Improved Electrochemical Performance of LaF₃-coated Layered Oxide Li_{1.2}Mn_{0.54}Ni_{0.13}Co_{0.13}O₂ Cathode Material for Lithium-Ion Batteries Prepared by Sol-Gel Method

Le Wen, Zhijian Chang, Shuning Zhao, Jinli Liu, Zihao Zheng, Fengli Bei*

China National Quality Supervision and Inspection Center for Industrial Explosive Materials, Nanjing University of Science and Technology, Nanjing, 210094, P.R. China.

*E-mail: beifl@njust.edu.cn

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In this article, the original Li_{1.2}Mn_{0.54}Ni_{0.13}Co_{0.13}O₂ lithium-rich manganese-based cathode material with a uniform distribution of polygonal prisms was synthesized by a simple and reproducible sol-gel method, followed by a simple chemical deposition method. The structure and electrochemical performance of the original and modified cathode materials were characterized by XRD, XPS, EDS, SEM, TEM, and constant current charge/discharge tests. The results showed that LaF₃ was uniformly coated on the surface of the original material and the thickness of the 2 wt% coating layer was about 2-3 nm. With this coating amount, the cathode material could obtain the best cycling and rate performance. The first coulomb efficiency of the modified material was 73%, which was 7% higher than that of the original material. Secondly, the cycling performance was improved. When the coated material was cycled at 0.2 C for 50 cycles, the discharge capacity was 325mAh·g⁻¹, and the capacity retention rate was 99.21%, while the original material was only 78.73%. Finally, the performance was also improved at high current density. The coated material could still reach 170mAh·g⁻¹ at 5C, which was 70% higher than the original material. The significant improvement in electrochemical performance was attributed to the fact that the LaF₃ coating layer made the material avoid direct contact with the electrolyte which could reduce the occurrence of side reactions and increase the stability of the material. Besides, expanded layer space resulted from lattice expansion after coating could broaden the transmission channel of lithium ions and facilitate the insertion-extraction of lithium ions during charge and discharge.

Keywords: Li-ion battery Li_{1.2}Mn_{0.54}Ni_{0.13}Co_{0.13}O₂ Layered oxide Lanthanum fluoride Surface coating

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