

## Lithium-Substituted Tunnel/Spinel Heterostructured Materials as the Novel Cathode for Sodium Ion Batteries

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The tunnel-type  $\text{Na}_{0.44}\text{MnO}_2$  as promising cathode materials for sodium-ion batteries (SIBs) have attracted interest owing to its abundant resources and potential low cost. However, manganese disproportionation associated with  $\text{Mn}^{3+}$  is hindering their practical application, resulting in rapid capacity decay and poor rate capability. Herein, a Li-substituted, tunnel/spinel heterostructured cathode is successfully synthesized to overcome these limitations. The multiphase transformation was prohibited by the Li dopant, which improves the structural reversibility. Meanwhile, the tunnel/spinel heterostructure provides 3D  $\text{Na}^+$  diffusion channels to effectively enhance the redox reaction kinetics. The optimized  $[\text{Na}_{0.396}\text{Li}_{0.044}][\text{Mn}_{0.97}\text{Li}_{0.03}]\text{O}_2$  composite delivers an excellent rate performance and cycle performance, demonstrating the potential of the cathode for practical applications. This strategy could be milestone for further sodium-deficient cathode materials.