Supporting Information

**Stable Ni-rich Layered Oxide Cathode for Sulfide All-Solid-State Lithium Battery**

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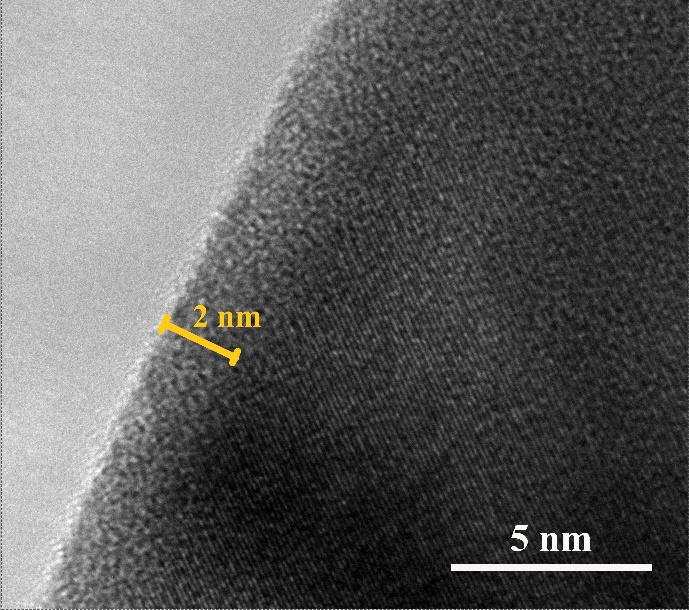
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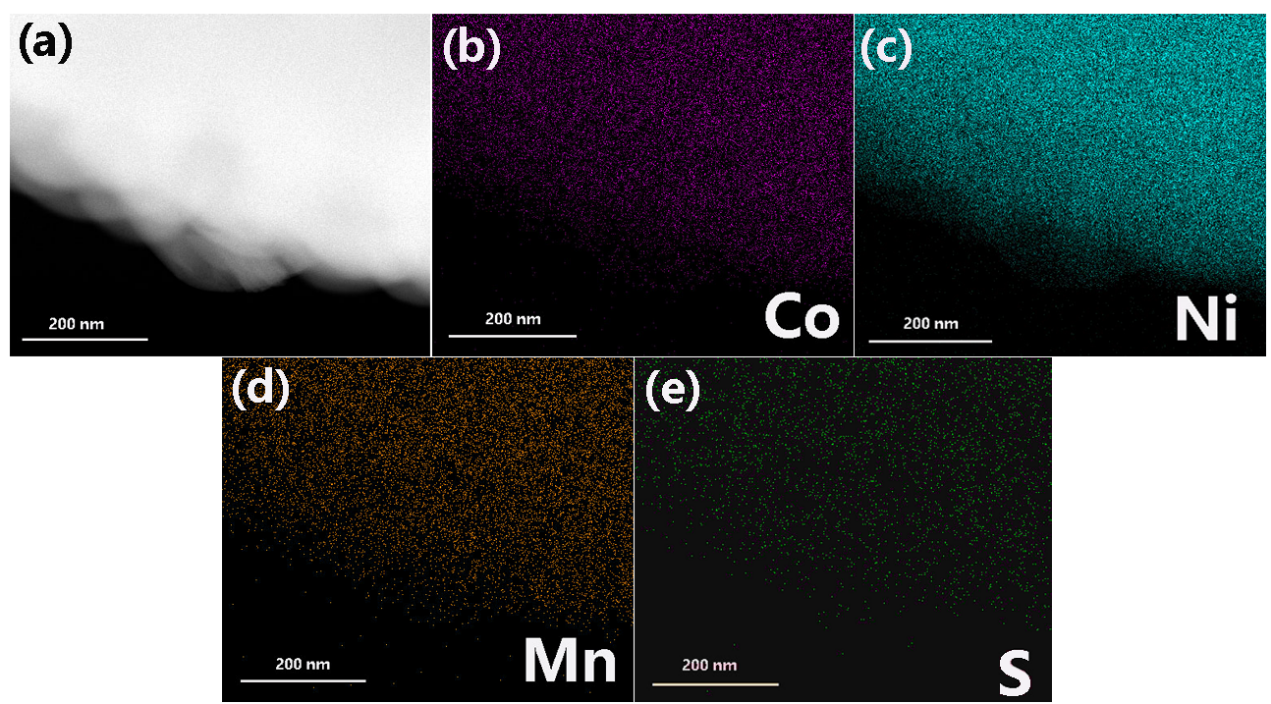
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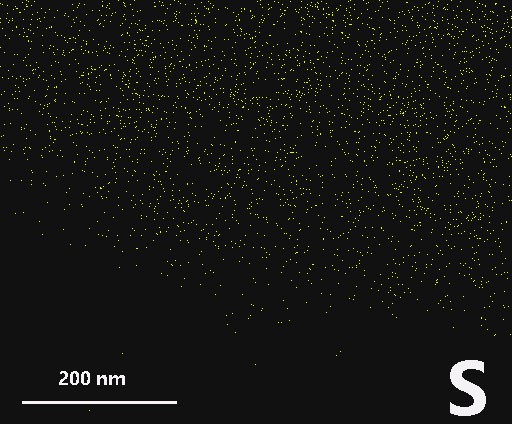
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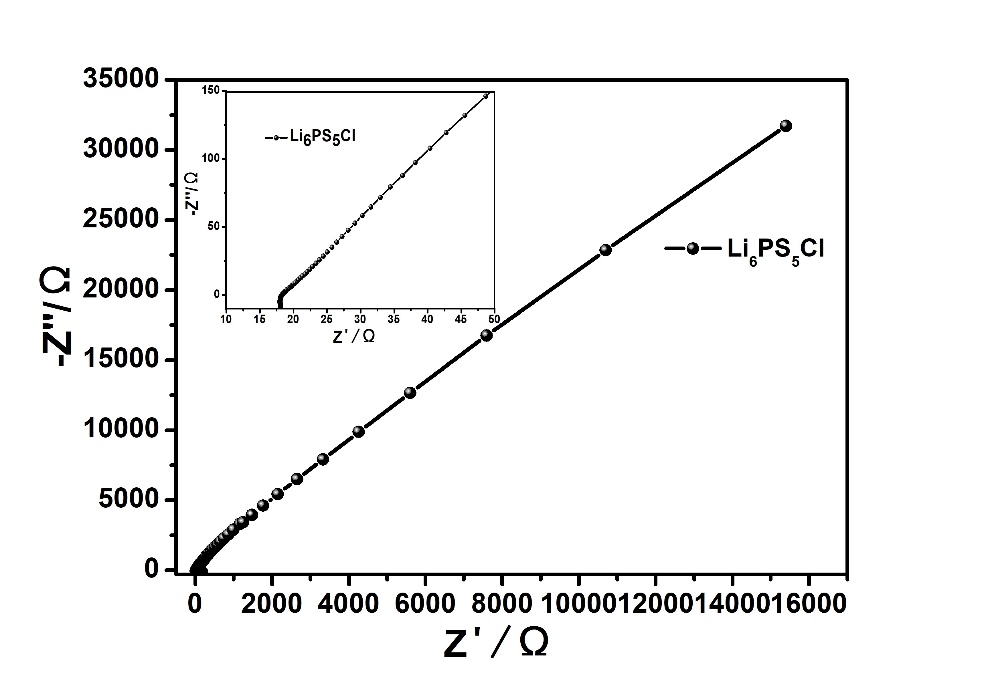
**Fig. S1.** TEM image of NCM88-S sample.



