Supporting Information

A nano-truncated Ni/La doped manganese spinel material for high rate performance and long cycle life lithium-ion batteries

Meng Li,[ab1] Yan Li,[ab1] Yujiao Guo,[ab] Junming Guo,*[ab] Mingwu Xiang, *[ab] Wei Bai,[ab] Xiaofang Liu[ab] and Hongli Bai[ab]

[a] National and Local Joint Engineering Research Center for Green Preparation Technology of Biobased Materials, Yunnan Minzu University, Kunming, 650500, China

[b] Key Laboratory of Green-chemistry Materials in University of Yunnan Province, Yunnan Minzu University, Kunming, 650500, China

[1] Meng Li and Yan Li are co-first authors of the article.

corresponding author E-mail addresses: guojunming@tsinghua.org.cn (J. M. Guo), xmwbboy@163.com (M. W. Xiang).

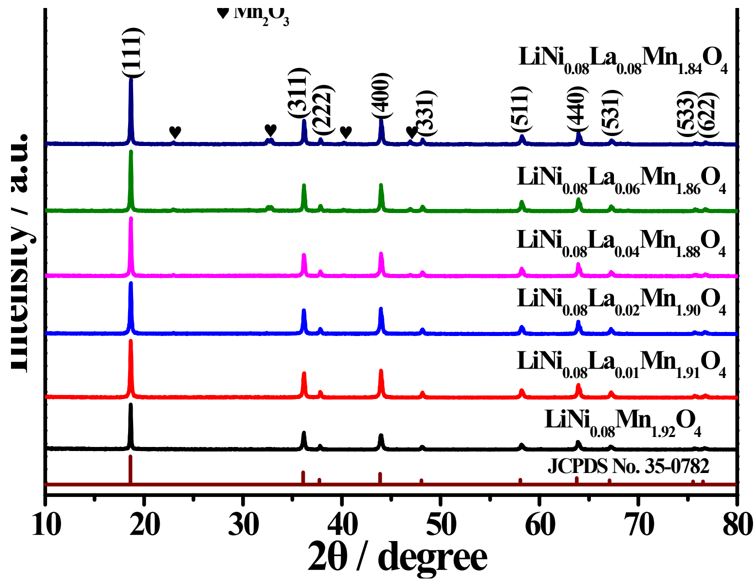

Fig. S1. XRD patterns of the $LiNi_{0.08}La_xMn_{1.92-x}O_4$ (x=0, 0.01, 0.02, 0.04, 0.06, 0.08) samples.

