Supplementary Information (SI) for Journal of Materials Chemistry A.

Supplementary information

High structural stability and Li-conduction of $LiNi_{0.8}Co_{0.1}Mn_{0.1}O_2$ cathode co-coated by Al_2O_3 and $LiNbO_3$ for high performance lithium-ion battery

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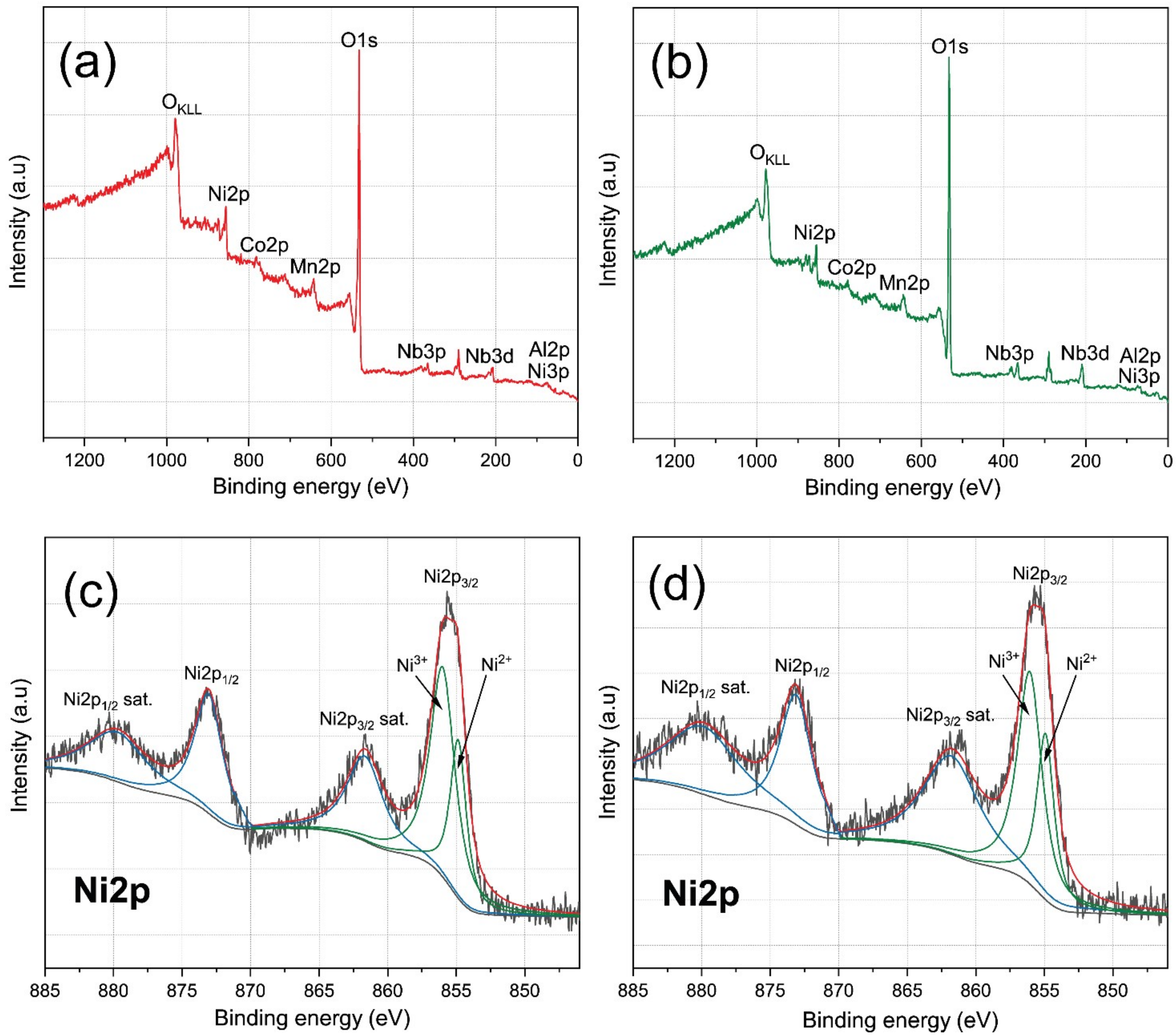


Figure S1. (a) Full-scan and (c) Ni2p XPS spectra of NCM-AlNb-0.25; (b) full-scan and (d) Ni2p XPS spectra of NCM-AlNb-1.

