Supporting Information

1D Nanobar-like $LiNi_{0.4}Co_{0.2}Mn_{0.4}O_2$ as Stable Cathode Material for Lithium-ion Batteries with Superior Long-term Capacity Retention and High Rate Capability

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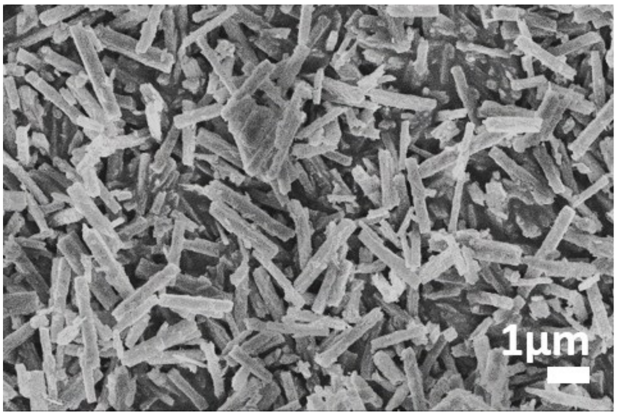

Fig. S1 SEM image of the nanobar-like (1D) MC_2O_4•H_2O (M=Li, Ni, Co, Mn) precursor.

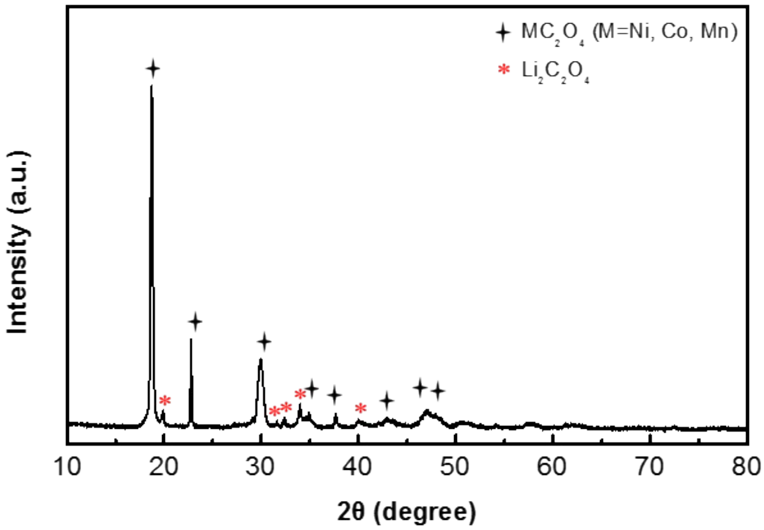

Fig. S2 XRD pattern of the nanobar-like (1D) MC_2O_4•H_2O (M=Li, Ni, Co, Mn) precursor.

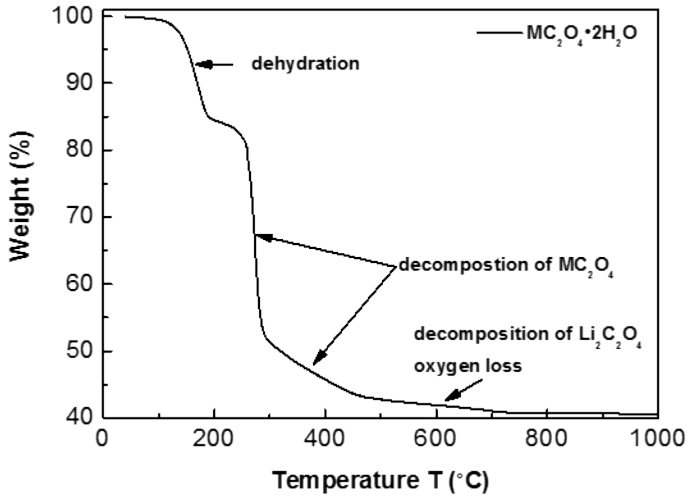

Fig. S3 TGA data of the nanobar-like (1D) MC_2O_4•H_2O (M=Li, Ni, Co, Mn) precursor.

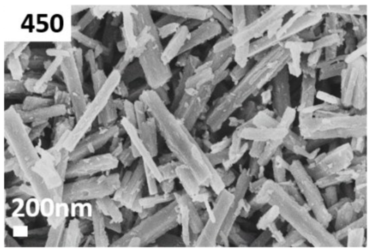

Fig. S4 SEM images of the nanobar-like (1D) MC_2O_4•H_2O (M=Li, Ni, Co, Mn) precursor after pre-heating at 450 ^{o}C.

