Electronic Supplementary Material (ESI) for Inorganic Chemistry Frontiers.

Supporting Information

Electrospun Nb-doped $LiNi_{0.4}Co_{0.2}Mn_{0.4}O_2$ nanobelts for lithium-ion battery

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S1. Results and Discussion

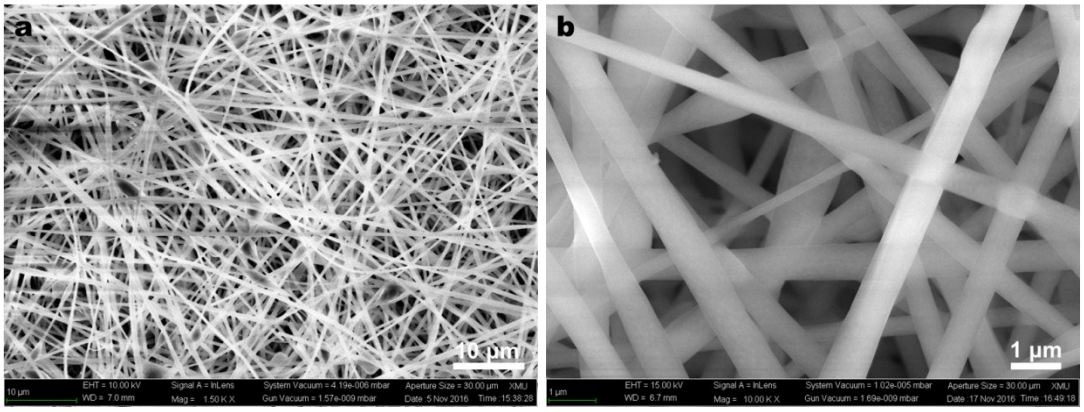

Figure S1. (a) Low-magnification SEM image, and (b) high-magnification SEM image of the as-electrospun PAN/metal acetates nanofibres.

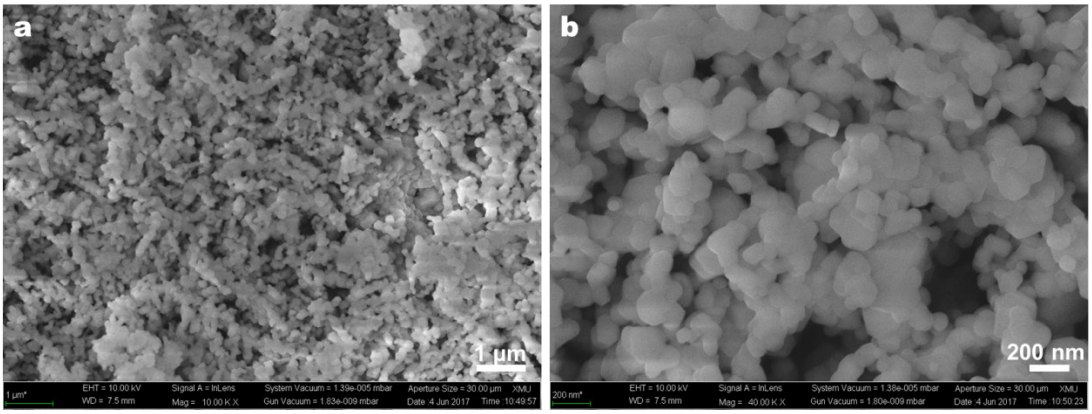

Figure S2. (a) Low-magnification SEM image, and (b) high-magnification SEM image of the nanoparticles obtained by directly sintering the PAN/metal acetates nanofibres to 750 ^{o}C.

