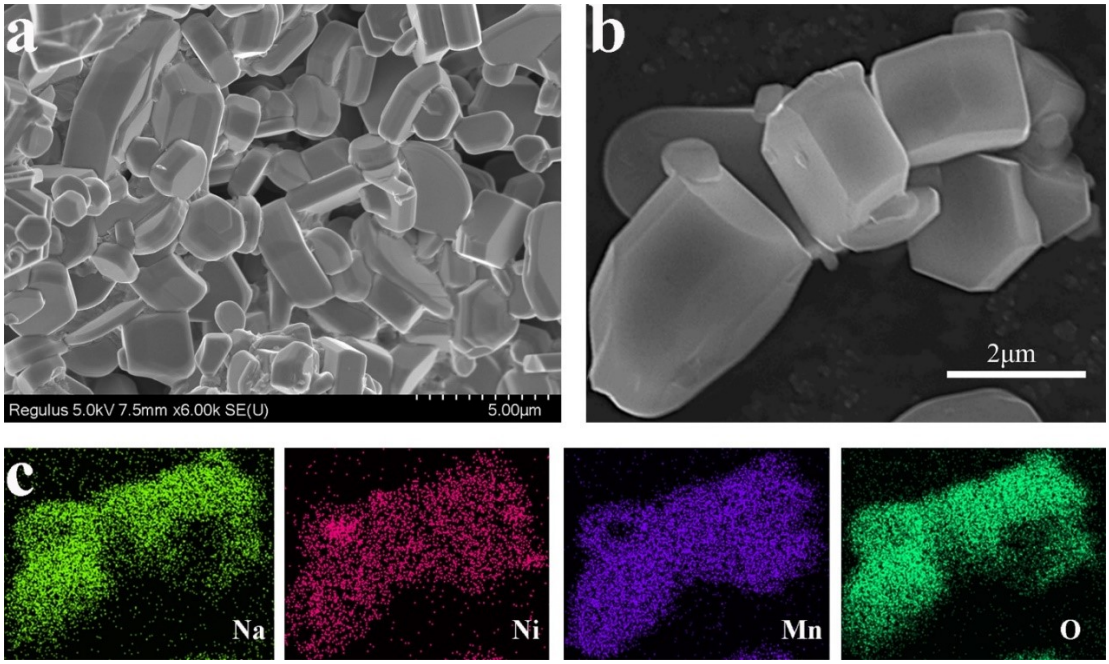

Fig. S1. SEM images and EDS mapping of NNMO sample.

