The Effect of Microwave Treatment on the Mn^{3+} Concentration of Spinel Cathode Material Studied by XPS, XRD and Electrochemical methods

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The performance of $LiMn_{1.5}Ni_{0.5}O_4$ as a lithium ion battery cathode material is intricately linked to (i) the presence of Mn^{3+} ions, (ii) degree of disorder and (iii) impurity phases. It is common knowledge that the Mn^{3+} ion is electrochemically active, however, a portion of the Mn^{3+} ions may also form Mn^{2+} through the disproportion reaction; Mn^{2+} dissolves into the electrolyte and causes significant capacity loss during cycling [1]. To enhance the number of charge discharge cycles and eliminate impurity phases in the $LiMn_{1.5}Ni_{0.5}O_4$, four reported approaches are adopted which are expensive, toxic and time consuming [1-4]. The preferred synthesis strategy for the high-voltage $LiMn_{1.5}Ni_{0.5}O_4$ spinel should be able to (i) control the amount of the Mn^{3+} in the final lattice structure, and hence the site disorder, (ii) limit the amount of the $Li_yNi_{1-y}O$ impurity phase, and (iii) maintain its high voltage (4.8 – 5.0 V) and achieve a capacity close to, or better than the theoretical value of ~ 147 $mA.h.g^{-1}$. In this study, $LiMn_{1.5}Ni_{0.5}O_4$ precursor cathode material was treated with microwave irradiation, at different times (0, 10 and 20 minutes), in order to control the Mn^{3+} concentration and thus increase the rate capability, cycle stability and capacity of the material. The three irradiation times are compared (XRD and Galvanostatic charge-discharge) and the optimum time is chosen for further temperature comparison. $LiMn_{1.5}Ni_{0.}5O_4$ is then prepared at 700 °C and 800 °C, both treated with microwave irradiation at the determined optimum time, and compared. This presentation will describe the effect of microwave irradiation on the cathode material in terms of spectroscopy (XRD, XPS), microscopy (SEM) and electrochemistry (CV, Galvanostatic charge-discharge test, and EIS). Ultimately it will be shown that microwave treatment increases the performance of the $LiMn_{1.5}Ni_{0.5}O_4$ cathode material.

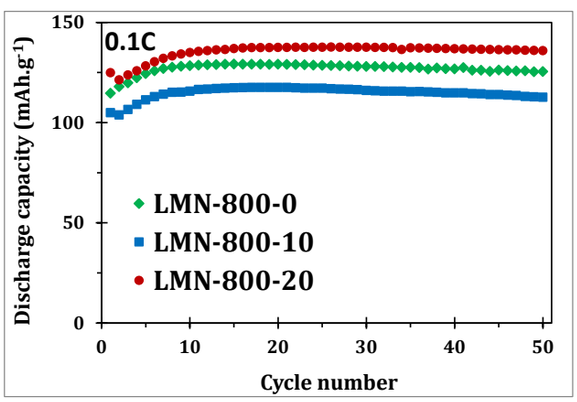

Figure 1: The discharge capacities of the $LiMn_{1.5}Ni_{0.5}O_4$ treated with microwaves for 0, 10 and 20 minutes.

References

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