Layered Oxide Cathodes with Ambient Processing for Potassium-Ion Batteries

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Potassium-ion batteries are attracting increasing interest as sustainable alternatives to lithium-ion systems owing to the abundance of potassium, low material cost, high liquid-electrolyte ionic conductivity, and compatibility with graphite-based anodes. Layered manganese oxides are particularly promising group of cathode materials because they combine low-cost transition metals with high operating voltage and scalable synthesis. However, most reported K-layered oxide cathodes are processed under dry-room or glovebox conditions, limiting their practical manufacturability. Here, we investigate ambient-processed K0.5MnO2 cathodes for potassium-ion batteries and evaluate how air exposure, electrolyte formulation, and cell design affect their structural stability and electrochemical performance.

K0.5MnO2 was synthesized by a solid-state route and deliberately processed under ambient conditions. Structural and surface changes induced by air exposure were examined using X-ray diffraction, X-ray photoelectron spectroscopy, and Raman spectroscopy, revealing the sensitivity of the layered oxide framework and surface chemistry to moisture and atmospheric species. The electrochemical behavior was then studied in potassium half-cells using KTFSI-based electrolytes with different solvent systems, including TEGDME and EC/DEC, to identify electrolyte environments that improve reversibility and cycling stability. Rate capability, capacity retention, and long-term cycling were further assessed to determine strategies for increasing the reversible capacity of ambient-processed cathodes. Finally, the optimized cathode/electrolyte combination was evaluated in full-cell configurations to examine its practical relevance beyond half-cell testing.