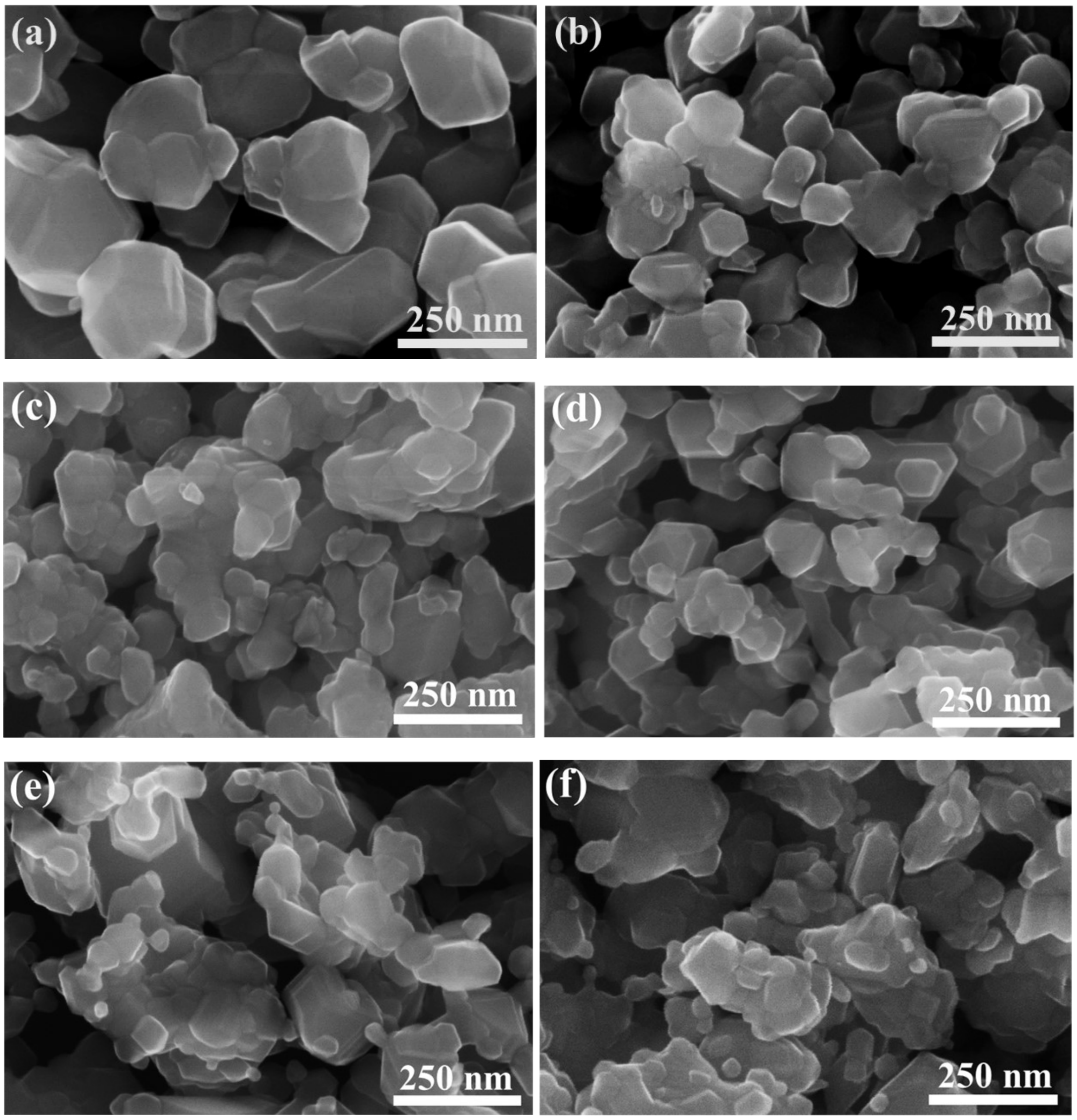

Fig. S2. SEM images of the $LiNi_{0.08}La_xMn_{1.92-x}O_4$ samples: (a) x=0, (b) x=0.01, (c) x=0.02, (d) x=0.04, (e) x=0.06 and (f) x=0.08.

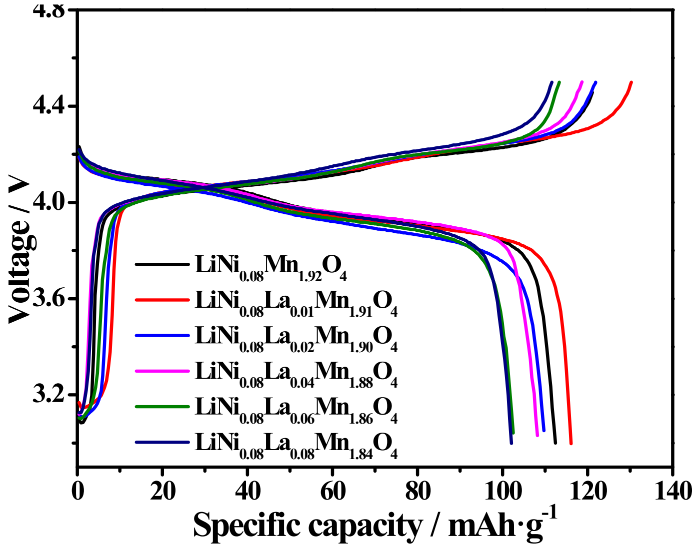

Fig. S3. first charge/discharge curves of the $LiNi_{0.08}La_xMn_{1.92-x}O_4$ (x=0, 0.01, 0.02, 0.04, 0.06, 0.08) samples at 1 C.

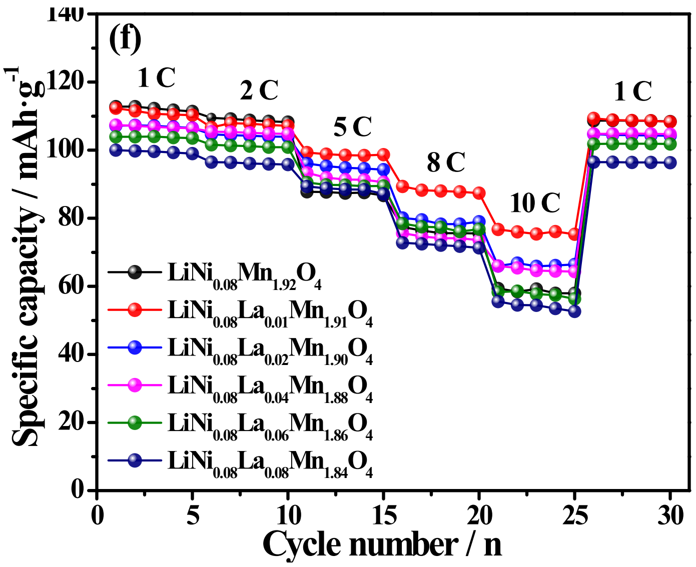

Fig. S4. rate performances of the $LiNi_{0.08}La_xMn_{1.92-x}O_4$ (x=0, 0.01, 0.02, 0.04, 0.06, 0.08) samples.