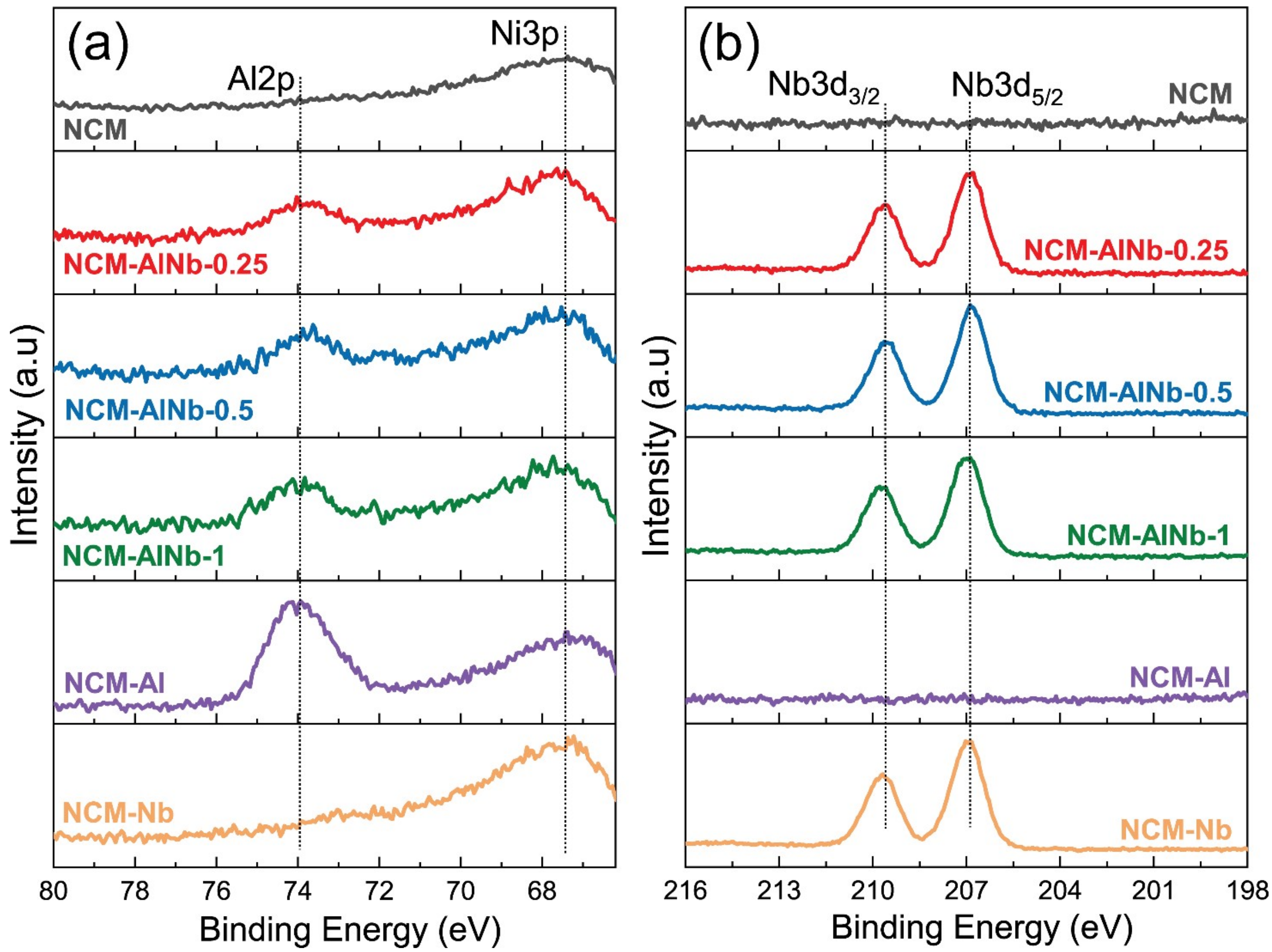


Figure S2. (a) Al2p XPS spectra and (b) Nb3d XPS spectra of uncoated and coated NCMs.

