Facile Synthesis of Ni-doped Nano-LiMn₂O₄ (0 ≤ x ≤ 0.10) Cathode Materials and Their Electrochemical Performances

Yue Yu^{1,2,3}, Shimin Wang^{1,2,3}, Junming Guo^{1,2,3,*}, Changwei Su^{1,2,3,*}, Xiaofang Liu^{1,2,3}, Wei Bai^{1,2,3}, Hongli Bai^{1,2,3}, Rui Wang^{1,2,3}

¹ Key Laboratory of Comprehensive Utilization of Mineral Resources in Ethnic Regions, Yunnan Minzu University, Kunming 650500, China

² Key Laboratory of Resource Clean Conversion in Ethnic Regions, Education Department of Yunnan, Yunnan Minzu University, Kunming 650500, China

³ Joint Research Centre for International Cross-border Ethnic Regions Biomass Clean Utilization in Yunnan, Yunnan Minzu University, Kunming 650500, China

*E-mail: guojunming@tsinghua.org.cn, ying_xinsheng@163.com

doi: 10.20964/2018.10.15

Received: 4 June 2018 / Accepted: 20 July 2018 / Published: 1 September 2018

A series of Ni-doped nano-LiNi_xMn_{2-x}O₄ (0 ≤ x ≤ 0.10) cathode materials were rapidly synthesized by a one-step solution combustion method. The as-obtained materials were characterized by X-ray diffraction (XRD), scanning electron microscopy (SEM), transmission electron microscopy (TEM), X-ray photoelectron spectroscopy (XPS), etc. All the LiNi_xMn_{2-x}O₄ samples corresponds to spinel structure with particle size of 50-80 nm. The optimized LiNi_{0.08}Mn_{1.92}O₄ sample not only delivers excellent discharge capacity and improved cycling stability, but also possesses a large Li⁺ diffusion coefficient ($D_{Li^+} = 1.491 \times 10^{-11} \text{ cm}^2 \cdot \text{s}^{-1}$) and a small activation energy ($E_a = 23.81 \text{ kJ} \cdot \text{mol}^{-1}$). The cyclic voltammogram (CV) and electrochemical impedance spectroscopy (EIS) tests indicate that the optimized LiNi_{0.08}Mn_{1.92}O₄ has a good reversibility and a favorable kinetics in electrochemical reaction, whilst showing a greatly reduced charge transfer resistance. It is clearly illustrated that the Ni-doping can boost Li⁺ diffusion, eliminate the disadvantageous Jahn-Teller effects and enhance the lithium ion kinetic process in the LiMn₂O₄.

Keywords: solution combustion method; nano-LiMn₂O₄; Ni-doped; Li⁺ diffusion coefficient; activation energy; Jahn-Teller effects

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