Construction Molybdate Conversion Coating for Aluminum Current Collector in Commercial Lithium-Ion Battery

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Abstract To ensure reliable deployment of stable high-voltage lithium-ion battery (LIBs), it is imperative to investigate the corrosion mechanism of the Aluminum (Al) current collector and implement corresponding protective measures. This research on Al corrosion in commercial $LiPF_6$-ester electrolyte (LB-092) indicates that the stability of the passivation layer (AlF_3/Al_2O_3) is significantly affected by the operating voltage. The corrosion resistance, R_{pit}, displays a nonlinear distribution with a peak at 4 V, and pitting occurs beyond 4 V. The heterogeneous and wrinkled AlF_3 layer triggers localized breakdown. The established model of pitting initiation and expansion is supported by morphological evolution, quantitative component analysis, and electrochemical test results. Based on the established pitting corrosion model, a molybdate conversion coating (MCC) is further constructed on the Al surface through chemical conversion to inhibit the corrosion of the Al current collector in LB-092 electrolyte. The obtained MCC exhibits compact structure and good combination with Al matrix. Electrochemical tests show that MCC reduces the corrosion current density by an order of magnitude. Furthermore, in Li||NMC333 cells, the capacity retention of the cell with MCC-Al cathode is 75.6 % at 4.5 V high voltage, while that of control cell is only 7.2 %. The protective mechanism can be attributed to the Mo(VI) in the outer layer of the MCC being continuously reduced to Mo(IV) during battery operation, thereby resisting the erosion by HF and inhibiting the depth expansion of pitting.

Keywords Aluminum current collector, Pitting corrosion, Passivation layer, Electrochemical stability, Molybdate conversion coating, Lithium-ion battery,

Reference

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