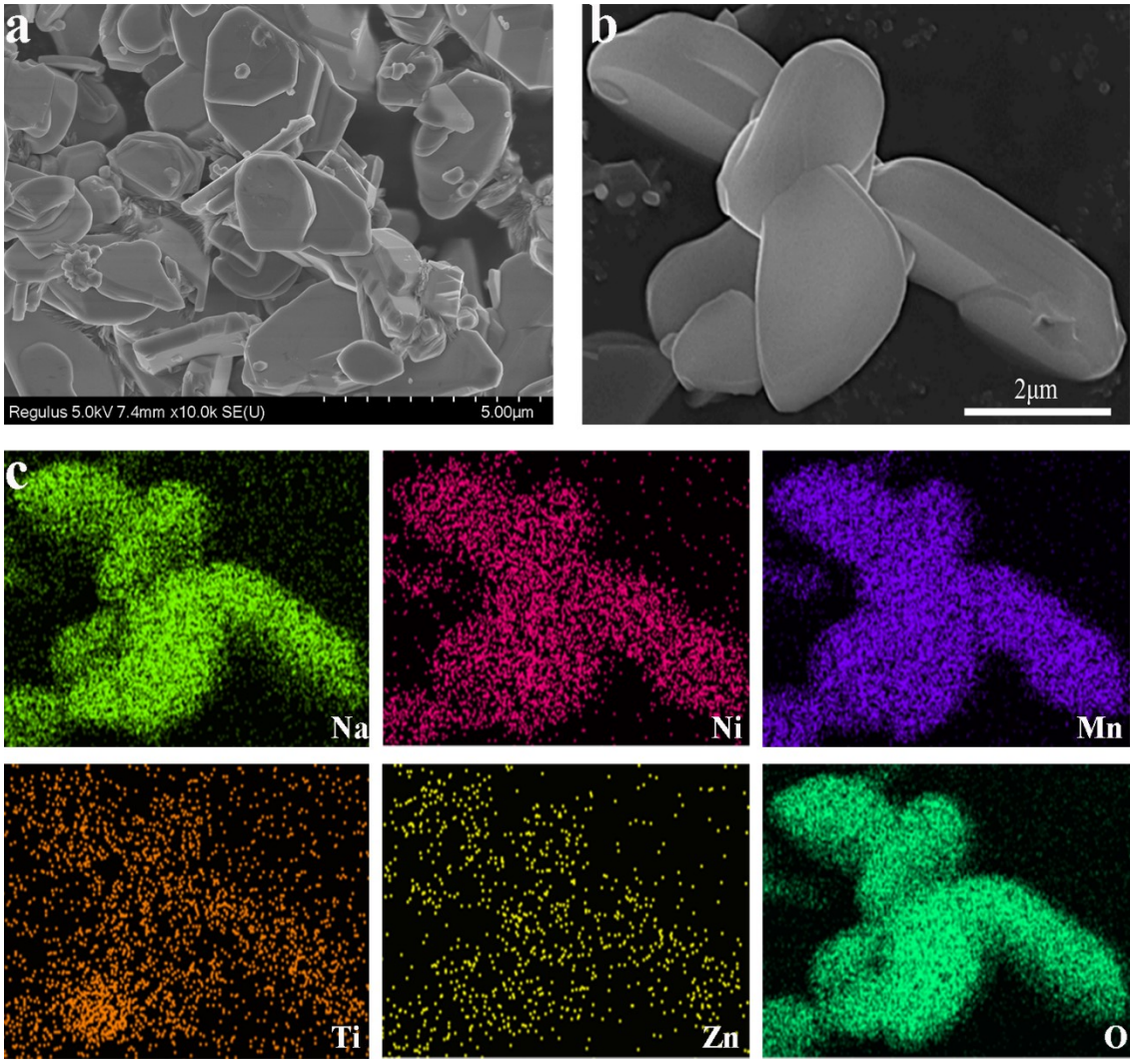

Fig. S2. SEM images and EDS mapping of NNZMTO sample.

