# Supporting Information for

## Micron-Sized Monocrystalline $LiNi_{1/3}Co_{1/3}Mn_{1/3}O_2$ as High Volumetric Energy-Density Cathode for Lithium-Ion Batteries

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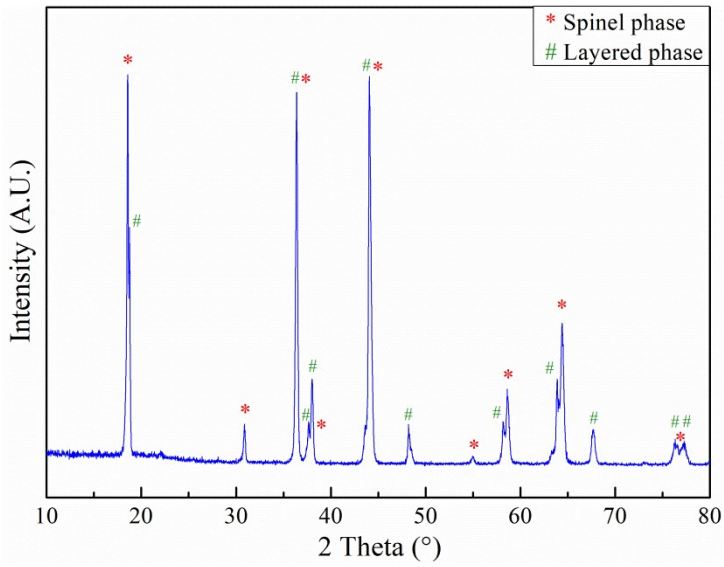


Figure S1 The XRD results of the as-prepared materials mixed with stoichiometric ratio $Li_2CO_3$ (Li/M=0.35) and calcined at 1000 °C.

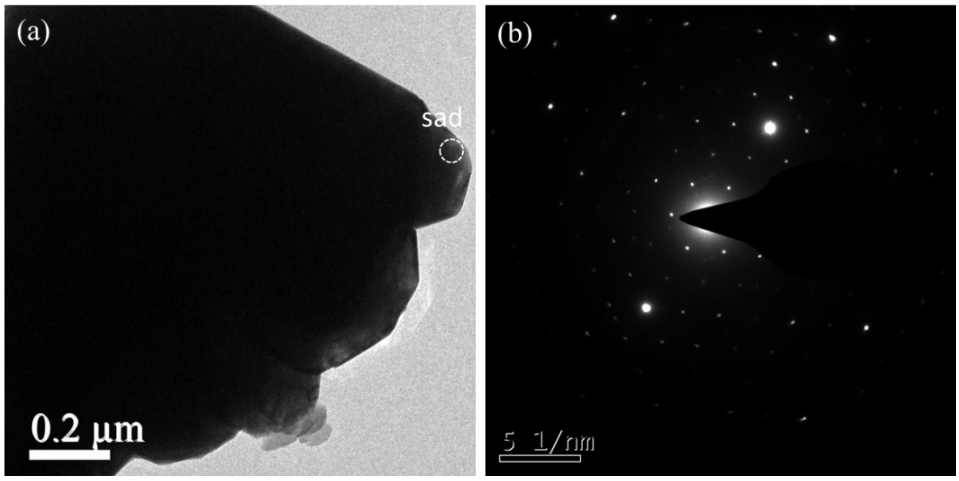


Figure S2 (a) TEM image and (b) selected area electron diffraction (SAED) of the MSM-NCM material.

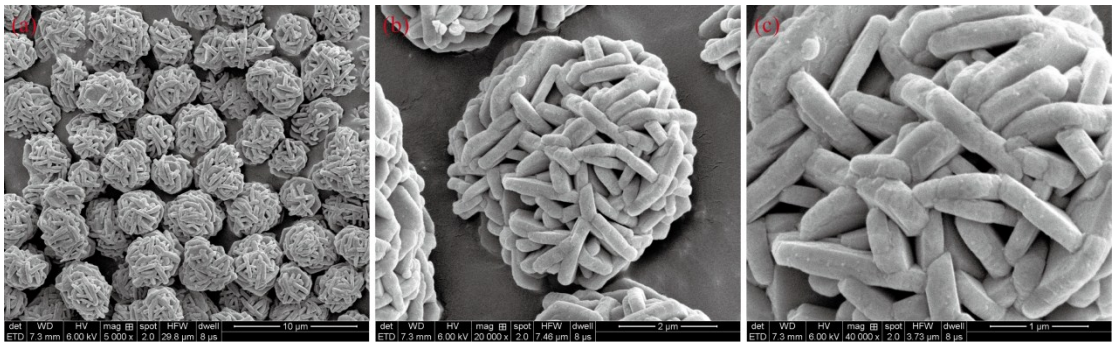


Figure S3 The SEM images of the normal $LiNi_{1/3}Co_{1/3}Mn_{1/3}O_2$ calcined at 900 °C.