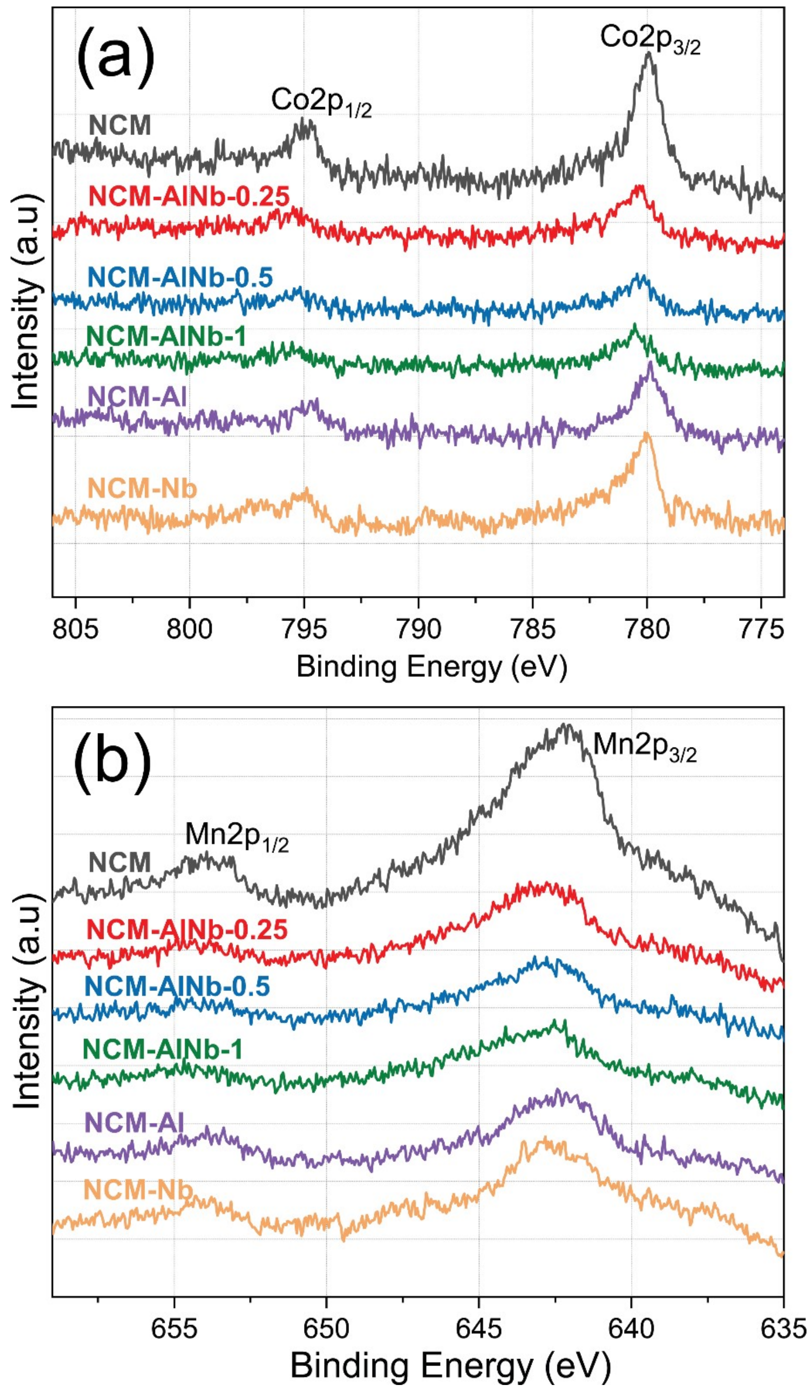


Figure S3. (a) Co2p XPS spectra and (b) Mn2p XPS spectra of uncoated and coated NCMs.