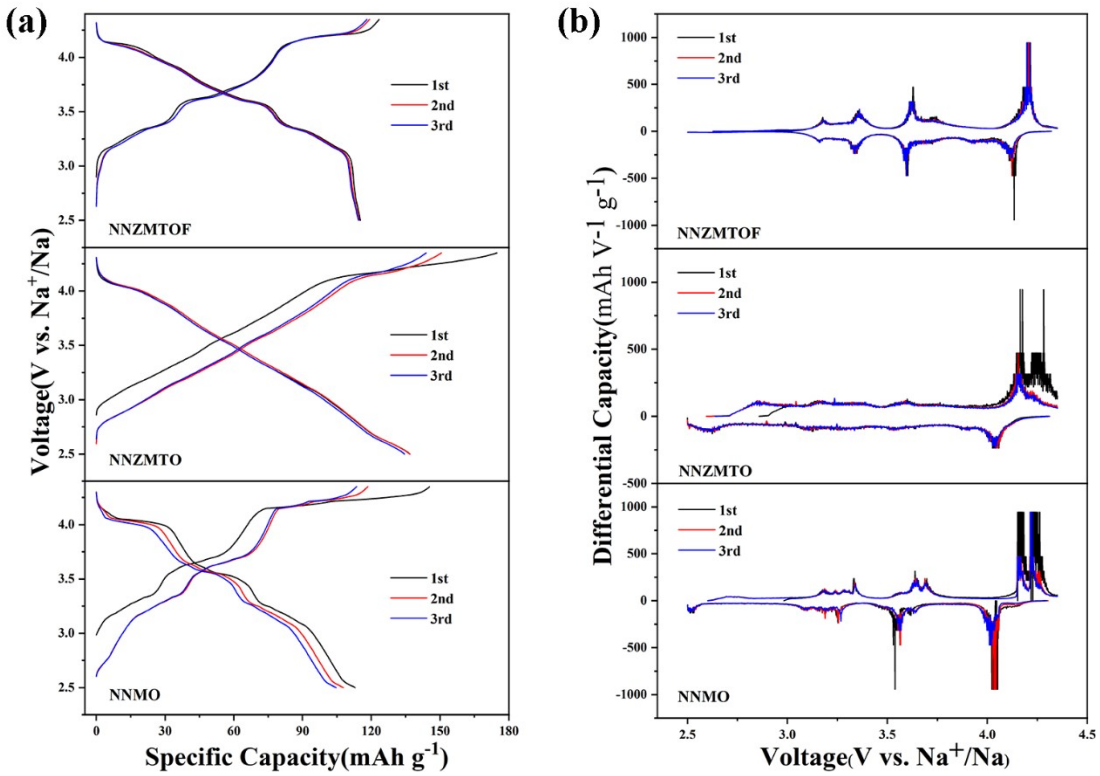

Fig. S3. Charge-discharge and dQ/dV curves: The first four charge-discharge (a) and corresponding dQ/dV curves (b) of NNZMTOF, NNZMTO and NNMO at low current density of 0.2C.

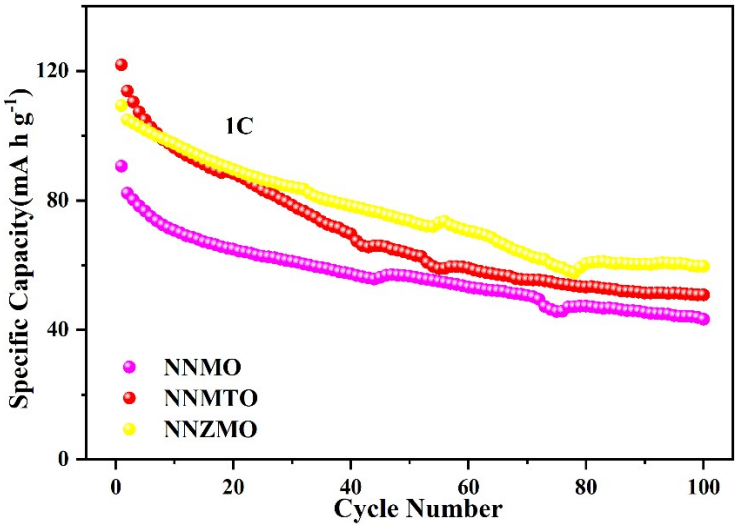

Fig. S4. The comparing investigation of cycling performance on NNZMTOF, NNZMO, NNMTO and NNMO at 1C.