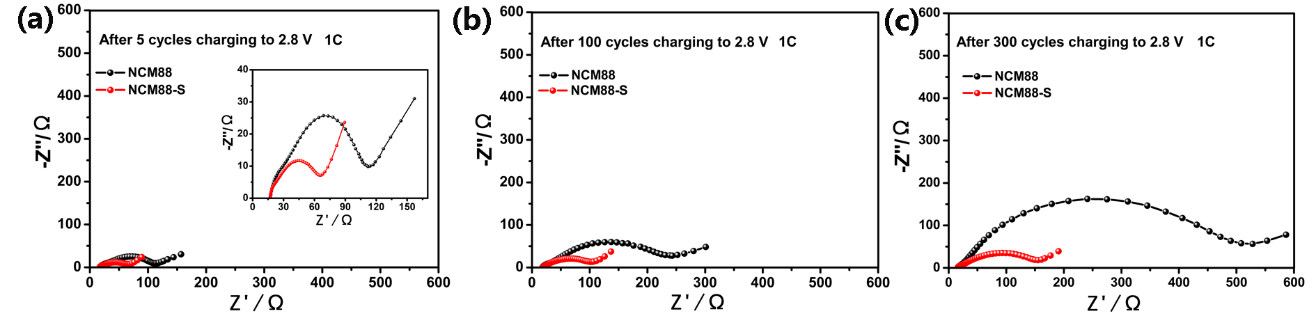
**Fig. S2.** TEM-EDX elemental mappings of NCM88-S powder corresponding to (b) Co, (c) Ni, (d) Mn, and (e) S.