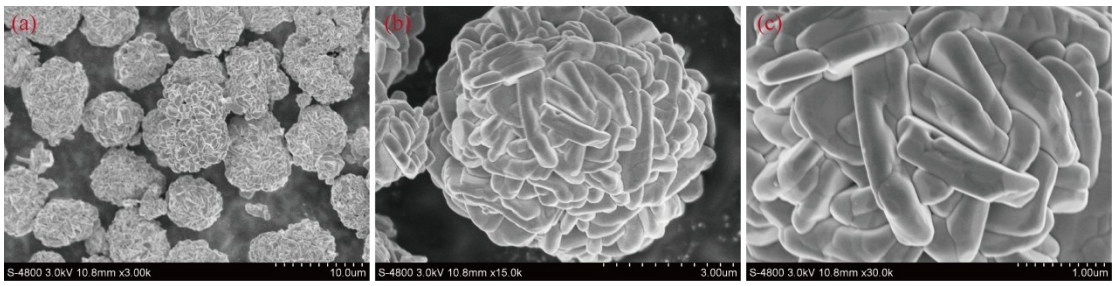


Figure S4 The SEM images of the normal $LiNi_{1/3}Co_{1/3}Mn_{1/3}O_2$ calcined at 1000 °C.

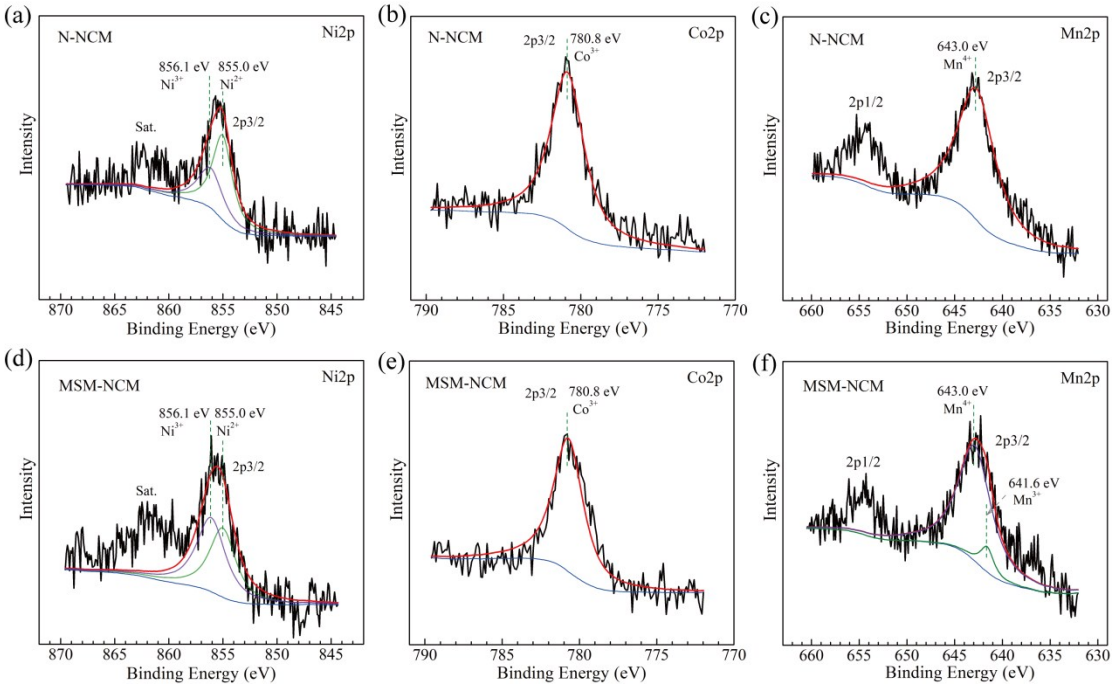


Figure S5 XPS results of the pristine of N-NCM and MSM-NCM materials: (a,d) Ni 2p, (b,e) Co 2p, and (c,f) Mn 2p.

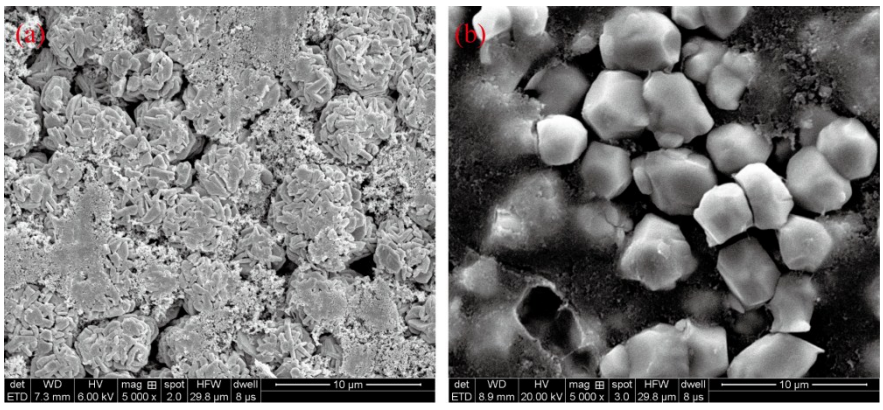


Figure S6 SEM images of (a) the positive electrode based on the normal $LiNi_{1/3}Co_{1/3}Mn_{1/3}O_2$ and (b) the positive electrode based on the micron-sized monocrystalline $LiNi_{1/3}Co_{1/3}Mn_{1/3}O_2$. Both electrodes are tableted at the pressure of 15 MPa.