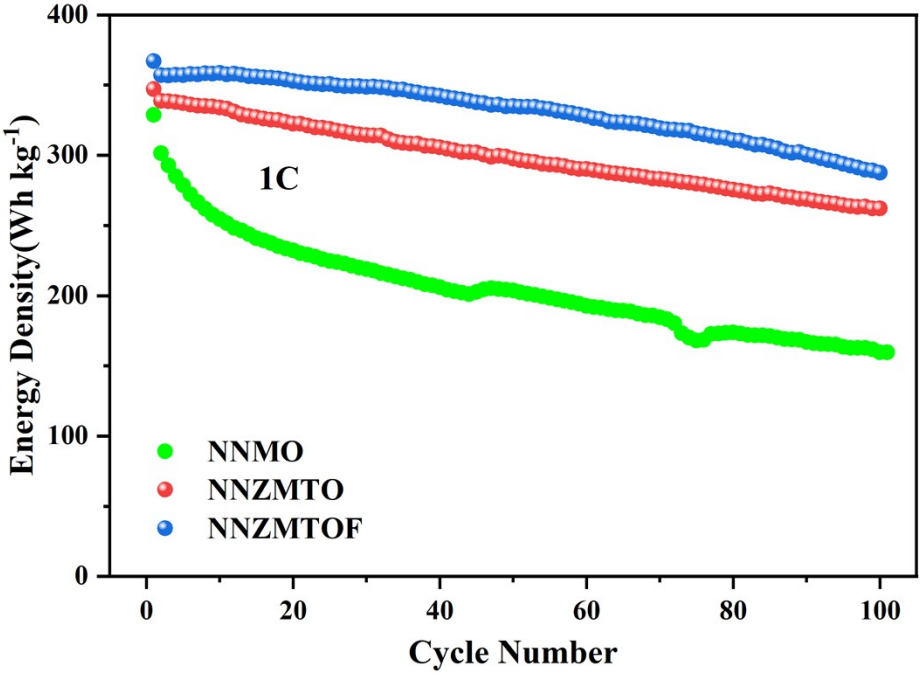

Fig. S5. Comparing energy density of three samples during 100 cycles at 1C.

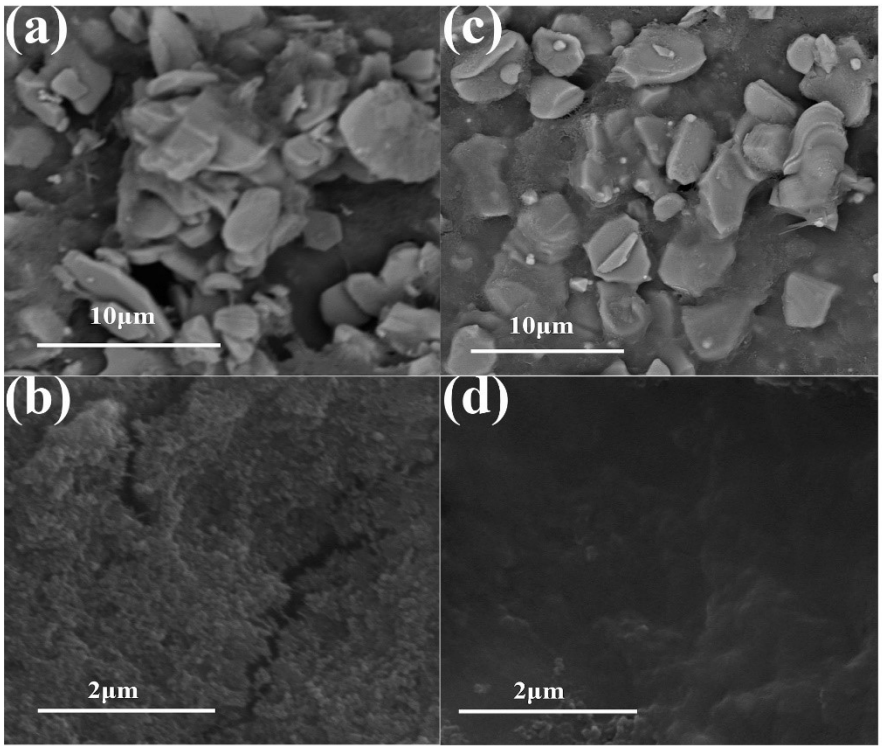

Fig. S6. Comparison of surface morphology of electrodes before and after 100 cycles: (a, b) NNMO; (c, d) NNZMTOF.

