

Supporting Information

Highly Activated Oxygen Redox Enabling Large-capacity Li-rich Layered Manganese-Based Oxide Cathode

Table S1. ICP results of the LLMO-L2, LLMO-L3, and LLMO-L5 samples

<i>Samples</i>	Li	Ni	Co	Mn
LLMO811(Theoretical value)	0.60	0.16	0.02	0.22
LLMO811-L2	0.5557	0.1814	0.0214	0.2415
LLMO811-L3	0.5575	0.1807	0.0213	0.2405
LLMO811-L5	0.6311	0.1477	0.0244	0.1968

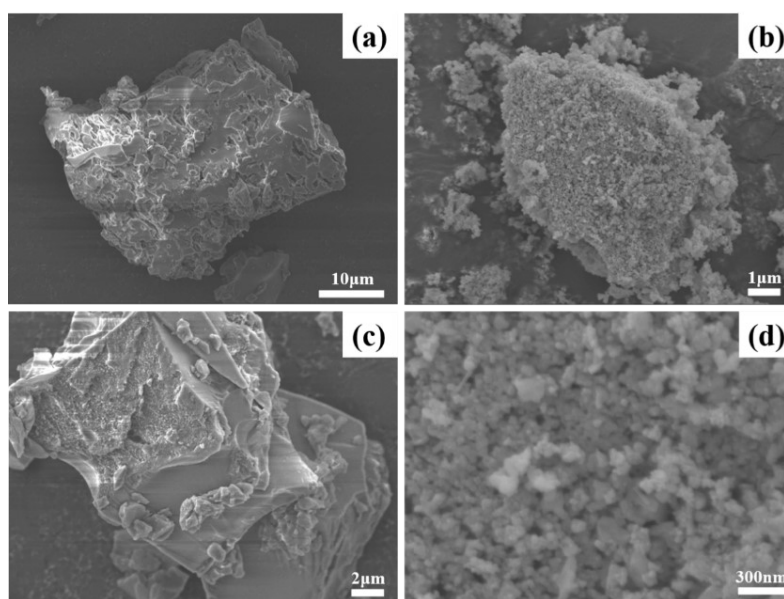


Figure S1. SEM images of the LLMO-L3 precursor before (a, c) and after pyrolysis (b, d).

Table S2. Cell parameters of samples with different amounts of excess lithium

<i>Samples</i>	<i>a</i> (Å)	<i>c</i> (Å)	<i>V</i> (Å ³)	<i>c/a</i>
LLMO-L2	2.8712	14.2538	101.77Å ³	4.9644
LLMO-L3	2.8701	14.2533	101.73Å ³	4.9661

LLMO-L5	2.8704	14.2251	101.5Å ³	4.9558
---------	--------	---------	---------------------	--------

Table S3. $I_{(003)}/I_{(104)}$ ratio of samples with different amounts of excess lithium

<i>Samples</i>	$I_{(003)}$	$I_{(004)}$	$I_{(003)}/I_{(004)}$
LLMO-L2	9207	3889	2.3674
LLMO-L3	6497	2978	2.1817
LLMO-L5	7130	3123	2.2831

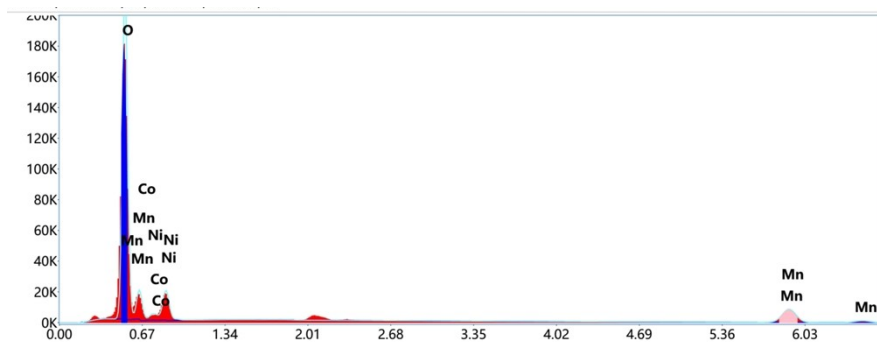


Figure S2. EDS element distribution curve

Table S4. The proportion of each element calculated from EDS

<i>Element</i>	Weight %	MDL	Atomic %
O	30.4	0.04	60.5
Mn	37.8	0.35	21.9
Co	3.4	0.50	1.8
Ni	27.6	0.68	14.9

Table S5 Electrochemical properties of samples with different amounts of excess lithium

<i>Samples</i>	LLMO-L2	LLMO-L3	LLMO-L5
ICE	82.9%	83.8%	82.2%
Capacity Retention (80 Cycles)	78.8%	79.3%	77.9%
Capacity Reversibility (5C to 1C)	97.0%	97.2%	97.3%
Voltage Decay (80 Cycles)	86.7%	84.1%	88.1%

