Improving electrochemical performances of sulfide-based solid battery by understanding and designing interface of cathode/electrolyte

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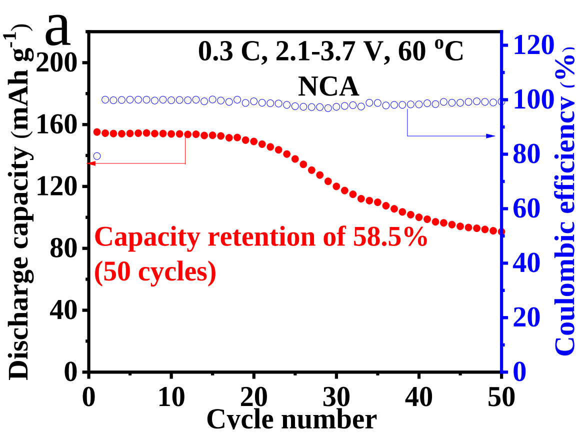
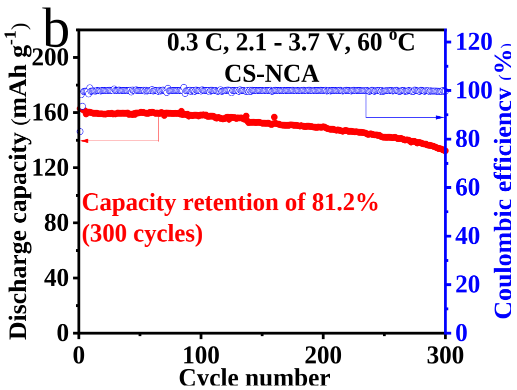
The interfacial instability between layered oxide cathode and sulfide electrolyte, especially for Ni-rich oxide cathode, is a serious issue for all-solid-state lithium batteries (ASSLB).[1] Coating with lithium ionic conductors such as $LiNbO_3$, Li_2SiO_3, $Li_4Ti_5O_{12}$ and $Li_2O{\cdot}ZrO_2$ on the oxide materials is an effective method to reduce the interfacial impedance between oxide cathode and sulfide electrolyte. The coating material composition, morphology as well as covering degree of coating materials on surface of active cathode materials should play a important role on electrochemical performances of batteries. However, these investigations are seldom done in detail. In this work, the effect of crystallization degree of $LiNbO_3$ by controlling different sintering temperatures on the interface between $LiCoO_2$ and sulfide electrolyte is investigated. Moreover, the introduction of core-shell structure into Ni-rich NCA/NCM cathode materials can significantly improve the interfacial stability and thus increase the electrochemical performances of ASSLB with sulfide electrolyte, as shown in Fig.1. Ultimately, $LiNbO_3$-coated core-shell NCA/NCM can remarkably enhance the electrochemical performances of ASSLB.[2] In fact, the interfacial resistance between cathode and electrolyte indeed reduces gradually by introduction of core-shell structure and subsequent $LiNbO_3$-coating. The results indicate that the novel double bufer layers strategy is a more effective approach to design high-performance oxide cathode material for ASSLB using sulfide electrolyte. In addition, mechanical damage during cycling, severe interfacial side reactions and physical contact failure of cathode and solid electrolyte (SE) are investigated comparatively using single crystal NCM811 with different particle size as well as its polycrytal.





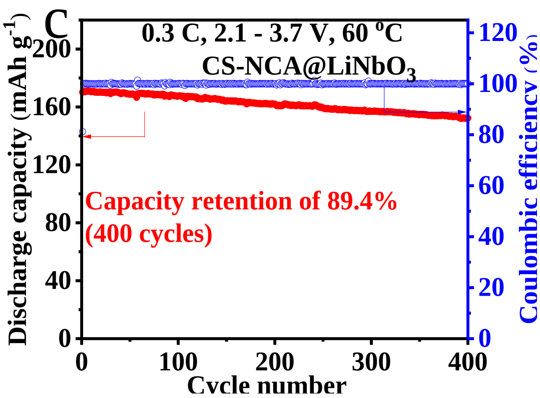
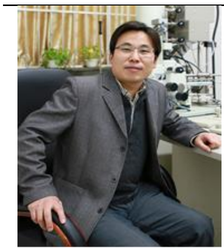


Figure 1. cycle performance curves of NCA, CS-NCA(core-shell structured NCA), and CS-NCA@$LiNbO_3$ ($LiNbO_3$ coated NCA woth core-shell structure) cathodes for ASSLB at 60 °C. 1 C=200 mA g-1.

References

[1] X. Li, L. Jin, D. Song, H. Zhang, X. Shi, Z. Wang, L. Zhang, L. Zhu, J. Energy Chem. 40 (2020) 39-45.

[2] X. Li, M. Liang, J. Sheng, D. Song, H. Zhang, X. Shi, L. Zhang, Energy Storage Mater. 18 (2019) 100-106.



Prof. Lianqi Zhang was born in 1973. He received his Ph.d from Saga university in 2003 in Japan. After graduation he moved to national institute for materials science and work as a postdoctor with Prof. Takada in Tsukuba from April of 2003 to March of 2007. And then he continued his research still as a postdoctor in Tokyo institute of technology for one year. In 2008, he joined in Tianjin institute of power sources as a senior engineer. In the end of 2010, he became professor in Tianjin university of technology. His research topics are forcused on inversitigations on cathode materials for Li-ion battery, all solid state lithium battery as well as recycling spent Li-ion battery.

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