

Stabilized Lithium-Rich Layered Cathode Materials for High-Rate Lithium-Ion Batteries

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The lithium-rich layered compounds based on Ni, Co, and Mn are the promising cathode materials for lithium-ion batteries due to the high discharge capacity. However, the structural and chemical rearrangements from the enrichment of transition metal atoms at the surface of the particles during the synthesis and the electrochemical cycling hinder the lithium ion transportation to the bulk structure, which results in the capacity and voltage fades as well as poor rate capabilities. In this work, we develop the lithium- and manganese-rich transition metal oxide particles with a nanoscale zirconium-rich surface layer via a one-pot synthesis. The new surface phase is formed based on well-developed crystallographic facets by introducing the potassium nitrate in the precursor solutions. The atomic-scale observation by STEM–HAADF and EDS mapping analyses reveal that the zirconium atoms are mostly distributed on Li⁺-diffusive (20–2) planes with a cation-disordered rock-salt-like phase, which are epitaxially grown on the layered bulk structure. This zirconium-segregated surface phase is believed to suppress the undesirable segregation of 3d metal atoms at surface and simultaneously facilitate facile lithium-ion diffusion to the bulk region, which are even durable upon electrochemical cycling. As a result, the electrochemical performance of the electrodes are superior in the high-rate performance and long-term cycling stability over hundreds of cycles.