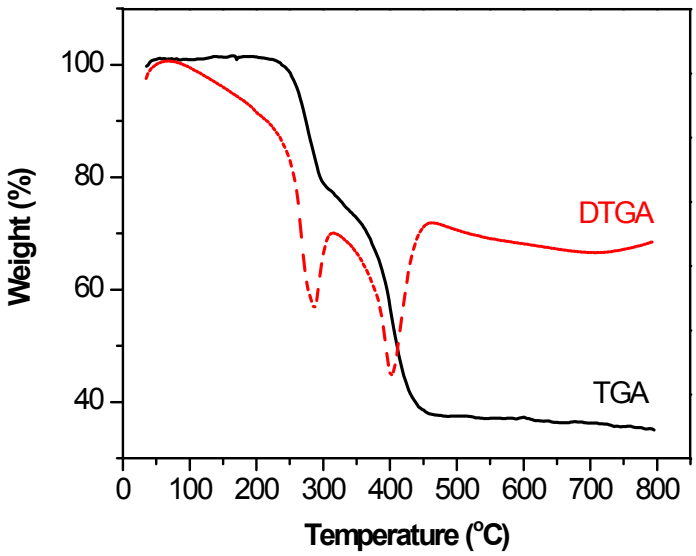

Figure S3. TGA-DTGA curves of the electrospun PAN/NCM composite nanofibres.

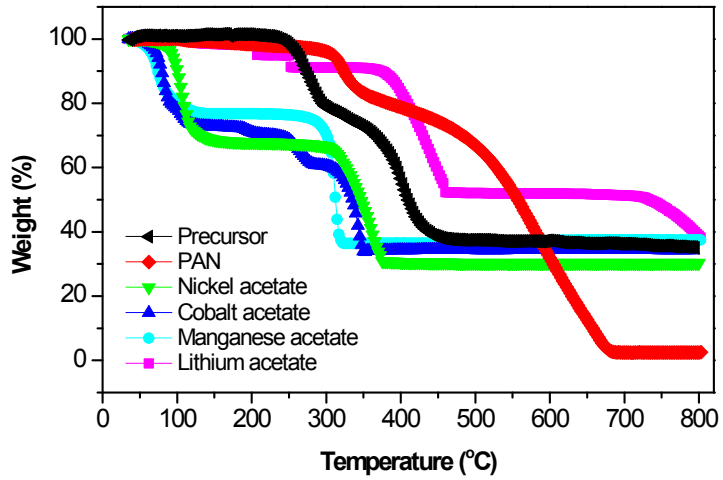

Figure S4. TGA curves of the electrospun PAN/NCM composite precursor, PAN and metal acetates.

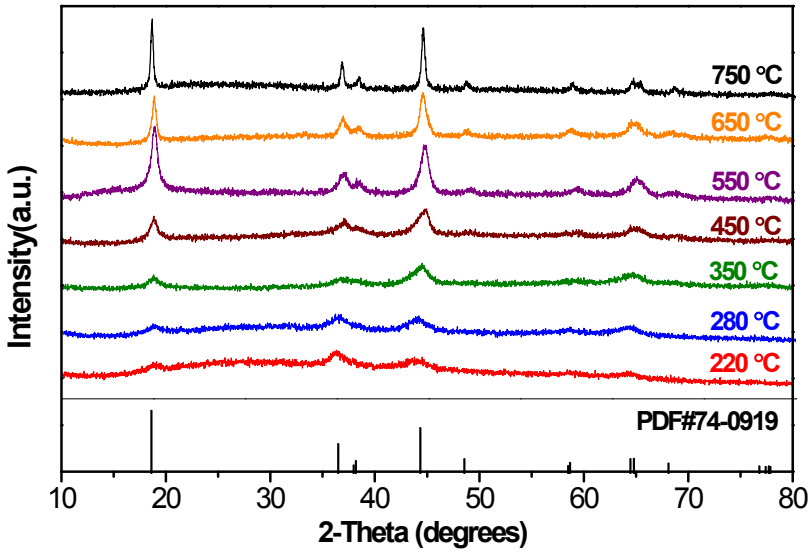

Figure S4. XRD patterns of the samples obtained at different temperatures.