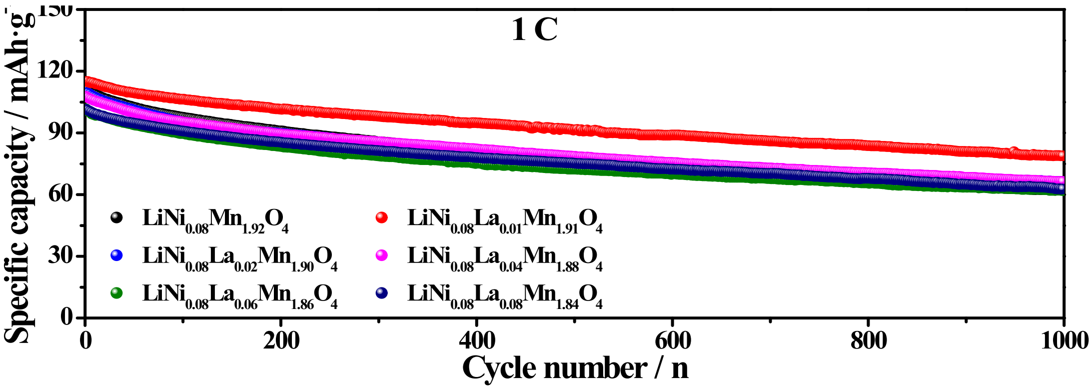

Fig. S5. cycling performances of the $LiNi_{0.08}La_xMn_{1.92-x}O_4$ (x=0, 0.01, 0.02, 0.04, 0.06, 0.08) samples at 1 C.

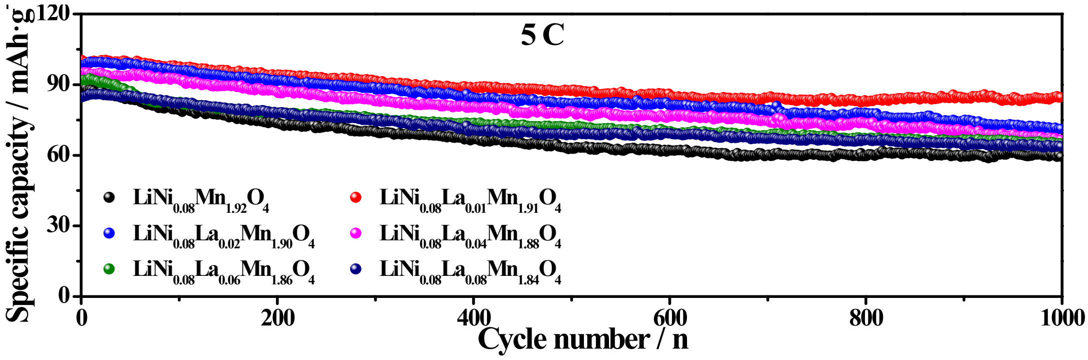

Fig. S6. cycling performances of the $LiNi_{0.08}La_xMn_{1.92-x}O_4$ (x=0, 0.01, 0.02, 0.04, 0.06, 0.08) samples at 5 C.

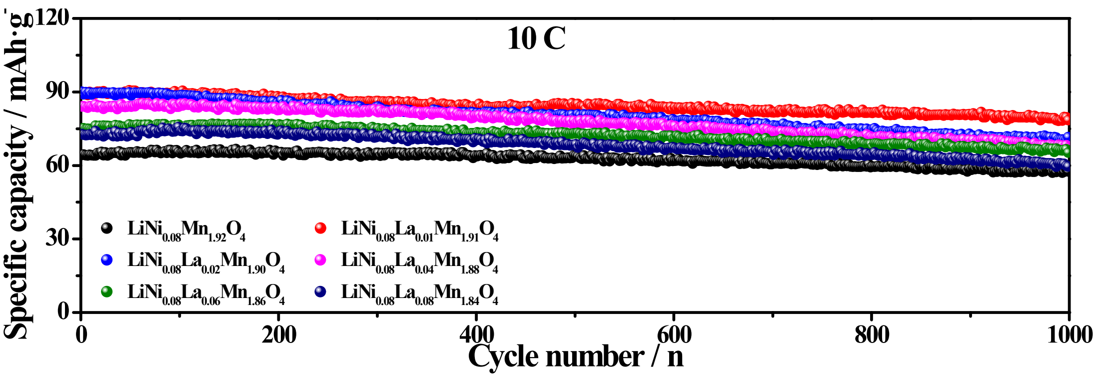

Fig. S7. cycling performances of the $LiNi_{0.08}La_xMn_{1.92-x}O_4$ (x=0, 0.01, 0.02, 0.04, 0.06, 0.08) samples at 10 C.

