Efficient metthod of designing stable layered cathode material for sodium ion batteries using Aluminium doping

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Sodium-ion batteries (SIBs) receive significant attention for electrochemical energy storage and conversion owing to their wide availability and the low cost of Na resources[1, 2.] Among available cathode materials, layered oxides are mostly studied due to their high specific capacities. These layered oxides are classified into two main groups, differing by the alkali-ion intercalation site, i.e., O-type layered materials that host the ions in octahedral sites and P-type materials that accommodate the alkali ions in prismatic sites[3-5]. In particular, sodium ions can lead to further distinct structures, i.e., O3, P2 and P3, where the number indicates the number of transition metal layers in the repeating cell unit[3]. Despite their high specific capacity, sodium layered oxides suffer from severe capacity fading when cycled at higher voltages. This key issue must be addressed in order to develop high-performance cathodes for sodium ion batteries (SIBs). Herein, we present a comprehensive study on the influence of Al doping of Mn sites on the structural and electrochemical properties of a P2-$Na_{0.5}Mn_{0.5-x}Al_xCo_{0.5}O_2$ (x = 0, 0.02, or 0.05) cathode for SIBs. Detailed structural, morphological, and electrochemical investigations were carried out using X-ray diffraction, cyclic voltammetry, and galvanostatic charge-discharge measurements and some new insights are proposed. Rietveld refinement confirmed that Al doping caused TMO_6-octahedra (TM= Transition metal) shrinkage, resulting in wider interlayer spacing. The optimized cathode exhibited remarkable electrochemical performance, with better stability and improved rate performance.

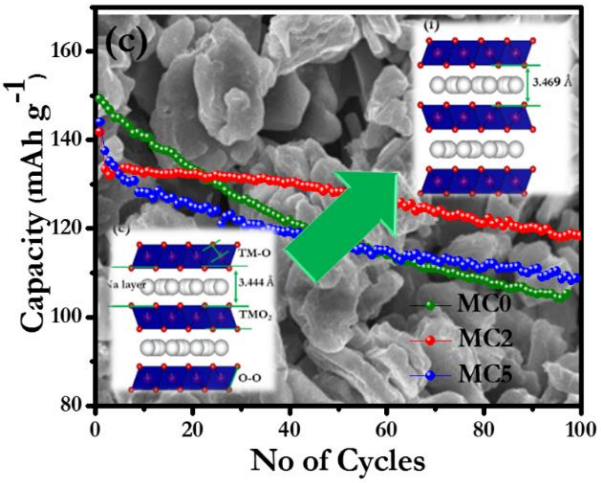

Fig. 1 Cyclic stability of pristine and Aluminium doped samples.

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