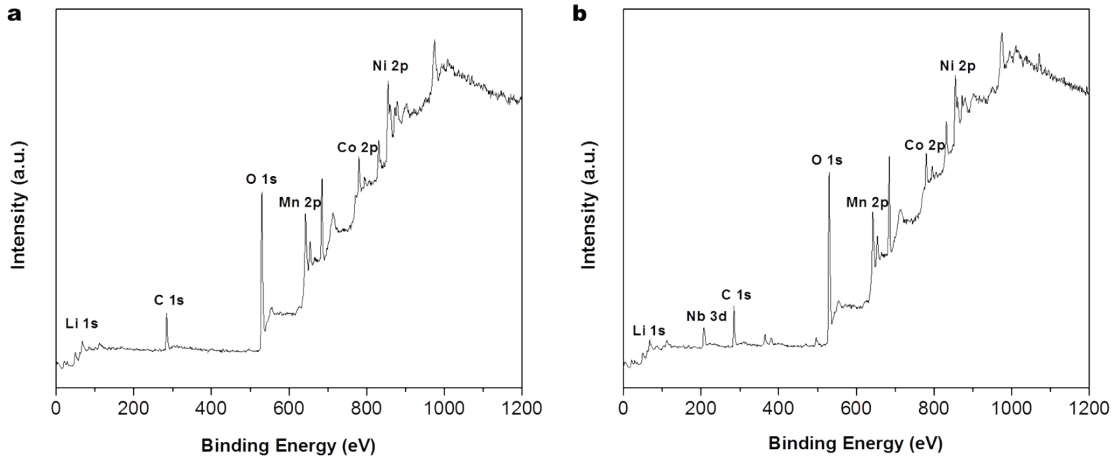

Figure S5. The wide XPS spectra of (a) NCM nanobelts, and (b) Nb-NCM nanobelts.

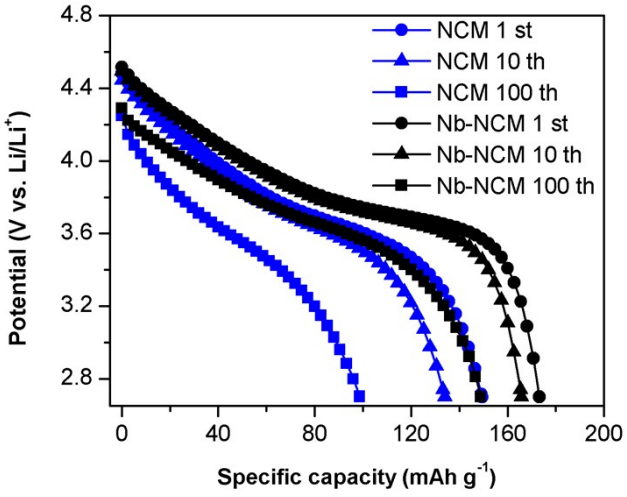

Figure S6. Discharge curves of Nb-NCM and NCM electrodes at 1 C.