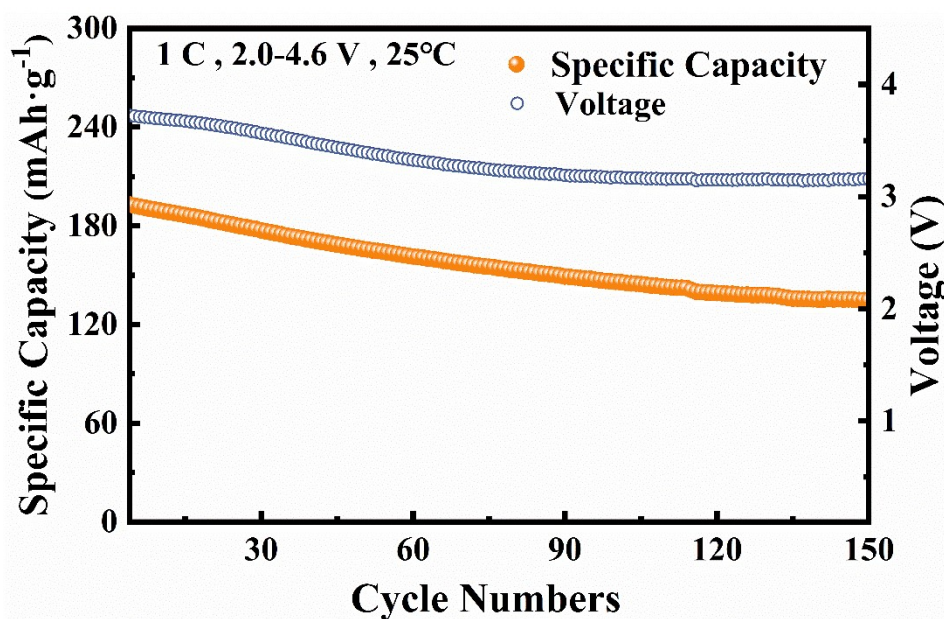


Figure S3. The cycling performance of LLMO-L3 at 1C

Table S6 O atomic percentage calculated by fitting the XPS peaks at different voltage states

<i>Samples</i>	M-O	C=O	C-O	O⁻/O₂²⁻
original sample	41.1%	58.9%	0	0
1st-4.0	0	61.6%	38.4%	0
1st-4.8	13.7%	41.0%	31.9%	13.4%
1st-3.5	11.8%	68.4%	19.8%	0
1st-2.0	0	61.1%	38.9%	0
2nd-4.6	11.9%	41.5%	30.1%	16.5%

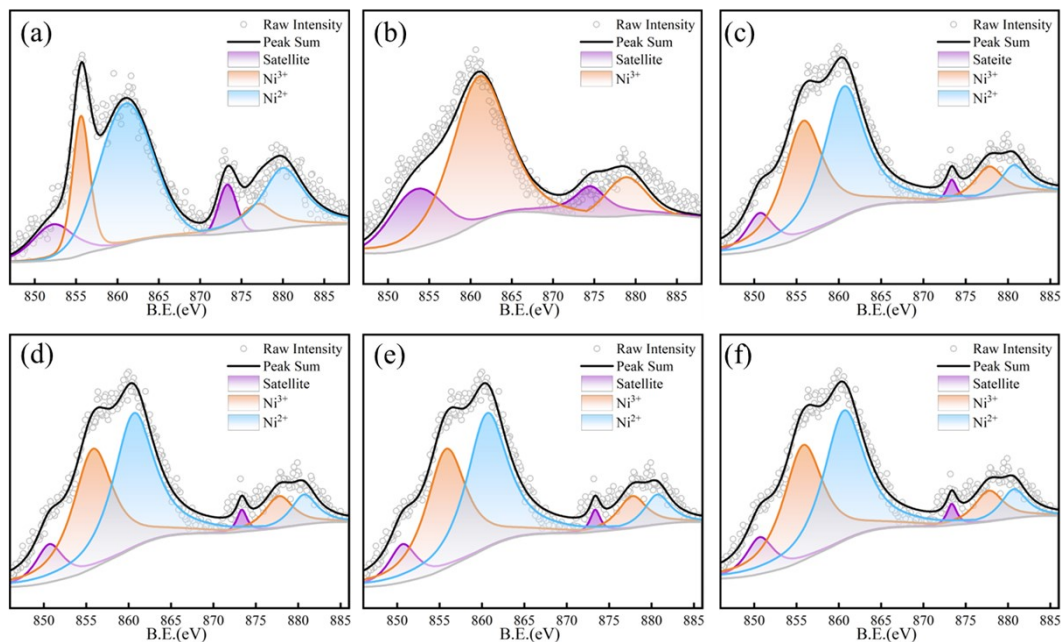


Figure S4. Ni 2p spectra of LLMO-L3 at different voltage points. (a) pristine electrode, (b) 1st-4.0, (c) 1st-4.8, (d) 1st-3.5, (e) 1st-2.0, (f) 2nd-4.6

Table S7. Cell parameters of LLMO-L3 at different voltage

<i>Samples</i>	<i>a</i> (Å)	<i>c</i> (Å)	<i>V</i> (Å ³)	<i>c/a</i>
LLMO-L3	2.8701	14.2533	101.73Å ³	4.9661
1st-4.0V	2.8580	14.1530	100.12Å ³	4.9521
1st-4.8V	2.8661	14.5747	103.11Å ³	5.0852
1st-3.5V	2.8826	14.3844	103.51Å ³	4.9901
1st-2.0V	2.8587	14.2445	100.95Å ³	4.9828