

## Supplementary Materials for High-Ni Cathode Material improved by Zr for Stable Cycling of Li-Ion Rechargeable Batteries

Kwangjin Park<sup>a</sup>, Dong Jin Ham<sup>b</sup>, Seong Yong Park<sup>c</sup>, Jihyun Jang<sup>b</sup>, Dong-Hee Yeon<sup>b</sup>, San Moon<sup>b\*</sup>, Sueng  
Jin Ahn<sup>b\*</sup>

<sup>a</sup>Department of Mechanical Engineering, Gachon University, 1342 Sunnamdaero, Sujeong-Gu,  
Sunnam Si, Gyeonggi-do 13120, Republic of Korea

<sup>b</sup>Energy Laboratory, Samsung Advanced Institute of Technology, Samsung Electronics Co. Ltd., 130,  
Samsung-ro, Yeongtong-gu, Suwon-Si, Gyeonggi-do 16678, Republic of Korea

<sup>c</sup>Analytical Engineering Group, Samsung Advanced Institute of Technology, 130 Samsung-ro,  
Yeongtong-gu, Suwon-si, Gyeonggi-do 443-803, Republic of Korea

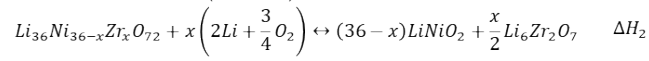
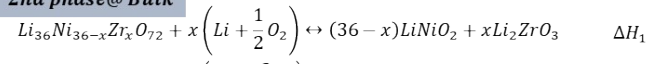
Correspondence to: [jaminanman@gmail.com](mailto:jaminanman@gmail.com)

<b>Sample</b>	<b><i>a</i> (Å)</b>	<b><i>c</i> (Å)</b>	<b><i>Intensity ratio (003)/(104)</i></b>
<b>Pristine NCM</b>	<b>2.8729</b>	<b>14.1976</b>	<b>1.50</b>
<b>S-NCM</b>	<b>2.8735</b>	<b>14.2028</b>	<b>1.62</b>
<b>L-NCM</b>	<b>2.8745</b>	<b>14.2079</b>	<b>1.63</b>

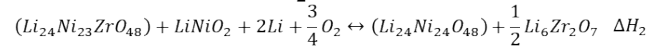
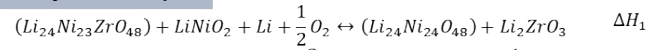
**Table S1.**  
Lattice parameters of pristine NCM, Zr solid NCM, and Zr solution NCM.

(a)

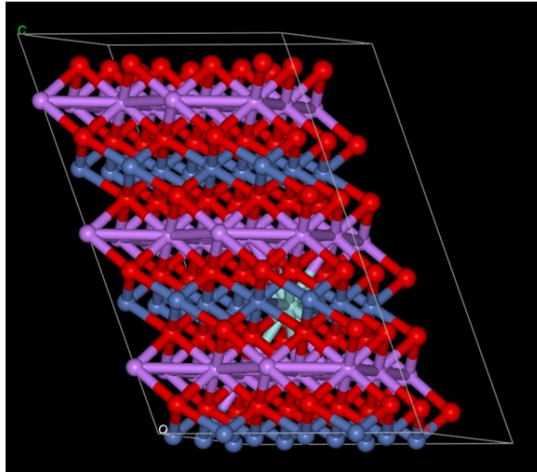
**2nd phase@ Bulk**



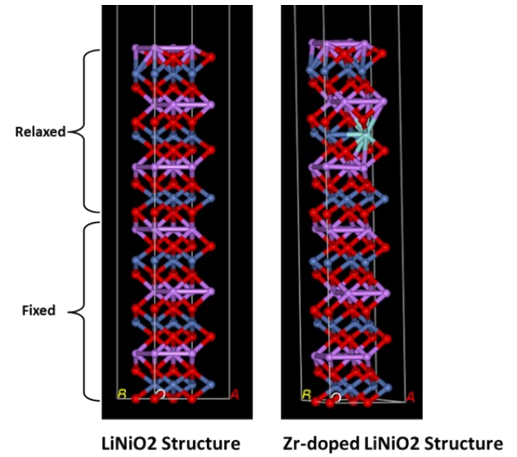
**2nd phase@ surface**



(b)