The calculation of the lithium ion diffusion coefficient (D_{Li^+}):

The corresponding Randles-Sevcik formula is as follows:[1]

$$i_p = (2.69\times10^5)\, n^{3/2} C_{Li^+} A D_{Li}^{1/2} v^{1/2} \quad (25℃) \tag{1}$$

in the equation, i_p stands the peak current value (A), the electron transfer number n is 1, C_{Li^+} denotes the Li^+ volume concentration (0.024 mol·cm^{-3}), A means the electrode superficial area (2.01

cm^2), and v is the scan speed ($V\cdot s^{-1}$). The D_{Li^+} value is computed though the fitting linear connection between i_p and $v^{1/2}$ (Fig. S8).

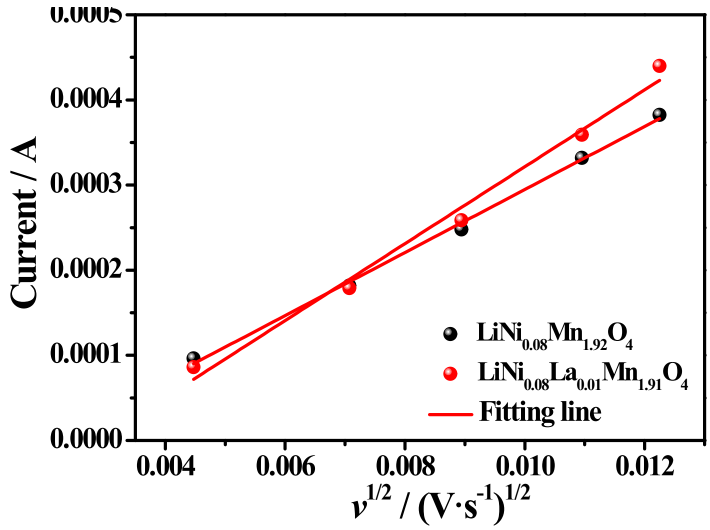

Fig. S8. Fitting plots about peak current vs. square root of scan rate for $LiNi_{0.08}Mn_{1.92}O_4$ and $LiNi_{0.08}La_{0.01}Mn_{1.91}O_4$ samples.

The calculation of the apparent activation energy (E_a):

The E_a value is calculated on the basis of EIS data at different temperatures from the following formulas:[2]

$$i_0 = RT/nFR_{ct} \tag{2}$$

$$i_0 = A\exp(-E_a/RT) \tag{3}$$

where, i_0 expresses exchange current (A), the gas constant value of R is 8.314 $J\cdot mol^{-1}\cdot K^{-1}$, T means absolute temperature (K), the electron transfer number n is 1, the Faraday constant value of F is 96484.5 $C\cdot mol^{-1}$, and A is an independent coefficient of temperature. According to the aforementioned (2) and (3) formulas, the E_a can be stated as $E_a=-Rk\ln 10$ (k denotes the slope of the fitting line in Fig. S9). The E_a value can be further calculated.

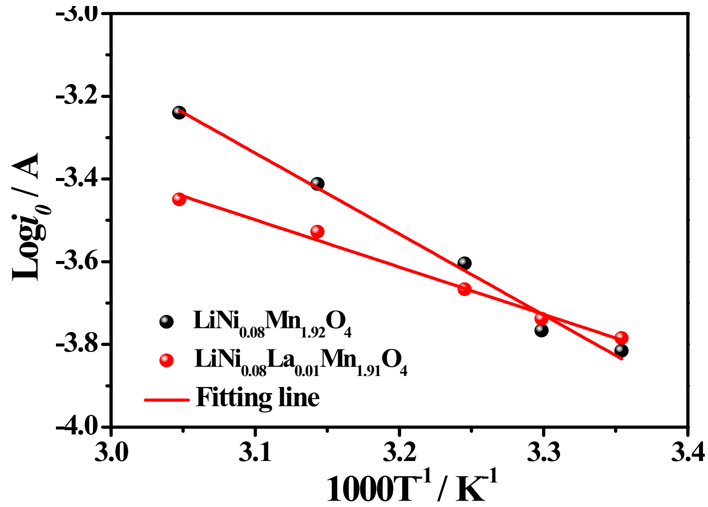

Fig. S9. Arrhenius plots about logi_0 vs. 1000T^{-1} for $LiNi_{0.08}Mn_{1.92}O_4$ and $LiNi_{0.08}La_{0.01}Mn_{1.91}O_4$ samples.

References

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2 S. L. Chou, J. Z. Wang, H. K. Liu, S. X. Dou, J. Phys. Chem. C, 2011, 115, 16220–16227.