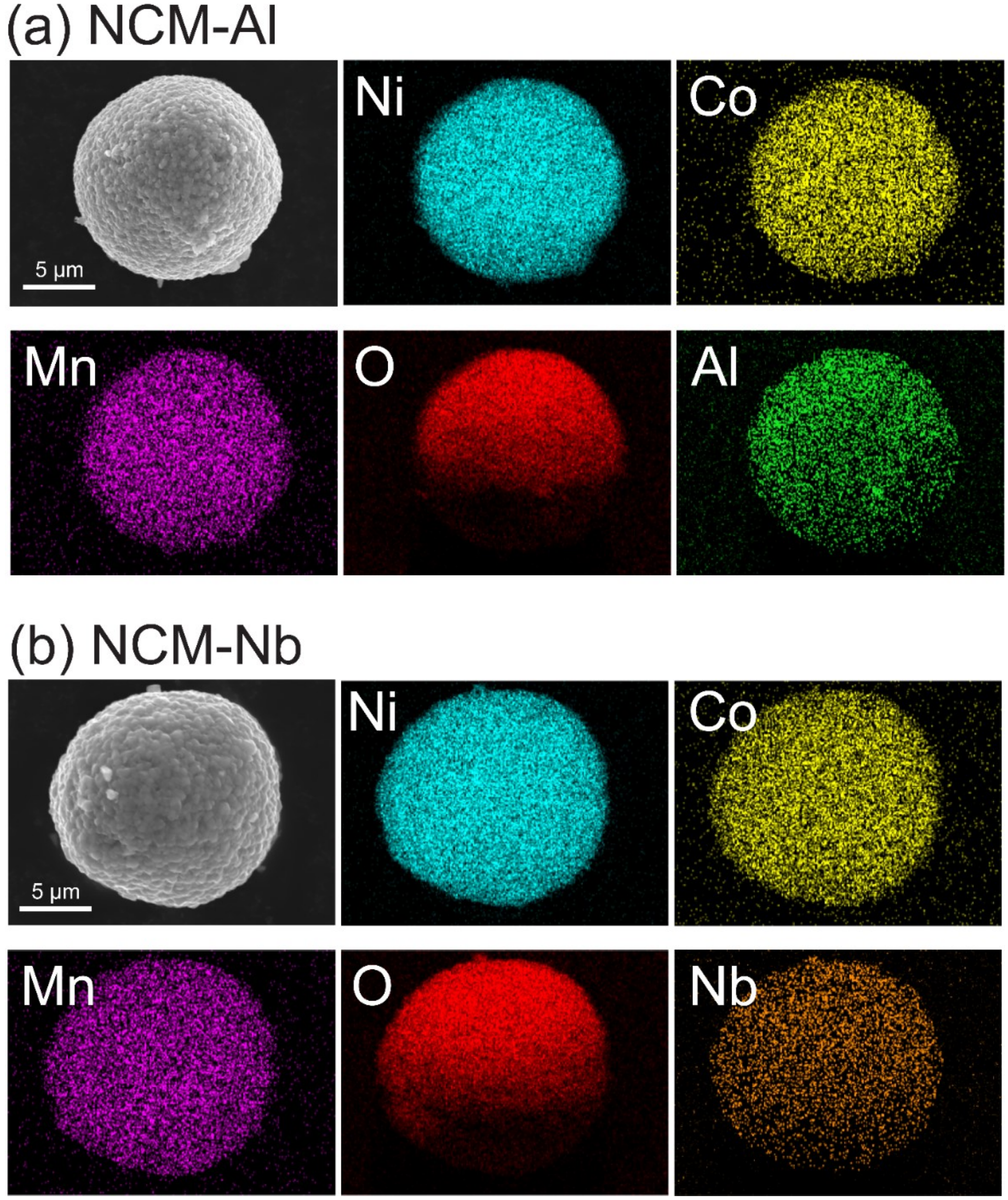