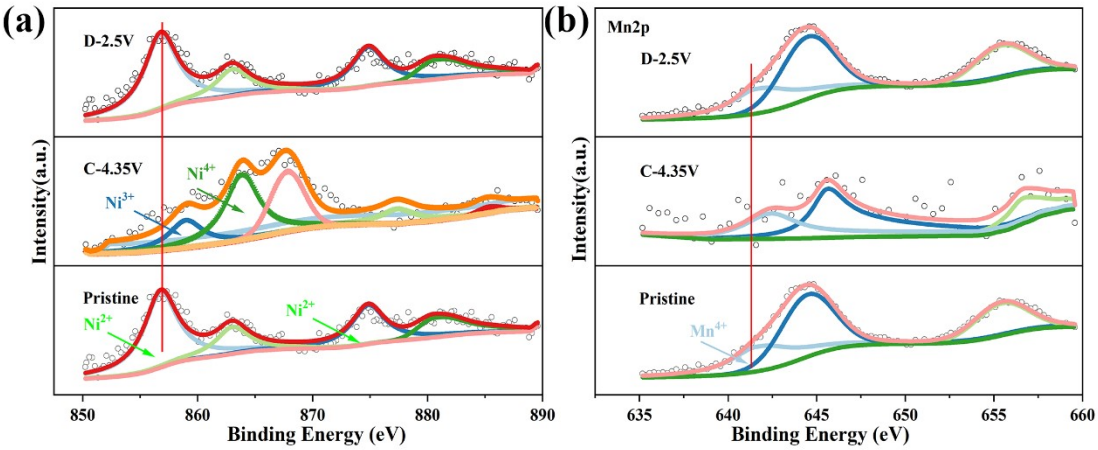

Fig. S7. Ex-site XPS analysis of NNZMTO at different states: (a) Ni 2p and (b) Mn 2p high-resolution spectra.

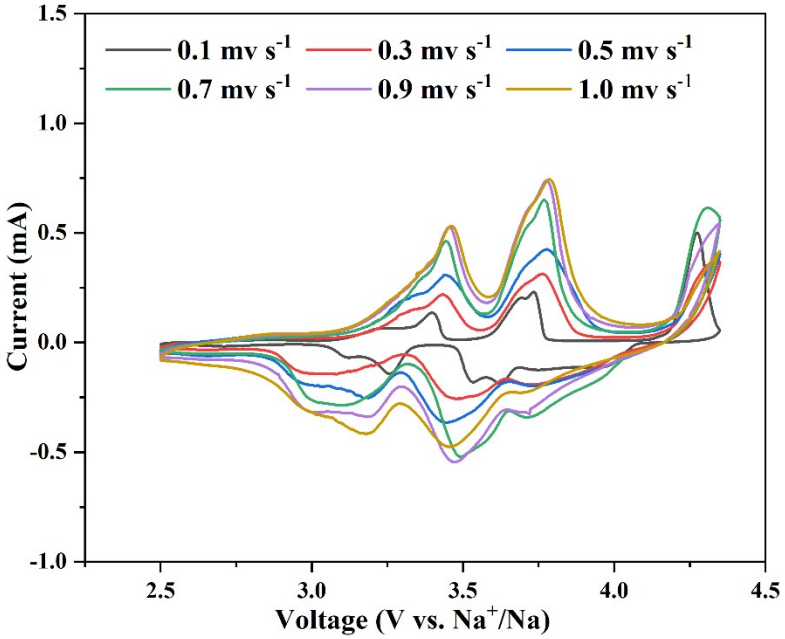

Fig. S8. Multi-sweep CVs of NNMO.

