Effect of Cerium Substitution on Structural and Electrochemical Performance of $\text{Li}[\text{Li}_{0.2}\text{Mn}_{0.54}\text{Co}_{0.13}\text{Ni}_{0.13}]\text{O}_2$ Cathode Material for Lithium-Ion Battery

Zhaojun Tian, Yi Lu*

Hunan University of Science and Technology, School of Resource, Environment and Safety Engineering, Xiangtan, Hunan 411201

*E-mail: luyi-hnust@foxmail.com

doi: 10.20964/2020.03.68

Received: 14 November 2019 / Accepted: 2 January 2020 / Published: 10 February 2020

To enhance the cyclic stability and high rate performance of the advanced Lithium-rich and manganese-based layered structure cathode materials, the $\text{Li}_{1.20}[\text{Mn}_{0.54-x}\text{Ni}_{0.13}\text{Co}_{0.13}\text{Ce}_x]\text{O}_2$ ($x = 0, 0.01, 0.02, 0.03$) were synthesized by partially substituting Mn^{4+} with different amounts of Ce^{3+} via the traditional co-precipitation method. The effect of Ce^{3+} doping on the crystal structure, particles morphology and electrochemical properties of the $\text{Li}_{1.20}[\text{Mn}_{0.54}\text{Co}_{0.13}\text{Ni}_{0.13}]\text{O}_2$ was studied by X-ray diffraction (XRD), scanning electron microscope (SEM), galvanostatic charge-discharge tests and electrochemical impedance spectroscopy (EIS) measurement. The XRD, SEM and EDS results demonstrated that the cathodes after Ce^{3+} doping delivered the larger crystal lattice parameters, the lower cation mixing between Ni^{2+} and Li^+ and the smaller size of cathode particles. Therefore, the superior rate capacity and cyclic performance were obtained for the Ce^{3+} doped cathodes. Particularly, the $\text{Li}_{1.20}[\text{Mn}_{0.52}\text{Ni}_{0.13}\text{Co}_{0.13}\text{Ce}_{0.02}]\text{O}_2$ demonstrated the optimal electrochemical properties, which delivered a high discharge capacity of 136.7 mAhg^{-1} at 5C high rate and a high capacity retention of 91.2% at 2C rate after 100 cycles. While the pristine cathode only exhibited a discharge capacity of 92.8 mAhg^{-1} at 5C rate, 43.9 mAhg^{-1} smaller than that of the $\text{Li}_{1.20}[\text{Mn}_{0.52}\text{Ni}_{0.13}\text{Co}_{0.13}\text{Ce}_{0.02}]\text{O}_2$. In addition, it retained a discharge capacity of 112.3 mAhg^{-1} with a capacity retention of only 81.5% after 100 cycles at 2C rate. The larger capacity retention and superior rate performance of Ce^{3+} doped cathodes could be ascribed to the fast Li^+ diffusing speed, the high cation ordering and lower charge transfer resistance during cycling.

Keywords: $\text{Li}_{1.20}[\text{Mn}_{0.54}\text{Co}_{0.13}\text{Ni}_{0.13}]\text{O}_2$; Rare earth; Cerium doping; High rate capacity; Long-life cycle performance

[FULL TEXT](#)

© 2020 The Authors. Published by ESG (www.electrochemsci.org). This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution license (<http://creativecommons.org/licenses/by/4.0/>).