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Improving the Cycling Performance and Thermal Stability of $LiNi_{0.6}Co_{0.2}Mn_{0.2}O_2$ Cathode Materials by Nb-doping and Surface Modification

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Niobium (Nb)-doped, Li_3NbO_4 surface-modified $LiNi_{0.6}Co_{0.2}Mn_{0.2}O_2$ (NCM622) cathodes were prepared using solid-phase reactions. These modifications helped in improving the thermal stability and cycling performance of the cathodes. XRD and EDX measurements of the prepared samples confirmed the uniform distribution of Nb, whereas Li_3NbO_4 was found to occur at the grain boundaries and on the surface of primary NCM622 particles. The thermal stability of the prepared samples was evaluated by measuring the amount of O_2 released from the cathode material during overcharging. This quantification was conducted using a gas chromatography–mass spectroscopy analysis. Decomposition of the NCM622 cathode material was suppressed by Nb-doping. Furthermore, electrochemical tests showed that the Nb-doped, Li_3NbO_4 surface-modified NCM622 exhibited an excellent cycling performance over 500 cycles in the 3.0–4.1 V voltage range at a current rate of 2 C at 60 °C, during which the sample retained 91.4% of its initial capacity. This capacity retention was much higher than that for both the samples prepared using only Nb doping without Li_3NbO_4 surface modification (36.8%) and that of undoped NCM622 (70.7%). Our results indicate that Nb doping and Li_3NbO_4 surface modification are effective for improving the cathode's thermal stability and cycling performance, respectively.

Keywords: Lithium-ion battery, NCM622 cathode material, Nb-doping and Li_3NbO_4 surface modification, cycling performance, thermal stability

FULL TEXT