Effect of Foreign Metal Ions Doping on The Structural and Electrochemical Properties of $LiNi_{0.5}Mn_{0.5}O_2$

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$LiNi_{0.5}Mn_{0.5}O_2$ is of great interest as a cathode material for lithium rechargeable batteries due to its good battery performance [1]. However, it has some drawbacks such as the difficulty in preparation and poor rate capability [2, 3]. Although foreign metal ions doping is a well-published method to improve the structural and electrochemical properties of cathode materials, the influence of foreign metal ions doping on the structural and electrochemical characters of $LiNi_{0.5}Mn_{0.5}O_2$ is not very clear [4,5]. In this work, $LiNi_{0.5}Mn_{0.5-x}Ti_xO_2$ and $LiNi_{0.5-x}Mn_{0.5-x}Co_{2x}O_2$ were prepared and their structural and electrochemical properties were characterized.

Compounds were prepared by spray dry method. The charge/discharge tests were carried out using the CR2032 coin-type cell using lithium metal as anode. The cathode contains a mixture of 20 mg of accurately weighted active materials and 13 mg of the teflonized acetylene black (TAB-2) as conducting binder. The electrolyte is 1 M $LiPF_6$ in ethylene carbonate / dimethyl carbonate (EC/ DMC, 1:2 by volume).

Fig.1 shows the XRD patterns of $LiNi_{0.5}Mn_{0.5-x}Ti_xO_2$ ($0 \le x \le 0.5$).Ti doping reduces the formation of the impurity (NiO) and promotes the formation of Li-Ni-Mn-Ti-O system. High Ti content ($x > 0.3$) makes the cation mixing severe and results in a phase transition from layered to rock-salt structure. An appropriate amount of Ti doping ($0.05<x<0.2$) in $LiNi_{0.5}Mn_{0.5-x}Ti_xO_2$ can slightly increase the capacity.

Cobalt doping into $LiNi_{0.5}Mn_{0.5}O_2$ is helpful to the formation of the layered structure and alleviated the degree of the cation mixing. The cobalt doping in $LiNi_{0.5}Mn_{0.5}O_2$ can not only reduce the cell polarization, but also increase the reversible capacity. Moreover, cobalt doping also improves the rate capability of $LiNi_{0.5}Mn_{0.5}O_2$. Fig.2 shows the cyclic performance of $LiNi_{0.425}Mn_{0.425}Co_{0.15}O_2$ operated at different conditions.

In general, the structural and electrochemical properties of $LiNi_{0.5}Mn_{0.5}O_2$ are prone to be affected by foreign metal ions doping. Co substitution in $LiNi_{0.5}Mn_{0.5}O_2$ can greatly upgrade the battery performance of $LiNi_{0.5}Mn_{0.5}O_2$.

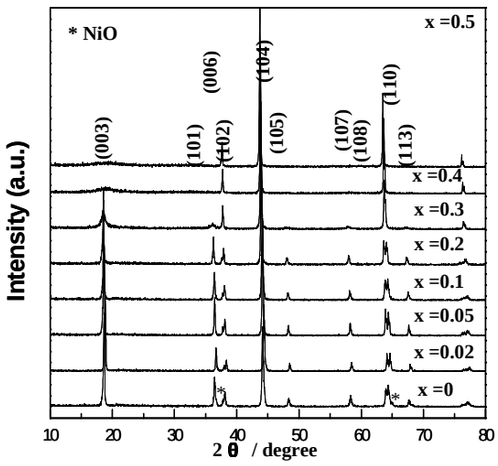

Fig.1. XRD patterns of $LiNi_{0.5}Mn_{0.5-x}Ti_xO_2$ ($0 \le x \le 0.5$)

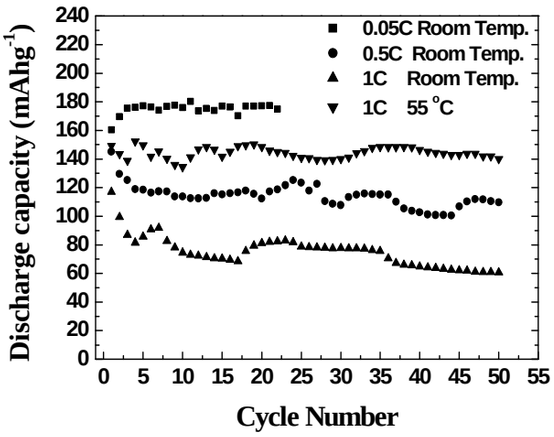

Fig. 2. Cyclic performance of $LiNi_{0.425}Mn_{0.425}Co_{0.15}O_2$ operated at different conditions.

References

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