Synthesis and Characterization of New Iron-Containing Materials for 5V Lithium Batteries

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As known from the literature, lithium-manganese spinels doped with transition metals like Cr, Fe, Co, Ni and Cu using in Li batteries may provide exceptionally high working potentials in the range of 4.5 – 5.1 V [1, 2, 3]. Therefore, these systems may be regarded as good candidates for high-energy lithium accumulators. Among them iron-containing materials are the must cheaper and less toxic ones compared with conventional $LiCoO_2$ or undoped lithium-manganese spinels. However, the data available concerning Fe-doped $LiMn_2O_4$ materials are contradictory: the synthesis conditions are not optimized, the charge-discharge characteristics are not investigated as a function of the morphology, chemical and phase composition, etc.

In this work iron-containing materials based on mixed lithium-manganese spinels $LiFe_xMn_{2-x}O_4$ have been synthesized using a mechanochemical technique from various starting reagents. It was found that composition $LiFe_{0.5}Mn_{1.5}O_4$ with the crystal structure of the spinel-type is easy formed after the mechanical treatment of Li_2CO_3, Fe_2O_3, MnO_2 followed by heat treatment at 500^{o}C. The attempts to prepare solid solutions $LiFe_xMn_{2-x}O_4$ with $x > 0.5$ have been undertaken. It turned that the heating of the initial mixtures at higher 600^{o}C results in formation of two-phase composites consisting of the spinel phases $LiFe_xMn_{2-x}O_4$ ($0<x<0.5$) and $Li_{0.5}Fe_{2.5}O_4$. If the heat treatment is carried out at lower temperatures, then the formation of $Li_{0.5}Fe_{2.5}O_4$ spinel may be avoided. However, the time of synthesis drastically increases.

Preliminary test of the obtained iron-containing materials shows that their electrochemical characteristics are similar to those reported earlier [1,2]. Further investigations of lithium intercalation-deintercalation processes, X-ray diffraction and Moessbauer spectroscopy studies of synthesized systems are under progress.

References

[1]. T.Ohzuku, K.Ariyoshi, S.Takeda, Y.Sakai, Electrochimica Acta 46 (2001) 2327-2336.
[2]. F. Bonino, S. Panero, B. Scrosati J. Power Sources 97-98 (2001) 389-392.
[3]. A.R.West, H.Kawai, H.Kageyama, M.Tabuchi, M.Nagata, H.Tukamoto, J. Mater. Chem. 11 (2001) 1662-1670.