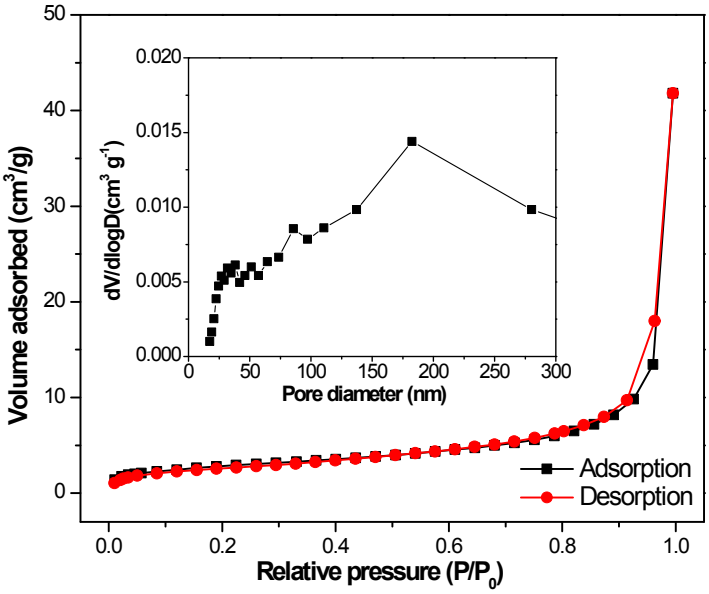

Figure S7. Nitrogen adsorption/desorption isotherms and the corresponding pore size distribution for the Nb-NCM nanobelts.

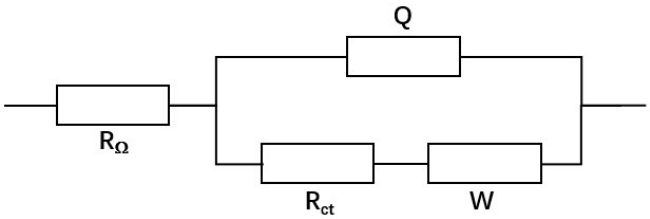

Figure S8. The simplified equivalent circuit of the Nb-NCM nanobelts and NCM nanobelts.

Table S1. The measured elemental content of Nb-NCM nanobelts by EDS.

	Ni	**Co**	**Mn**	**Nb**
1	0.547	0.270	0.420	0.016
2	0.539	0.278	0.456	0.023
3	0.545	0.272	0.455	0.023
4	0.559	0.270	0.449	0.022
5	0.552	0.277	0.421	0.015
6	0.528	0.235	0.432	0.018
7	0.459	0.226	0.480	0.022

8	0.573	0.244	0.483	0.019
9	0.577	0.262	0.449	0.018
10	0.556	0.229	0.455	0.021
AVG	0.5435	0.2563	0.45	0.0197
Atom%	**42.8%**	**20.2%**	**35.4%**	**1.6%**

Table S2. Crystal lattice parameters of Nb-NCM and NCM samples.

Samples	NCM	Nb-NCM
a (Å)	2.87331(15)	2.88152(12)
b (Å)	2.87331(15)	2.88152(12)
c (Å)	14.2672(16)	14.3103(15)
V (Å)	102.008(14)	102.902(12)
α	90	90
β	90	90
γ	120	120
R_p (%)	4.80	6.53
R_{wp} (%)	6.12	5.20

Table S3. The fitting values of the resistance components in the simplified equivalent circuit.

Components	**R_Ω/Ω**	**R_{ct}/Ω**	**R_{total}/Ω**
Nb-NCM nanobelts	4.5	136.0	140.5
NCM nanobelts	5.9	242.1	248.0

Table S4. Summary of the preparation and electrochemical performance of NCM microstructures with different morphologies.