Table S1 A comparison of tap-density and volemtric energy-density of layered $Li[NiCoMn]O_2$ and spinel $LiMn_2O_4$ cathode materials in the literatures.

| Composition | Morphology | Tap-density ($g\ cm^{-3}$) | Voltage range | volemtric energy-density $Wh\ L^{-1}$ | Ref. |
|---|---|---|---|---|---|
| $LiNi_{1/3}Co_{1/3}Mn_{1/3}O_2$ | sphere | 2.26 | 3.0-4.4 V | 1480 | This work |
| $LiNi_{1/3}Co_{1/3}Mn_{1/3}O_2$ | monocrystalline | 2.81 | 3.0-4.4 V | 1855 | This work |
| $LiNi_{1/3}Co_{1/3}Mn_{1/3}O_2$ | sphere | 2.28 | 3.0-4.4 V | ~1455 | 1 |
| $LiNi_{1/3}Co_{1/3}Mn_{1/3}O_2$ | sphere | 2.32 | 3.0-4.3 V | 1460 | 2 |
| $LiNi_{1/3}Co_{1/3}Mn_{1/3}O_2$ | sphere | 2.32 | 2.8-4.5 V | ~1590 | 3 |
| $LiNi_{1/3}Co_{1/3}Mn_{1/3}O_2$ | sphere | 2.38 | 3.0-4.3 V | ~1500 | 4 |
| $LiNi_{1/3}Co_{1/3}Mn_{1/3}O_2$ | sphere | 2.20 | 2.5-4.3 V | ~1315 | 5 |
| $LiNi_{1/3}Co_{1/3}Mn_{1/3}O_2$ | sphere | 2.56 | 2.8-4.3 V | 1615 | 6 |
| $LiNi_{0.5}Co_{0.2}Mn_{0.3}O_2$ | sphere | 2.59 | 3.0-4.3 V | 1650 | 7 |
| $LiNi_{0.5}Co_{0.2}Mn_{0.3}O_2$ | sphere | 2.01 | 3.0-4.6 V | 1413 | 8 |
| $LiNi_{0.6}Co_{0.2}Mn_{0.2}O_2$ | sphere | 2.59 | 3.0-4.3 V | 1750 | 9 |
| $LiNi_{0.6}Co_{0.2}Mn_{0.2}O_2$ | sphere | 2.32 | 2.8-4.3 V | ~1520 | 10 |
| $LiNi_{0.6}Co_{0.15}Mn_{0.25}O_2$ | sphere | 2.21 | 2.8-4.3 V | ~1400 | 10 |
| $LiNi_{0.8}Co_{0.15}Al_{0.05}O_2$ | sphere | 2.40 | 3.0-4.3 V | 1850 | 11 |
| $LiMn_{1.5}Ni_{0.5}O_4$ | sphere | 2.10 | 3.4-5.0 V | ~1250 | 12 |
| $LiMn_2O_4$ | monocrystalline | 2.23 | 3.3-4.3 V | ~980 | 13 |

Table S2 Mass (m), area (A), thickness (d) and volume (V) of the main components of the 18650-type full-cells using micron-sized monocrystalline $LiNi_{1/3}Co_{1/3}Mn_{1/3}O_2$ as cathode and MCMB as anode. The geometrical volume of a standard 18650-type full-cell is 16.5 $cm^3$.

| | $m$ (g) | $A$ ($cm^2$) | $d$ (μm) | $V$ ($cm^3$) |
|---|---|---|---|---|
| Separator | 1.4 | 944 | 23 | 2.2 |
| Cathode Al foil | 3.1 | 389 | 30 | 1.1 |
| Cathode active material | 17.2 | 654 | 67 | 4.4 |
| Anode Cu foil | 7.5 | 418 | 20 | 0.8 |
| Anode active material | 8.8 | 695 | 60 | 4.2 |
| Electrolyte | 4.4 | - | - | - |
| Housing | 9.2 | - | - | - |
| Sum | 51.6 | - | - | 12.7 |

Table S3 Mass (m), area (A), thickness (d) and volume (V) of the main components of the 18650-

type full-cells using normal spherical $LiNi_{1/3}Co_{1/3}Mn_{1/3}O_2$ as cathode and MCMB as anode. The geometrical volume of a standard 18650-type full-cell is 16.5 $cm^3$.

| | $m$ (g) | $A$ ($cm^2$) | $d$ (μm) | $V$ ($cm^3$) |
|---|---|---|---|---|
| Separator | 1.4 | 944 | 23 | 2.2 |
| Cathode Al foil | 3.1 | 389 | 30 | 1.1 |
| Cathode active material | 15.5 | 654 | 67 | 4.4 |
| Anode Cu foil | 7.5 | 418 | 20 | 0.8 |
| Anode active material | 7.9 | 695 | 60 | 4.2 |
| Electrolyte | 4.4 | - | - | - |
| Housing | 9.2 | - | - | - |
| Sum | 49.0 | - | - | 12.7 |

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