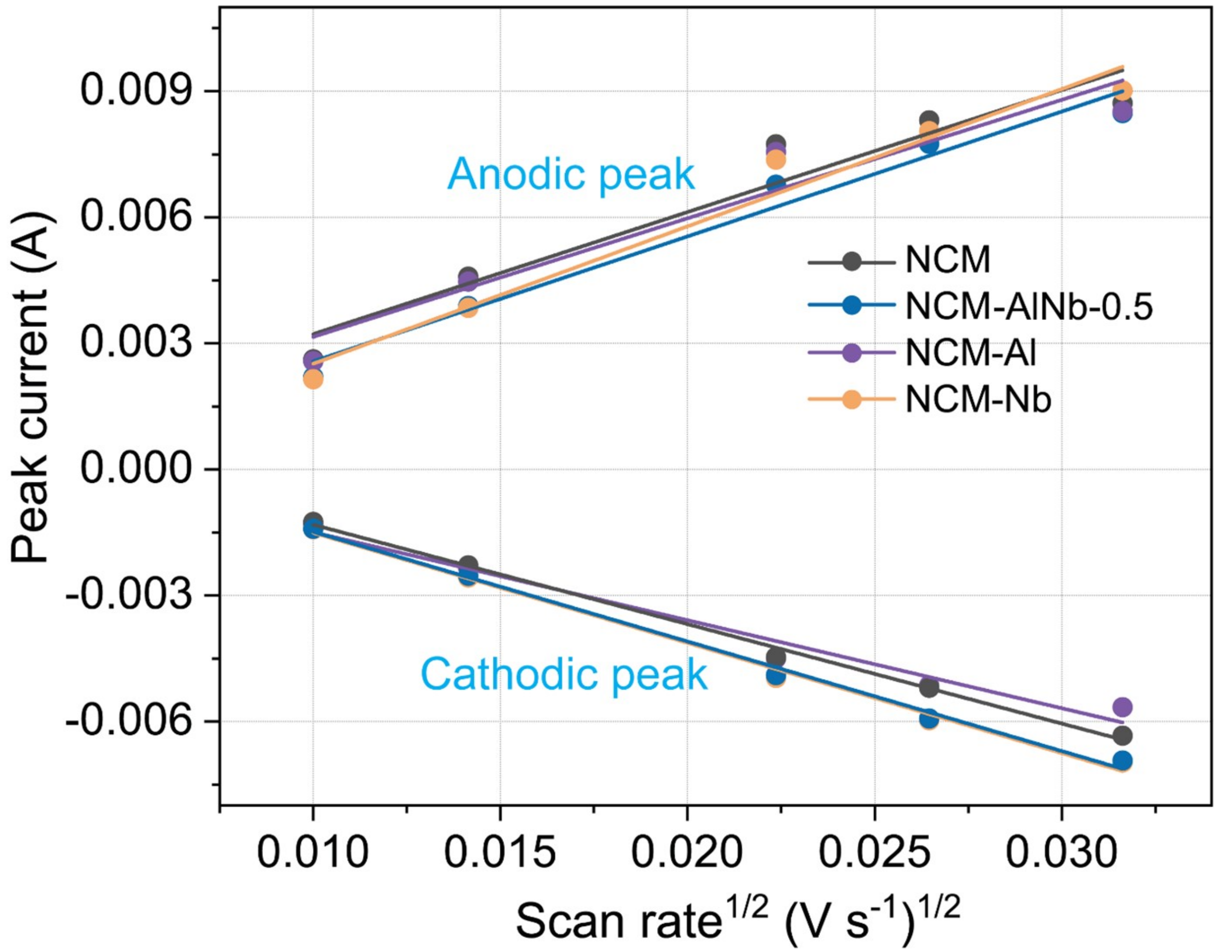