Ref.	Structure	Synthesis	Voltage	Capicity (mAh g^{-1})	Cycling Performance
1	1D nanobar-like $LiNi_{0.4}Co_{0.2}Mn_{0.4}O_2$	A precipitation process followed by a calcination step	3.0-4.3 V	177.1 (0.1 C)	161 (100 th)
				152.8 (1 C) 141.7 (2 C) 122.7 (5 C)	—
2	$LiNi_{0.4}Mn_{0.4}Co_{0.2}O_2$ spherical particles (5–20 μm)	Co-precipitation method	3.3-4.35 V	120 (1 C) 100 (2 C) 65 (5 C)	—
3	$LiNi_{0.4}Mn_{0.4}Co_{0.2}O_2$	Solid-state synthesis route	2.5-4.5 V	145 (0.1 C)	108 mAh g^{-1} (45 th)
4	$LiNi_{0.4}Co_{0.2}Mn_{0.4}O_2$	—	2.75-4.35 V	164.8 (0.1 C)	94.5 mAh g^{-1} (70 th)
5	Al_2O_3 coated $LiNi_{0.4}Mn_{0.4}Co_{0.2}O_2$ particles	High-temperature solid-state heating and atomic layer deposition	2.5-4.5 V	145 (1 C) 130 (2 C) 105 (5 C)	—
6	$LiNi_{0.4}Mn_{0.4}Co_{0.2}O_2$ microspheres	Soft-chemical method	2.5–4.4 V	142 (0.1 C)	119 mAh g^{-1} (20 th)
	$LiNi_{0.4}Mn_{0.4}Co_{0.2}O_2$ microspheres	Citric acid-assisted soft-chemical method	2.5–4.4 V	150 (0.1 C)	135 mAh g^{-1} (20 th)
	$LiNi_{0.4}Mn_{0.4}Co_{0.2}O_2$ microspheres	Oxalic acid-assisted soft-chemical method	2.5–4.4 V	156 (0.1 C)	145 mAh g^{-1} (20 th)
7	Bi_2O_3 coated $LiNi_{0.4}Mn_{0.4}Co_{0.2}O_2$ particles (~200 nm)	Adopting surfactant co-assisted sol–gel synthesis approach	2.5-4.5 V	160 (1 C) 120 (3C)	—
8	$LiNi_{0.4}Mn_{0.4}Co_{0.2}O_2$	Co-precipitation method	2.8-4.4 V	162 (0.1 C) 105 (1 C)	—
	MgO coated $LiNi_{0.4}Mn_{0.4}Co_{0.2}O_2$			166.6 (0.1 C) 110 (1 C)	—
9	$LiNi_{0.4}Mn_{0.4}Co_{0.2}O_2$ with SWNTs	Mixed-hydroxide method	2.5-4.5 V	147 (1 C) 140 (2 C)	—

10	$Li_{1.02}Ni_{0.4}Mn_{0.4}Co_{0.2}O_2$ particles (100-400 nm)	Sol-Gel process-ball-milled	2.5-4.3 V	167 (0.1 C) 157 (1 C) 144 (5 C)	—
				133 (8 C)	115.7 mAh g^{-1} (50 th)
11	$LiNi_{0.15}Co_{0.15}Fe_{0.05}Mn_{0.4}O_2$ particles (35-50 nm)	Glycine nitrate combustion method	2.0-4.7 V	175 (0.1 mA/cm^2)	119 mAh g^{-1} (20 th)
			2.0-4.3 V	145 (0.1 mA/cm^2)	—
12	$LiNi_{0.15}Co_{0.15}Al_{0.05}Mn_{0.4}O_2$ particles (30-80 nm)	Glycine nitrate combustion process	2.0-4.3 V	162 (0.1 mA/cm^2)	155 mAh g^{-1} (20 th)
13	Li_2ZrO_3-coated $LiNi_{0.4}Co_{0.2}Mn_{0.4}O_2$ particles (~1μm)	A $(Ni_{0.4}Co_{0.2}Mn_{0.4})(OH)_2$ precursor route	2.8-4.3 V	147 (0.1 C)	146 mAh g^{-1} (30 th)
			2.8-4.5 V	177.7 (0.1 C） 168.6 (0.5 C)	—
14	$LiNi_{0.4}Mn_{0.4}Co_{0.2}O_2$	Mixed-hydroxide method	3.0-4.2 V	145.6 (90 mA g^{-1})	131 mAh g^{-1} (60 th)
This Work	**Nb doped $LiNi_{0.4}Co_{0.2}Mn_{0.4}O_2$ nanobelts**	**Electrospinning method**	**2.7-4.6 V**	**203.2 (0.1 C)**	—
				173.2 (1 C)	**148.9 mAh g^{-1} (100 th)**
				159.0 (2 C)	**127.5 mAh g^{-1} (200 th)**
				153.0 (5 C)	**109.6 mAh g^{-1} (200 th)**

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