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Supplementary Information

Comprehensive study of the role of transition metals in O3-type layered $Na[Ni_xCo_yMn_z]O_2$ (x=1/3, 0.5, 0.6, and 0.8) cathodes for sodium-ion batteries

Jang-Yeon Hwang, ‡[a], Chong S. Yoon, ‡[b], Ilias Belharouak,*[c] and Yang-Kook Sun*[a]

[a] Department of Energy Engineering, Hanyang University, Seoul, 04763, Republic of Korea

[b] Department of Materials Science and Engineering, Hanyang University, Seoul, 133-791, South Korea

[c] Qatar Environment and Energy Research Institute, Qatar Foundation, P.O. Box 5825, Doha, Qatar

‡ These authors contributed equally to this work.

* To whom correspondence should be addressed.

Ilias Belharouak (ibelharouak@qf.org.qa),Yang-Kook Sun (yksun@hanyang.ac.kr)

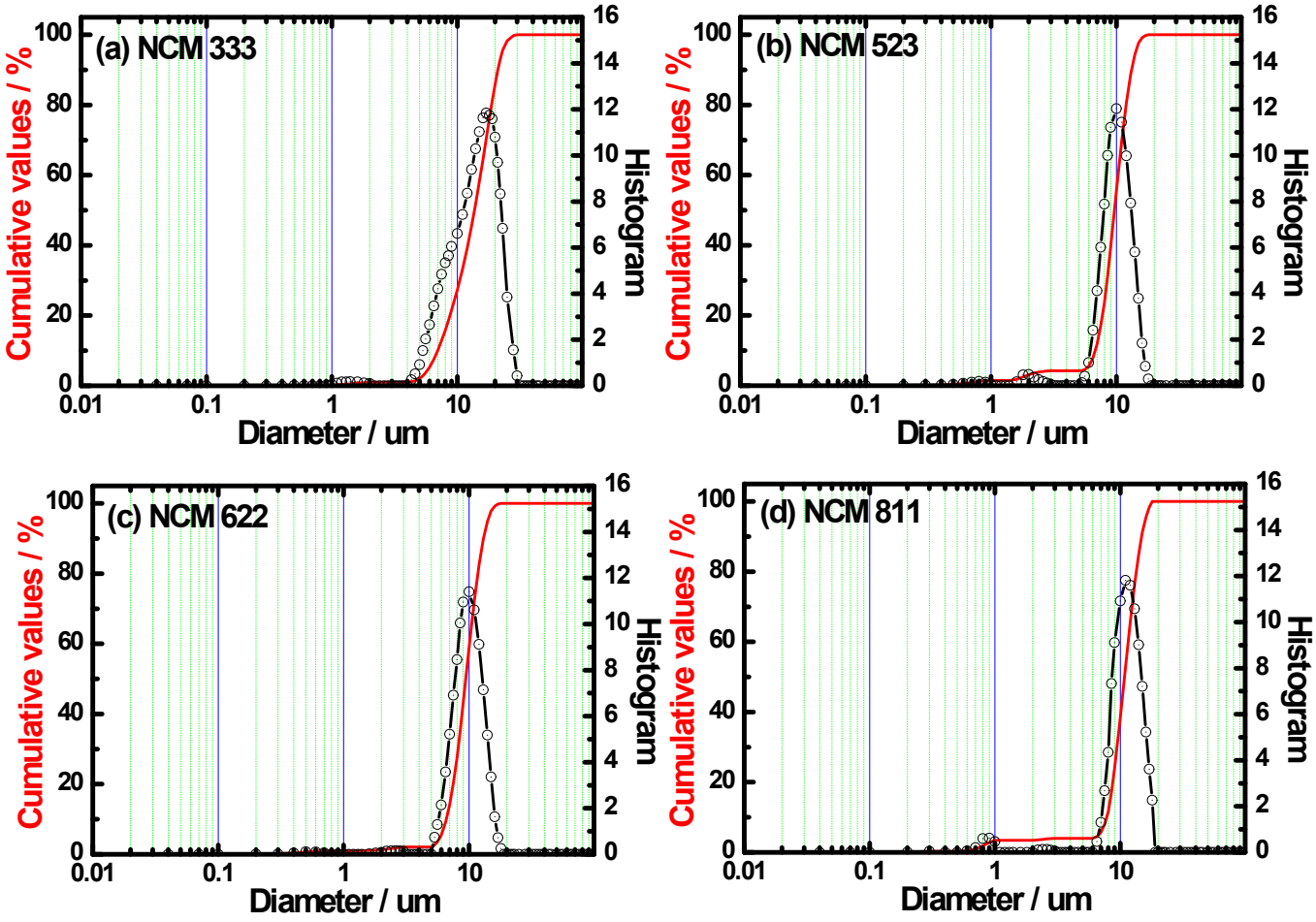

Fig. S1 Particle size analysis results of the $[Ni_xCo_yMn_z](OH)_2$ (x=1/3, 0.5, 0.6, and 0.8) precursors.