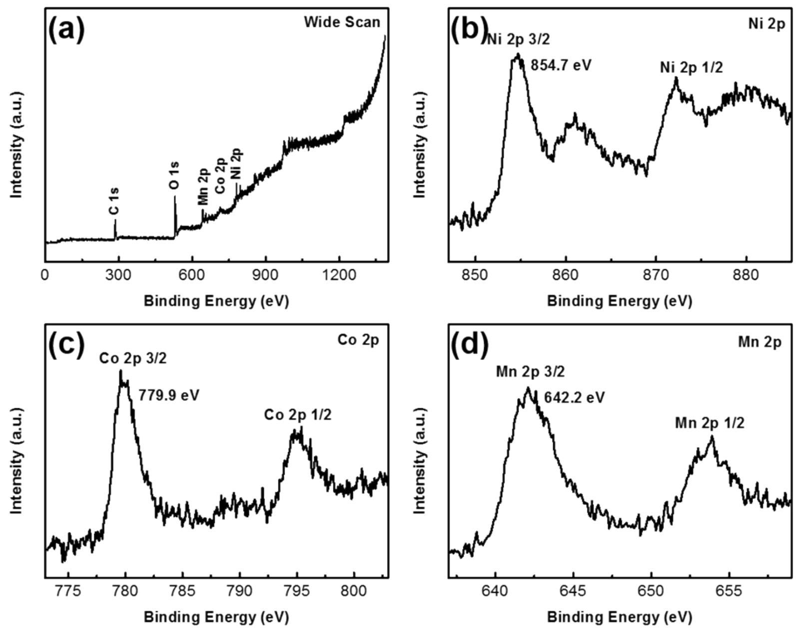

Fig. S5 X-ray photoelectron spectroscopy spectra (a) wide scan, (b) Ni 2p, (c) Co 2p and (d) Mn 2p of N-NCM-800.

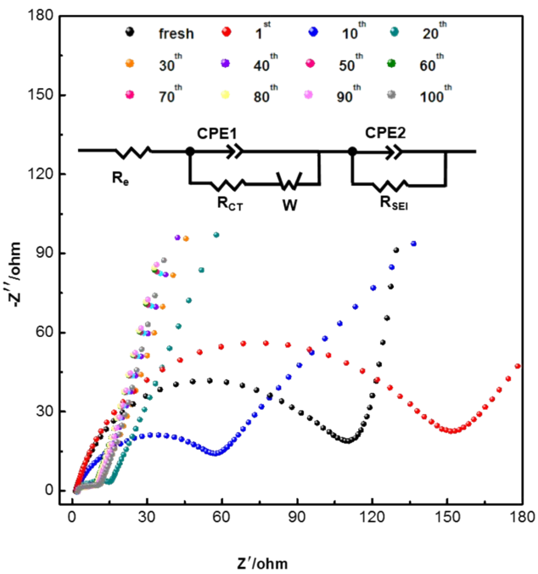

Fig. S6 Selected electrochemical impedance spectra of N-NCM-800.

Fig. S6 shows the selected electrochemical impedance spectra upon 100 continuous charge/discharge cycles at 0.1 C. The nature of the impedance plots is typical of conventional LIBs, a depressed semicircle in high-middle frequency and followed by a sharp straight line in the low frequency region. The Re shown in the insert panel of equivalent series resistance (ESR) refers to the internal resistance, a combination of total resistance from electrolyte, electrodes, separator. The high-frequency semicircle is assigned to the resistance of the formation of SEI layer and the corresponding constant phase element. The middle-frequency ascribes to the charge transfer resistance and its relative capacitance. The straight line in the low-frequency region corresponds to the Warburg diffusion process.

Reference	Voltage Range/ V	Specific Capacity/ mAh g^{-1}	Rate Capability/ mAh g^{-1}	Cycling Retention
NCM[1]	2.0-4.7 V	203 (0.05 C)	---	82% after 20 cycles at 0.05 C
NCM[2]	2.75-4.35 V	177 (0.2 C)	89 (3 C)	58% after 70 cycles at 1 C
Zr-doped NCM[3]	2.6-4.7 V	162 (0.2 C)	124 (2 C)	80% after 50 cycles at 0.2 C 69% after 50 cycles at 2 C
NCM[4]	2.0-4.4 V	165 (0.35 C)	70 (7 C)	90% after 50 cycles at 0.35 C
Bi_2O_3-coated NCM[5]	2.5-4.6 V	214 (0.1 C)	120 (3 C)	82% after 100 cycles at 0.1 C
Micro-ball NCM[6]	2.5-4.5 V	187 (0.1 C)	160 (2 C) 143 (5 C)	80% after 50 cycles at 5 C
NCM/SWCNT composites[7]	2.5-4.5 V	160 (0.1 C)	130 (5 C) 120 (10 C)	92% after 500 cycles at 5 C 91% after 500 cycles at 10 C
Li_2ZrO_3-coated NCM[8]	2.8-4.5 V	178 (0.075 C)	156 (1.5 C)	96.6% after 50 cycles at 0.3 C
This Work	3.0-4.3 V	177 (0.1 C)	123 (5 C) 104 (10 C)	91% after 100 cycles at 0.1 C 94% after 100 cycles at 10 C

Tab. S1 Comparison of electrochemical performance (capacity, rate capability and cycling stability) of the best performing NCM materials.[1-8]

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