(c)

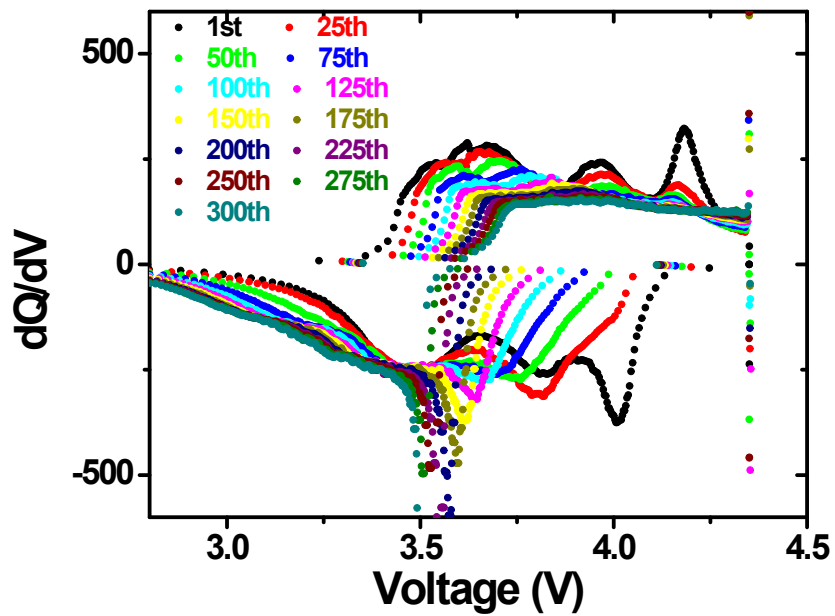


**Fig. S1.**

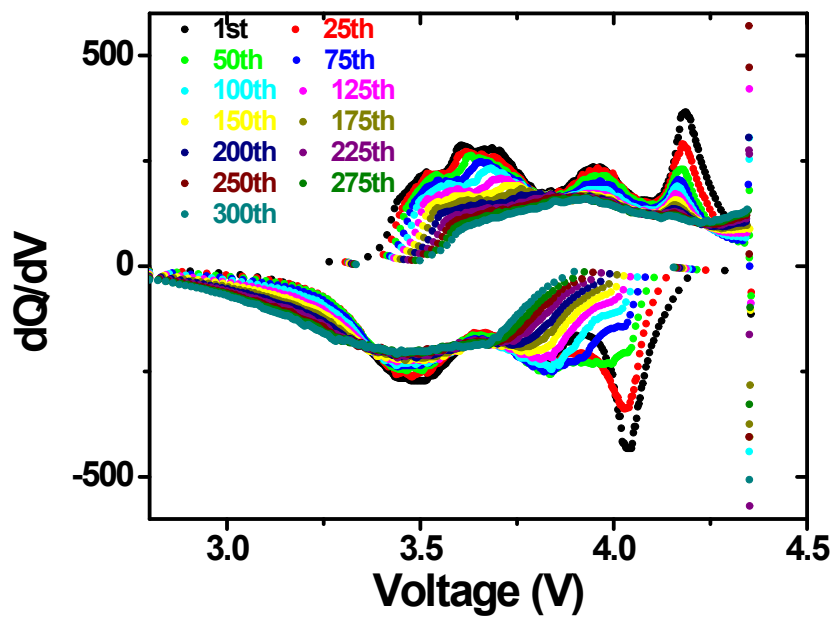
(a) Reactions of the bulk and surface

(b) Atomic model of LiNiO<sub>2</sub> slabs from the surface to the bulk

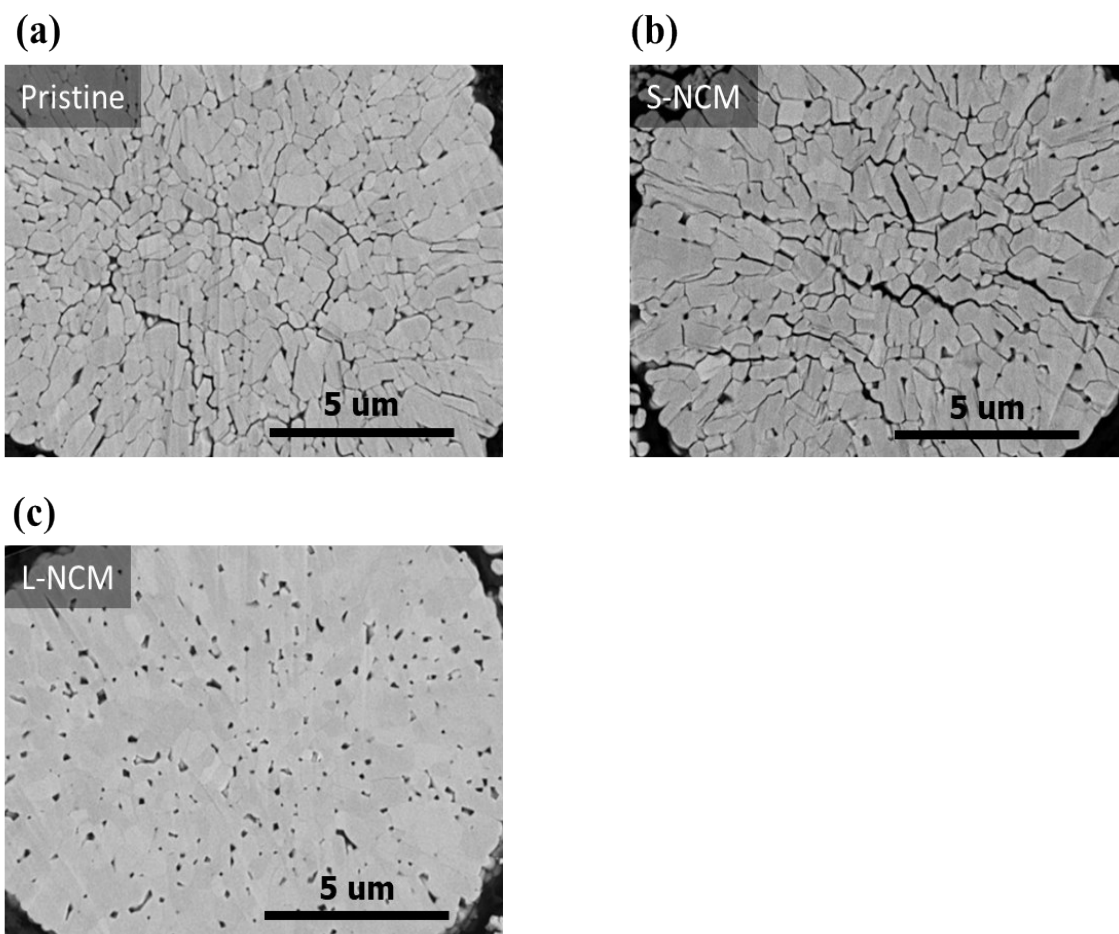
(a)



(b)



**Fig. S2.**  
 $dQ/dV$  at intervals of 25 cycles for (a) S-NCM (b) L-NCM



**Fig. S3.** Cross-sectional SEM images of the powder after the 1<sup>st</sup> cycle for (a) pristine NCM (b) S-NCM and (c) L-NCM.