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A Novel Environmentally Benign Positive Electrode Material with Improved Energy Density for Lithium Ion Batteries

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Abstract : The increasing requirements for high power and energy lithium ion batteries have led to the development of several classes of positive electrode materials. Among those one promising material is LiNixMnyCo1−x−yO2 due to its high reversible capacity and remarkable cycling performance. Further structural stabilization and improved electrochemical performance of this class of cathode materials can be achieved by cationic substitution to a transition metal such as Al, Mg, Cr, etc. The current study discusses a novel NMC type material obtained by simultaneous cationic substitution of the cobalt which is a toxic element, with aluminum and iron. A compound with the composition LiNi0.6Mn0.2Co0.15Al0.025Fe0.025O2 (NMCAF) was synthesized by the self-combustion method using sucrose as fuel. The material has a layered α-NaFeO2 type structure with a good hexagonal ordering. Rietveld refinement analysis of the XRD patterns revealed a very low cationic mixing compared to the non-substituted material LiNi0.6Mn0,2Co0.2O2 suggesting a structural stabilization. Galvanostatic cycling measurements indicate improved electrochemical performance after the metal substitution. An initial discharge capacity of about 190 mAh.g−1 at slow rate (C/20), and a good cycling stability even at moderately faster rates (C/5 and C) have been observed. The long term cycling displayed a capacity retention of about 90% after 10 cycles.

Keywords : cationic substitution, lithium ion batteries, positive electrode material, self-combustion synthesis method
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