Figure S4. SEM images and EDS mapping of (a) NCM-Al, and (b) NCM-Nb.

Table S1. Comparison of electrochemical performances of Al_2O_3-$LiNbO_3$ co-coated NCM811 with those in other recently published papers that use either Al or Nb-based materials for coating.

Active material	Coating material	Specific capacity (mAh g^{-1})	Retention	Ref.
$LiNi_{0.8}Co_{0.1}Mn_{0.1}O_2$	Al_2O_3-$LiNbO_3$ (wet process)	180.85 (0.5C, 2.75-4.3V)	92.08% (0.5C, 100 cycles)	This work
$LiNi_{0.7}Co_{0.15}Mn_{0.15}O_2$	Al_2O_3 (wet process)	160 (0.5C, 3.0-4.3V)	~90% (0.5C, 130 cycles)	1
$LiCoO_2$	Al_2O_3 (wet process)	174 (0.1C, 2.75-4.4V)	~97% (0.5C, 50 cycles)	2
$Li[Ni_{0.8}Co_{0.2}]_{0.7}[Ni_{0.2}Mn_{0.8}]_{0.3}O_2$	Al_2O_3 (wet process)	197 (0.2C, 2.7-4.5V)	88.83% (0.2C, 100 cycles)	3
$LiNi_{0.8}Co_{0.15}Al_{0.05}O_2$	Al_2O_3 (wet process)	171.4 (0.1C, 2.5-4.2V)	83.4% (0.1C, 100 cycles)	4
$LiNi_{0.6}Co_{0.2}Mn_{0.2}O_2$	PVA/ Al_2O_3 (sol-gel)	203.95 (0.5C, 3.0-4.55V)	90% (0.5C, 100 cycles)	5
Mg-doped $LiNi_{0.6}Co_{0.2}Mn_{0.2}O_2$	$LiNbO_3$ (wet process)	155 (1C, 2.8-4.3V)	90.82% (1C, 100 cycles)	6
$LiNb_{0.83}Co_{0.11}Mn_{0.06}O_2$	$C_4H_4NNbO_9$	211.8 (0.2C, 2.7-4.4V)	86.6% (1C, 100 cycles)	7
$LiNi_{0.8}Co_{0.1}Mn_{0.1}O_2$	Nb_2O_5	200.2 (0.1C, 3.0-4.3V)	90.6 % (0.1C, 100 cycles)	8
$LiNb_{0.83}Co_{0.11}Mn_{0.06}O_2$	Nb_2O_5	195 (0.1C)	86.6% (1C, 200 cycles)	9
$LiNi_{0.5}Co_{0.2}Mn_{0.3}O_2$	$LiNbO_3$	207.2 (0.2C, 3.0-4.5V)	~83% (1C, 100 cycles)	10



Anodic peak

Sample	NCM	NCM-AlNb-0.5	NCM-Al	NCM-Nb
Intercept	3.15876E-4	-4.02915E-4	3.33203E-4	-7.53677E-4
Slope	0.29041 ± 0.045	0.29733 ± 0.028	0.2821 ± 0.043	0.32685 ± 0.034

Cathodic peak

Sample	NCM	NCM-AlNb-0.5	NCM-Al	NCM-Nb
Intercept	0.00105	0.00112	5.98284E-4	0.00111
Slope	-0.2367 ± 0.008	-0.26092 ± 0.010	-0.20949 ± 0.020	-0.26221 ± 0.011

Figure S5. Relationship between the peak current (I_p) and the square root of the scan rate ($v^{1/2}$).

