Synthesis and Characterization of $\text{LiNi}_{1/3}\text{Co}_{1/3}\text{Mn}_{1/3}\text{O}_2$ as Cathode Materials for Li-Ion Batteries via an Efficacious Sol-Gel Method

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A series of $\text{LiNi}_{1/3}\text{Co}_{1/3}\text{Mn}_{1/3}\text{O}_2$ powders have been successfully prepared as cathode materials for lithium-ion batteries by a citric acid-assisted sol-gel method. The crystal structures and microstructures of as-prepared cathode materials were characterized by X-ray diffraction and scanning electron microscopy. Charge/discharge cycling and cyclic voltammetry were also employed to investigate their electrochemical behaviors. X-ray diffraction results show that calcinations temperature and time have the important effects on the crystal structure of $\text{LiNi}_{1/3}\text{Co}_{1/3}\text{Mn}_{1/3}\text{O}_2$ powders. Among all the $\text{LiNi}_{1/3}\text{Co}_{1/3}\text{Mn}_{1/3}\text{O}_2$ powders, the $\text{LiNi}_{1/3}\text{Co}_{1/3}\text{Mn}_{1/3}\text{O}_2$ powder calcined at 850 °C for 16 h demonstrates a phase-pure hexagonal lattice with the best ordered layered structure. Scanning electron microscopy with element mapping tests reveal that the homogeneous $\text{LiNi}_{1/3}\text{Co}_{1/3}\text{Mn}_{1/3}\text{O}_2$ solid solution has been achieved via this synthesis method. The $\text{LiNi}_{1/3}\text{Co}_{1/3}\text{Mn}_{1/3}\text{O}_2$ powder heated at 850 °C for 16 h can deliver a high initial discharge capacity of 199.9 mAh g⁻¹ and still retain the discharge capacity of 143.6 mAh g⁻¹ after 80 cycles at the current rate of 20 mA g⁻¹ in the voltage range of 2.5–4.6 V. Cyclic voltammetry results confirm that as-obtained $\text{LiNi}_{1/3}\text{Co}_{1/3}\text{Mn}_{1/3}\text{O}_2$ powder at 850 °C for 16 h displays the decreased electrode polarization and stable crystal structure upon cycling.

Keywords: $\text{LiNi}_{1/3}\text{Co}_{1/3}\text{Mn}_{1/3}\text{O}_2$; Cathode materials; Sol-gel synthesis; Characterization; Lithium-ion batteries; Electrochemical performances

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