Table S1 Chemical compositions of the prepared $[Ni_xCo_yMn_z](OH)_2$ (x=1/3, 0.5, 0.6, and 0.8) powders determined by ICP-AES.

		Metal stoichiometry determined by ICP-AES			
x	Formula	Ni	Co	Mn	Prepared Precursor
1/3	$[Ni_{1/3}Co_{1/3}Mn_{1/3}](OH)_2$	0.3244	0.3319	0.3437	$[Ni_{0.3244}Co_{0.3319}Mn_{0.3437}](OH)_2$
0.5	$[Ni_{0.5}Co_{0.2}Mn_{0.3}](OH)_2$	0.5062	0.1998	0.2940	$[Ni_{0.5062}Co_{0.1998}Mn_{0.2940}](OH)_2$
0.6	$[Ni_{0.6}Co_{0.2}Mn_{0.2}](OH)_2$	0.6086	0.1977	0.1937	$[Ni_{0.6086}Co_{0.1977}Mn_{0.1937}](OH)_2$
0.8	$[Ni_{0.8}Co_{0.1}Mn_{0.1}](OH)_2$	0.7913	0.1055	0.1032	$[Ni_{0.7913}Co_{0.1055}Mn_{0.1032}](OH)_2$

Table S2 Lattice parameters of the $Na[Ni_xCo_yMn_z]O_2$ (x=1/3, 0.5, 0.6, and 0.8) cathodes.

Cathodes	a-axis / Å	c-axis / Å	volume / Å^3
$Na[Ni_{1/3}Co_{1/3}Mn_{1/3}]O_2$ (Na-NCM 333)	2.9384(2)	15.994(1)	119.59(4)
$Na[Ni_{0.5}Co_{0.2}Mn_{0.3}]O_2$ (Na-NCM 523)	2.9356(5)	15.847(7)	118.19(6)
$Na[Ni_{0.6}Co_{0.2}Mn_{0.2}]O_2$ (Na-NCM 622)	2.9345(2)	15.808(2)	117.88(2)
$Na[Ni_{0.8}Co_{0.1}Mn_{0.1}]O_2$ (Na-NCM 811)	2.9309(1)	15.776(8)	117.36(7)

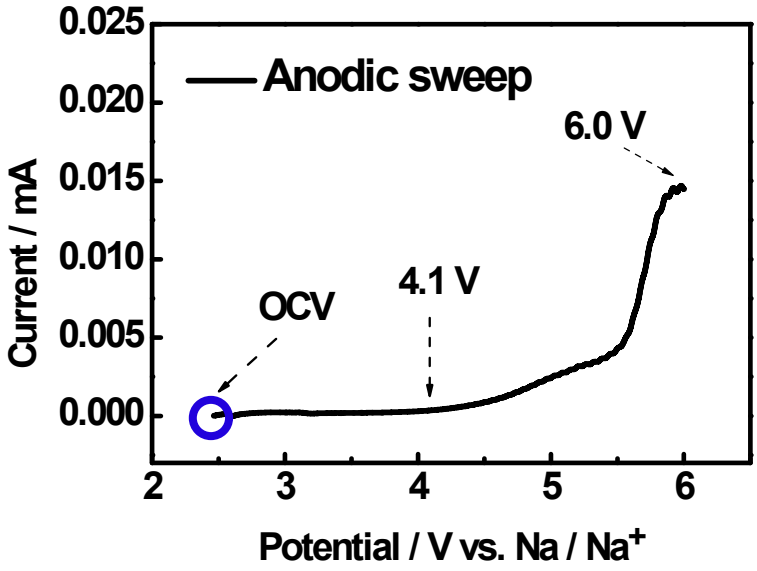

Fig. S2 Linear sweep voltammetry (LSV) results of a sodium cell using a 0.5 mol dm^{-3} $NaPF_6$ solution in propylene carbonate (PC) and fluoroethylene carbonate (98:2 by volume) electrolyte.