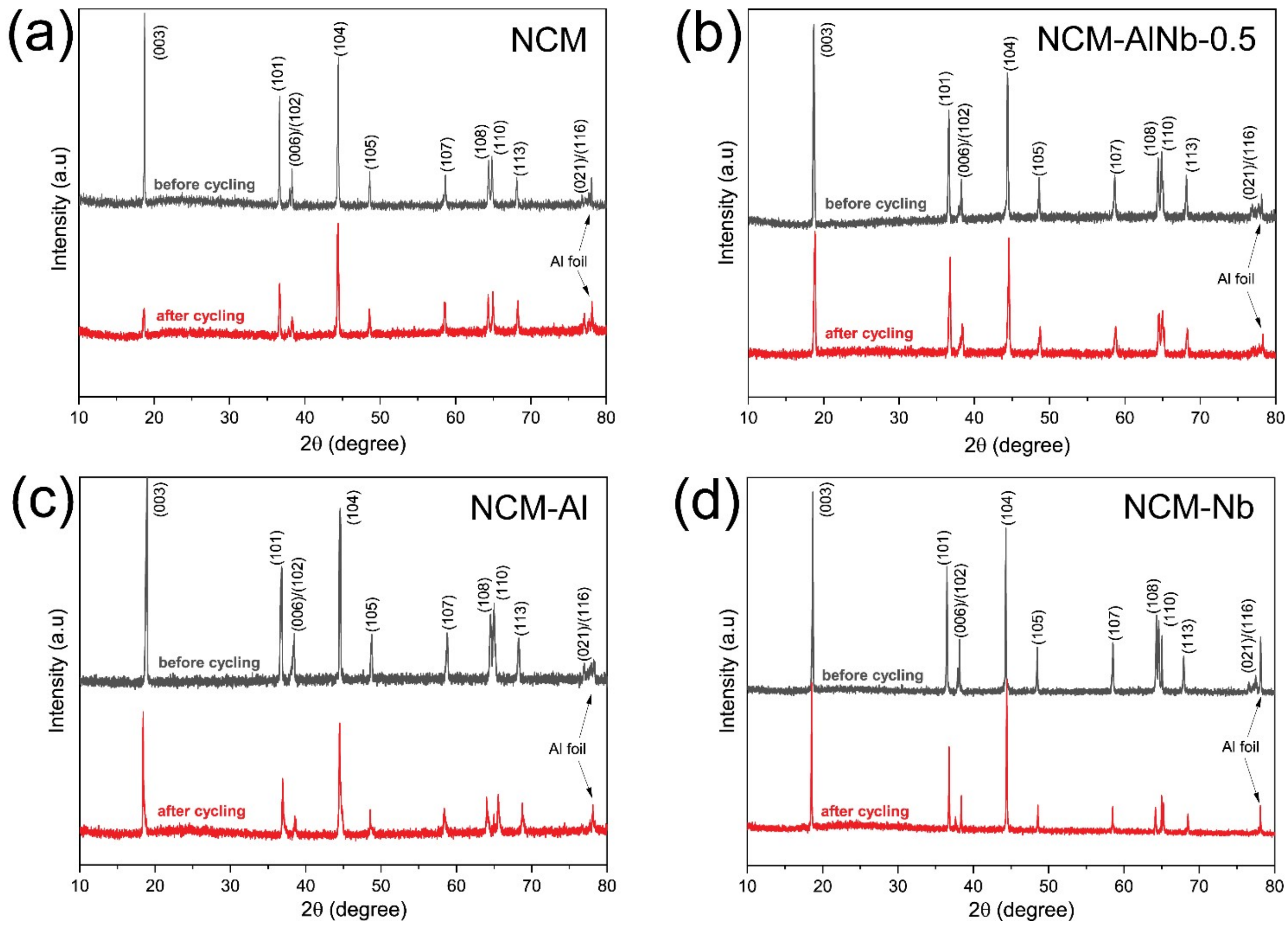


Figure S6. XRD spectra of (a) uncoated NCM, (b) NCM-AlNb-0.5, (c) NCM-Al and (d) NCM-Nb electrode before and after 100 charge-discharge cycles.

