Electrochemical Properties of $LiM_xFe_{1-x}PO_4$ Cathode Materials By Solid-state Reaction

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Abstract: Recently, lithium transition metal phosphates with an ordered olivine-type structure, $LiMPO_4$ (M=Fe, Mn, Ni, and Co), have attracted extensive attention due to a high theoretical specific capacity (170 mAh/g). The $LiFePO_4$ is the most attractive because of its high stability, low cost, high compatibility with environment. However, it is difficult to attain its full capacity because its electronic conductivity is very low, and diffusion of Li-ion in the olivine structure is slow and the supervalue cation doping was used. In this research, we are used the supervalue cation doping methode such as Cu, Ti, and Mg were partially replace the Fe. The cycling performance resulted of the used $LiM_xFe_{1-x}PO_4$ cathode materials for lithium batteries exhibit excellent high capacity than $LiFePO_4$/Li cells.

Key Words: $LiM_xFe_{1-x}PO_4$; supervalue cation; solid-state reaction

1. Introduction

Recently $LiFePO_4$ have been intensively studied as lithium insertion cathode materials for the next generation of lithium secondary batteries. It's also shows several advantages compared with conventional cathode materials such as $LiCoO_2$, $LiNiO_2$ and $LiMnO_2$, namely it is lower in toxicity and relatively inexpensive. In addition, $LiFePO_4$ has an interesting theoretical specific capacity of about 170 mAh/g, a good cycle stability and a technically attractive flat voltage versus current. But, $LiFePO_4$ slow speed of electronic conductivity and low lithium ion diffusion rate limit its application in industry. So we have chosen method of doping homogeneous cation in $LiFePO_4$ in order to effectively solve this problem. In fact, this method indeed improved its electrochemical properties.

2. Results and discussion

Elemental analysis results gave the basic characterization of the synthesized materials. The crystalline phases of $LiFePO_4$ were identified with X-ray diffraction and the XRD patterns of $LiM_xFe_{1-x}PO_4$ were analyzed. The pattern can be indexed to a single-phase material having an orthorhombic olivine-type structure. As shown the results the initial discharge capacity of $LiFePO_4$/Li is 129 mAh g^{-1}, the discharge capacity decreases to 6 mAh g^{-1} after 30 cycles; However, the initial discharge capacity of $LiTi_{0.05}Fe_{0.95}PO_4$/Li cell is 139 mAh g^{-1}, the discharge capacity is 137 mAh g^{-1} after 30 cycles. It is obvious that the discharge property of $LiTi_{0.05}Fe_{0.95}PO_4$/Li battery is better than that of $LiFePO_4$/Li battery.

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