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P2 manganese rich sodium layered oxides: Rational stoichiometries for enhanced performance

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Highlights

- Facile and scalable synthesis of manganese rich layered oxides.
- Jahn-Teller effect correlates strongly with electrochemical performance.
- Superior performing Na cathode materials at different C-rates.

Abstract

Sodium layered oxide materials have shown excellent performance as cathodes in sodium ion batteries, due to their flexibility, versatility, and intrinsically fast Na ion structural diffusion which leads to enhanced rate capability. In this work, we have examined two strategies to mitigate Jahn-Teller distortion and boost the performance of these systems: substituting with electrochemically active (e.g. Fe) and doping with electrochemically inactive materials (e.g. Zn). Here, Mn-rich P2- phase $Na_{2/3}Mn_{0.8}M_{0.1}M'_{0.1}O_2$ (M, M' = Fe^{3+}, Al^{3+}, Zn^{2+}, Cu^{2+}, Ti^{4+}) materials are synthesized from earth abundant precursors, via solid state-reaction, and characterized by X-ray diffraction, scanning electron microscopy and solid state NMR. The materials demonstrated a superior combination of capacity retention (74–94%) and specific charge at C/10 (~130–159 mAh g^{-1}) and 1C (~87–101 mAh g^{-1}) in the studied voltage window (2–4 V vs. Na^+/Na). Thus, this work represents not only a new family of high-performance materials, but also validation for the rational design approaches used herein.

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