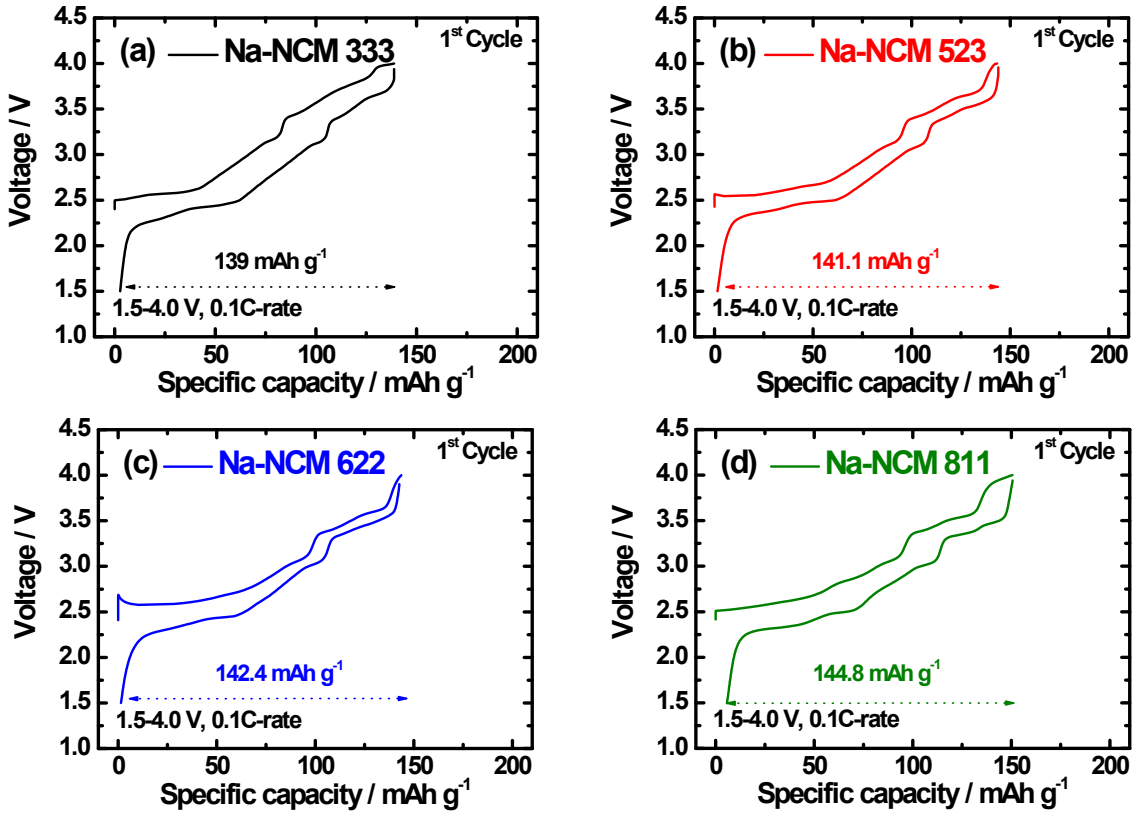

Fig. S3 The initial charge-discharge profiles of the $Na[Ni_xCo_yMn_z]O_2$ (x=1/3, 0.5, 0.6, and 0.8) electrodes in the voltage range of 1.5-4.0 V.

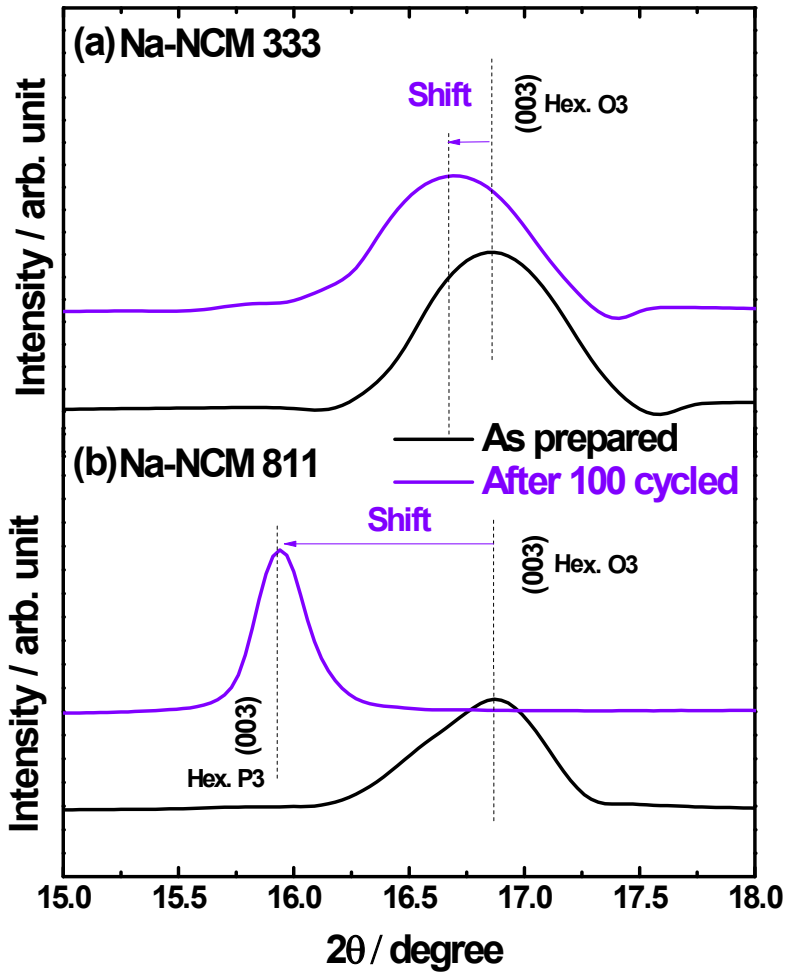

Fig. S4 XRD patterns of Na-NCM 333 and Na-NCM 811 electrodes between before and after cycling at 75 mA g^{-1} in the voltage range of 1.5 – 4.1 V.