Supplementary Material

Novel P2-type Layered Medium-Entropy Ceramics Oxide as Cathode Material for Sodium Ion Batteries

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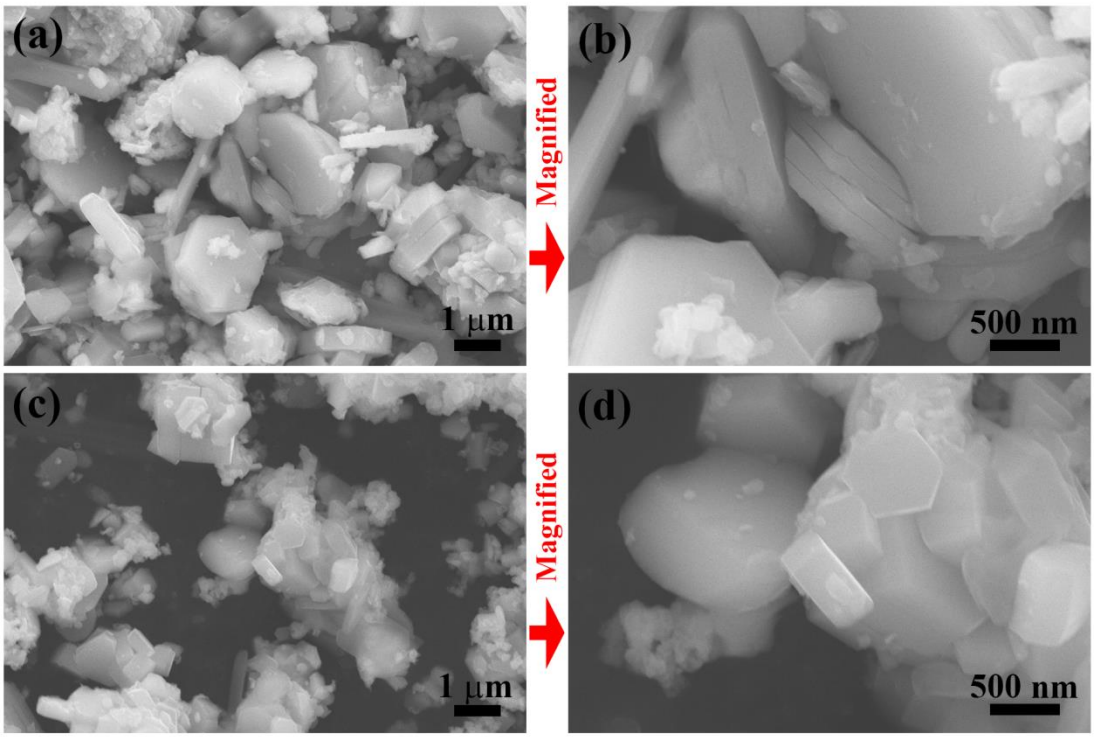

Fig. S1 (a,b) SEM images with gradually increased magnification of NaNMF-900. (c,d) SEM images with gradually increased magnification of NaNMF-1000.