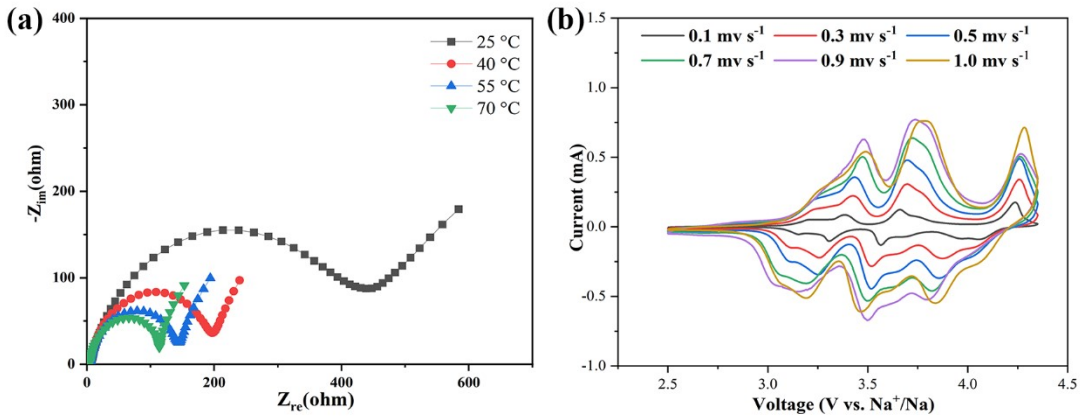

Fig. S9. (a) EIS results of NNZMTO at various temperatures; (b) multi-sweep CVs of NNZMTO at various scan rates.

Table S1 Crystallographic parameters of NNZMTOF refined by the Rietveld method.

Space group P63/mmc					
Lattice	a[Å]	c[Å]	V[Å^3]	R_{wp}(%)	R_p(%)
Hexagonal	2.889369	11.171439	80.769260	6.37	4.62
Atom	Site	x	y	z	Occ.
Na_f	2b	0	0	0.25	0.33
Na_c	2d	0.66670	0.33330	0.25	0.33
Ni	2a	0	0	0	0.28
Zn	2a	0	0	0	0.05
Mn	2a	0	0	0	0.62
Ti	2a	0	0	0	0.05
O	4f	0.66670	0.33330	0.08464	0.975
F	4f	0.66670	0.33330	0.08464	0.025

Table S2 The comparison of electrochemical performance of various layered oxide cathodes.

Materials	Potential window (V)	Rate performance (mA h g^{-1})	Capacity retention (%/cycling number)	Ref.
O3-$Na[Ni_{2/3}Ru_{1/3}]O_2$	1.5–4.6	160(210)	79% (200)	[1]
O3-$Na(Fe_{0.2}Co_{0.2}Ni_{0.2}Ti_{0.2}Sn_{0.1}Li_{0.1})O_2$	2.0–4.1	137.7 (10)	81% (100)	[2]
O3-$Na_{0.93}Li_{0.12}Ni_{0.25}Fe_{0.15}Mn_{0.48}O_2$	2.0–4.2	100(1600)	82.8% (200)	[3]
O3-$NaFe_{0.25}Mn_{0.25}Ni_{0.25}Ti_{0.25}O_2$	1.5–4.0	102.2(200)	72% (300)	[4]
O3-$NaNi_{0.2}Mn_{0.2}Fe_{0.6}O_2$	1.5–4.2	112.5 (24)	81.8% (100)	[5]
O3- $NaNi_{0.4}Mn_{0.4}Cu_{0.1}Ti_{0.1}O_2$	2.0–4.4	170.1 (15)	55% (100)	[6]
P3-$Na_{0.75}Mg_{0.08}Co_{0.10}Ni_{0.2}Mn_{0.60}O_2$	2.0–4.3	120 (30)	87.75(100)	[7]
P3- $Na_{0.5}Mg_{0.15}Al_{0.2}Mn_{0.65}O_2$	2.0–4.5	122 (200)	82% (100)	[8]
P3-$Na_{0.6}Ni_{0.3}Mn_{0.7}O_2$	1.5–4.0	170 (50)	49.2% (150)	[9]
P2/O3-$Na_{0.67}Li_{0.11}Fe_{0.36}Mn_{0.36}Ti_{0.17}O_2$	1.5-4.2	235(20)	85.4% (100)	[10]
P2/O3-$Na_{0.85}Mn_{0.5}Ni_{0.4}Ti_{0.1}O_2$	2.0–4.0	130(12)	91% (500)	[11]
P2/O3-$Na_{2/3}Ni_{1/3}Mn_{1/3}Sn_{1/3}O_2$	2.5–4.15	70(240)	82.2% (600)	[12]
NNZMTOF	2.5–4.35	98(170) 79.5(1700)	81.7% (100) 86% (1000)	This work

Reference

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