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

Xiaoyu Cao$^{1,*,}$, Yang Zhao$^1$, Limin Zhu$^1$, Lingling Xie$^1$, Xiaoli Cao$^2$, Shaoyi Xiong$^3$, Chiwei Wang$^{4,*}$

$^1$ School of Chemistry and Chemical Engineering, Henan University of Technology, Zhengzhou 450001, People’s Republic of China
$^2$ School of Electronics and Information Engineering, Sias International University, Zhengzhou 451150, People’s Republic of China
$^3$ Zhenghou Ruineng Electric Co. Ltd., Zhengzhou 450001, People’s Republic of China
$^4$ Tianjin EV Energies Co. Ltd., Tianjin 300380, People’s Republic of China

$^{*}$E-mail: caoxy@haut.edu.cn; wangchiwei@ejianlong.com

doi: 10.20964/2016.06.93

Received: 2 April 2016 / Accepted: 29 April 2016 / Published: 4 May 2016

A series of LiNi$_{1/3}$Co$_{1/3}$Mn$_{1/3}$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 LiNi$_{1/3}$Co$_{1/3}$Mn$_{1/3}$O$_2$ powders. Among all the LiNi$_{1/3}$Co$_{1/3}$Mn$_{1/3}$O$_2$ powders, the LiNi$_{1/3}$Co$_{1/3}$Mn$_{1/3}$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 LiNi$_{1/3}$Co$_{1/3}$Mn$_{1/3}$O$_2$ solid solution has been achieved via this synthesis method. The LiNi$_{1/3}$Co$_{1/3}$Mn$_{1/3}$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 LiNi$_{1/3}$Co$_{1/3}$Mn$_{1/3}$O$_2$ powder at 850°C for 16 h displays the decreased electrode polarization and stable crystal structure upon cycling.

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

FULL TEXT