**Fig. S3.** TEM-EDX of Sulfur in NCM88-S sample.



**Fig. S4.** Nyquist of plot of the Li6PS5Cl solid state electrolyte (80 mg) without attaching the battery electrodes.



**Fig. S5.** Nyquist plots of sulfide-based ASSLIBs using NCM88 cathode and NCM88-S cathode after (a) 5 cycles, (b)100 cycles, and (c)300 cycles.

**Table S1.** RSE, RSE/CAM, and RCell values of NCM88 and NCM88-S cathodes after 5 cycles, 100 cycles and 300 cycles.

|  |  |  |  |
| --- | --- | --- | --- |
|  | Cycle | NCM88（Ω） | NCM88-S（Ω） |
| RSE | 5 | 17.7 | 17.1 |
| 100 | 18.8 | 18.9 |
| 300 | 19.7 | 19.7 |
| RSE/CAM | 5 | 48.7 | 96.9 |
| 100 | 82.2 | 220.1 |
| 300 | 139.3 | 492.3 |
| RCell | 5 | 66.4 | 114 |
| 100 | 101 | 239 |
| 300 | 159 | 512 |

Fig. S4 shows the Nyquist plot of Li6PS5Cl solid electrolyte (80 mg) without attaching the battery electrodes. The Li6PS5Cl solid electrolyte showed a small RSE of 17 Ω. Therefore, in Fig. S5, the intersection point of the curve with the horizontal axis was ascribed to the solid electrolyte layer impedance RSE [1-2]. The semi-circle is regarded as an interfacial resistance (RSE/CAM), which reflects the interfacial impendence between cathode electrode and solid electrolyte. The impedance profiles of the whole cells consist of SE bulk resistance and interfacial SE/CAM resistance. Obviously, the interfacial resistance is the major component of cell resistance [3]. RSE, RSE/CAM, and RCell values of two cathodes after 5 cycles, 100 cycles and 300 cycles are summarized in Table S1.

[1] X.L. Li, M. Liang, J. Sheng, D.W. Song, H.Z. Zhang, X.X. Shi, L.Q. Zhang, Constructing double buffer layers to boost electrochemical performances of NCA cathode for ASSLB, Energy Stor. Mater. 18 (2019) 100-106.

[2] X.L. Li, Y.M. Sun, Z.Y. Wang, X.Q. Wang, H.Z. Zhang, D.W. Song, L.Q. Zhang, L.Y. Zhu, High-rate and long-life Ni-rich oxide cathode under high mass loading for sulfide-based all-solid-state lithium batteries. Electrochim. Acta 391 (2021) 138917.

[3] H. Visbal, [S. Fujiki](https://xueshu.baidu.com/s?wd=author%3A%28S%20Fujiki%29%20&tn=SE_baiduxueshu_c1gjeupa&ie=utf-8&sc_f_para=sc_hilight%3Dperson), [Y. Aihara](https://xueshu.baidu.com/s?wd=author%3A%28Y%20Aihara%29%20&tn=SE_baiduxueshu_c1gjeupa&ie=utf-8&sc_f_para=sc_hilight%3Dperson), [T. Watanabe](https://xueshu.baidu.com/s?wd=author%3A%28T%20Watanabe%29%20&tn=SE_baiduxueshu_c1gjeupa&ie=utf-8&sc_f_para=sc_hilight%3Dperson), Y.S. Park, S. Doo, The influence of the carbonate species on LiNi0.8Co0.15Al0.05O2 surfaces for all-solid-state lithium ion battery performance. J. Power Sources 269 (2014) 396-402.