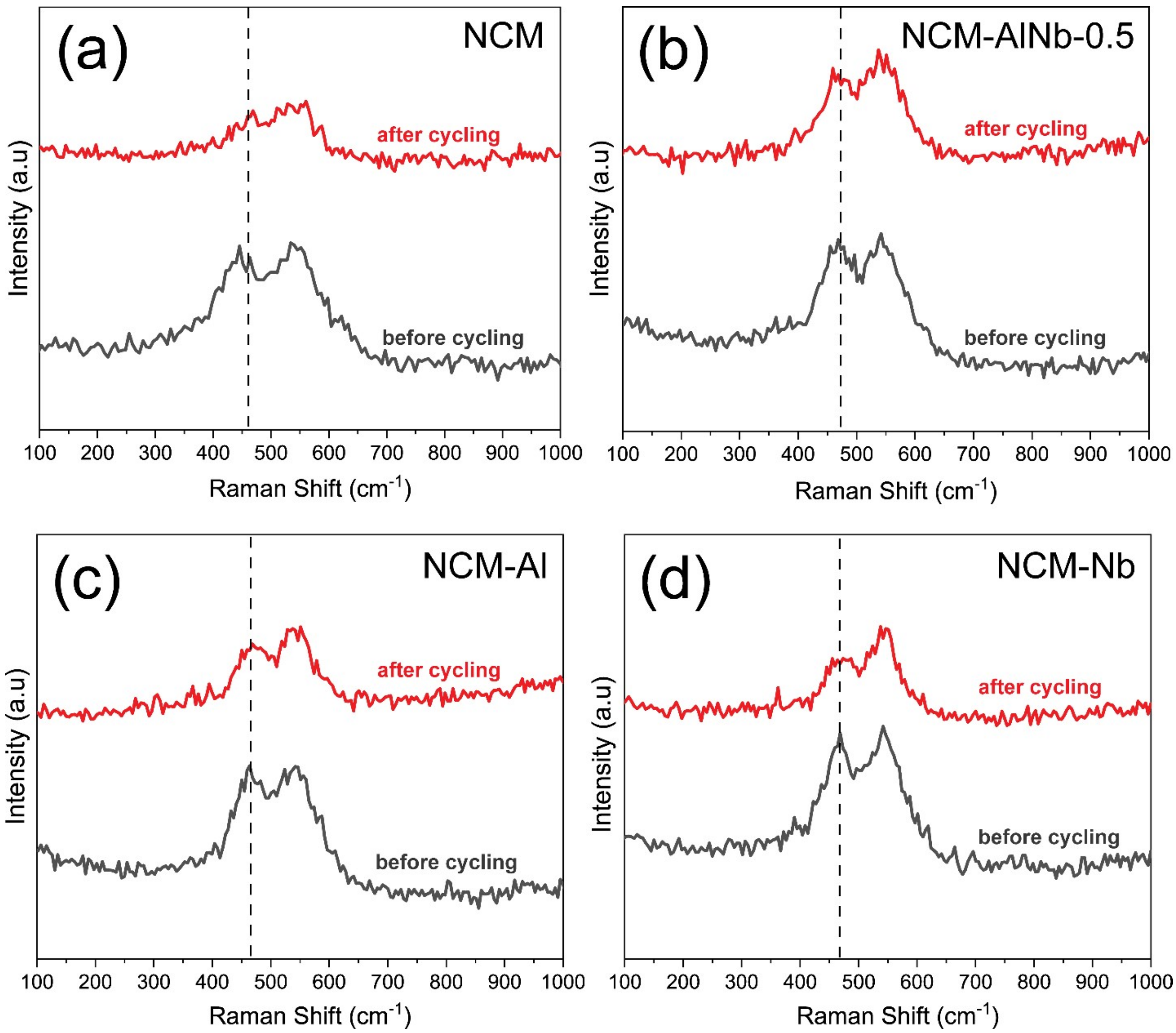


Figure S7. Raman spectra of (a) uncoated NCM, (b) NCM-AlNb-0.5, (c) NCM-Al and (d) NCM-Nb electrode before and after 100 charge-discharge cycles.

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