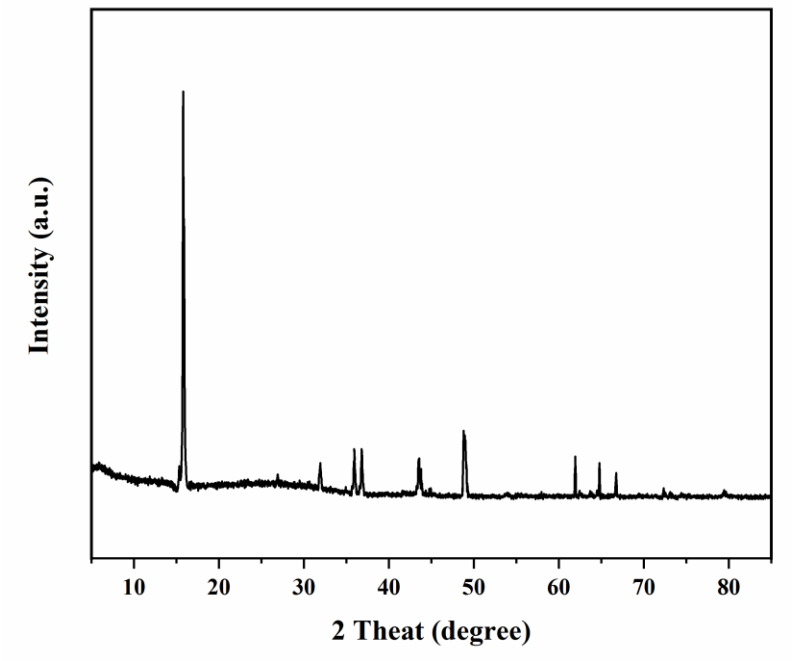

Fig. S2 XRD patterns of NaNMFA-2 powders.

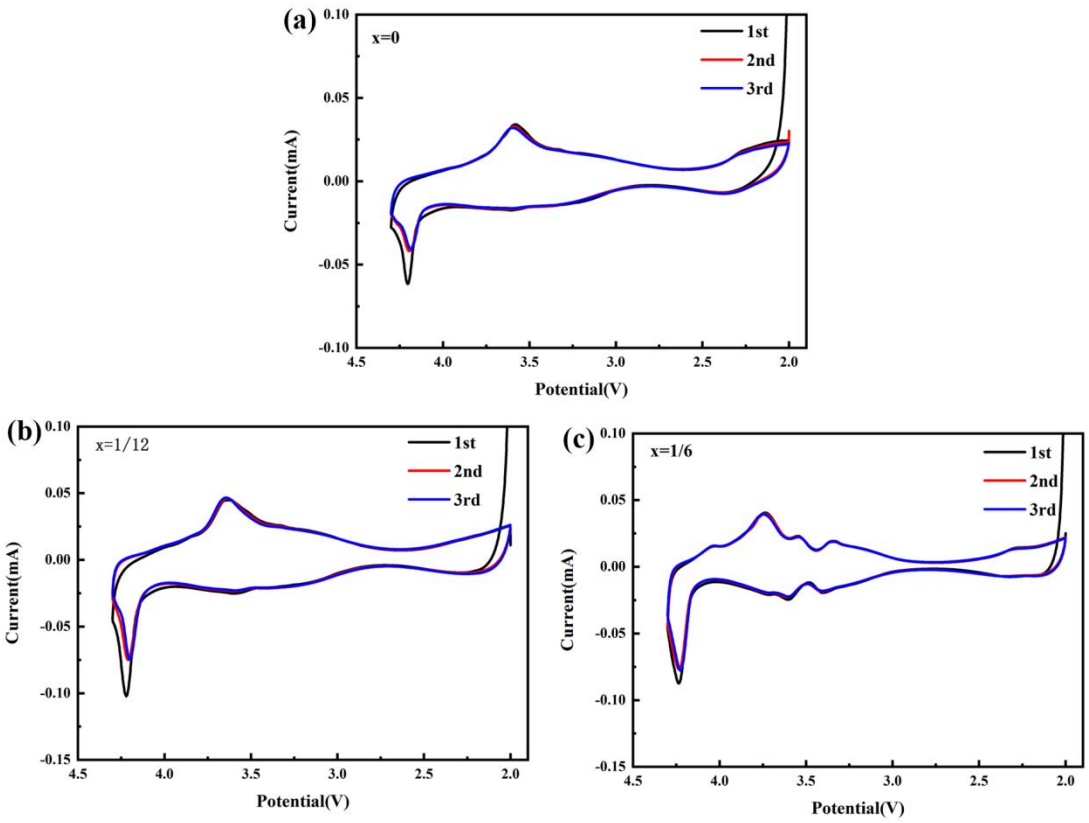

Fig. S3 The CV plot of the NaNMFA-1, NaNMFA-2 and NaNMFA-3 cell at a scan rate of 0.1 mV s^{-1}.

Table S1 Rietveld refinement results of the as-prepared materials

Sample	Lattice parameters (Å)		Rp	Rwp
	a	c		
900	2.896	11.216	2.89	4.54
950	2.894	11.222	3.68	4.65
1000	2.902	11.234	3.32	4.32

Table S2 Concentration (in ppm) of NaNMF-900 and theoretical molar ratio (fixing Mn content) of the elements detected in the sample by ICP-OES measurement

Element	ICP Concentration (ppm)	Experimental molar ratio*	Theoretical molar ratio
Na	6.63	0.643	0.67
Ni	8.69	0.33	0.33
Mn	8.42	0.341	0.33
Fe	8.87	0.354	0.33

*Errors calculated based on a 10% variation in ICP concentrations. No error is given for Ni since the Ni content is fixed to perform the calculations.

Table S3 Concentration (in ppm) of NaNMF-950 and theoretical molar ratio (fixing Mn content) of the elements detected in the sample by ICP-OES measurement

Element	ICP Concentration (ppm)	Experimental molar ratio*	Theoretical molar ratio
Na	6.54	0.629	0.67
Ni	8.76	0.33	0.33
Mn	8.82	0.355	0.33
Fe	9.01	0.356	0.33

*Errors calculated based on a 10% variation in ICP concentrations. No error is given for Ni since the Ni content is fixed to perform the calculations.

Table S4 Concentration (in ppm) of NaNMF-1000 and theoretical molar ratio (fixing Mn content) of the elements detected in the sample by ICP-OES measurement

Element	ICP Concentration (ppm)	Experimental molar ratio*	Theoretical molar ratio
Na	6.47	0.662	0.67
Ni	8.23	0.33	0.33
Mn	8.07	0.345	0.33
Fe	8.34	0.351	0.33

*Errors calculated based on a 10% variation in ICP concentrations. No error is given for Ni since the Ni content is fixed to perform the calculations.

Table S5. Comparison of cathode with the previously reported literature.

Materials Composition	Synthesis method	Working potential window	Current	Capacity	Cycle number	Capacity retention (%)	Reference
$Na_{2/3}Mn_{1/2}Fe_{1/4}Co_{1/4}O_2$	sol-gel	1.5–4.2 V	260 mA g^{-1}	106 mAh g^{-1}	100	64%	[S1]
$Na_{2/3}Mn_{0.6}Fe_{0.4}O_2$	solid-state	1.5–4.2 V	15 mA g^{-1}	90 mAh g^{-1}	20	74%	[S2]
$Na_{2/3}Mn_{1/2}Fe_{1/2}O_2$	sol-gel	1.5–4.0 V	13 mA g^{-1}	130.7 mAh g^{-1}	40	51.1%	[S3]
$Na_{0.61}Mn_{0.27}Fe_{0.34}Ti_{0.39}O_2$	solid-state	1.5–4.5 V	18 mA g^{-1}	77 mAh g^{-1}	100	90%	[S4]
$Na_{2/3}Mn_{1/2}Fe_{1/2}O_2$@Graphene	solid-state	1.5–3.9 V	0.1 C	60 mAh g^{-1}	140	67%	[S5]
$NaNi_{1/3}Fe_{1/3}Ti_{1/3}O_2$	solid-state	1.5–4.0 V	200 mA g^{-1}	61 mAh g^{-1}	1000	57%	[S6]
$NaNi_{0.33}Li_{0.11}Ti_{0.56}O_2$	solid-state	2.0–4.2 V	50 mA g^{-1}	91 mAh g^{-1}	100	81%	[S7]
$NaxCo_{0.7}Mn_{0.3}O2$	solid-state	2.0–4.1 V	1 C	80 mAh g^{-1}	225	84%	[S8]
$Na_{0.67}Ni_{0.23}Mg_{0.1}Mn_{0.67}O_2$	sol-gel	2.0–4.5 V	48 mA g^{-1}	84.9 mAh g^{-1}	100	81%	[S9]
$Na_{2/3}Ni_{1/3}Mn1/3Fe_{1/3-x}Al_xO_2$	solid-state	2.0–4.2 V	0.2 C	125.6 mAh g–1	60	79.8%	This work

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