High Energy MgO Doping Composite $0.5Li_2MnO_3 \cdot 0.5LiNi_{0.5}Mn_{0.5}O_2$ Cathode Material for Lithium-ion Battery

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Introduction

Last decade lithium-rich layered and spinel base oxide materials have been studied as a promising cathode materials for using in the next generation high energy lithium-ion batteries for intensely pursued for electric and hybrid electric vehicle applications. Commercial lithium ion cells are currently made largely with the layered $LiCoO_2$ cathode. However, only 50% of the theoretical capacity of $LiCoO_2$ can be utilized in practical cells due to the chemical and structural instabilities at deep charge as well as safety concerns. One of these composite layer materials, xLi_2MnO_3-$(1-x)LiNi_{0.5}Mn_{0.5}O_2$ ($0<x<1$), has been widely studied since Thackeray et al. discovered it when they were researching the $LiMnO_2$ layered material[1]. This material shows capacities larger than 280 $mAhg^{-1}$ and operating voltages larger than 4.5 V making it one of the cheapest high energy density material for Li-ion batteries. However, many challenges must be overcome in order to realize its commerciality, for example its poor capability and its voltage degradation during cycling.[2]

In this study, we are doping MgO with composite cathode. The effect of doping not only will provide stability in the composite structure in the lithiation and delithiation process, also improve electrochemical properties.

Experimental

$0.5Li_2MnO_3$-$0.5LiNi_{0.5}Mn_{0.5}O_2$ has been synthesized using carbonate based co-precipitation method.

The structural and morphological features have been studied by powder X-ray diffraction (XRD) and Scanning Electron Microscopy (SEM).Figure 1 shows the XRD patterns of as-synthesized LNMO powder. Results show the complete two phases formation of composite material corresponding to the two group space of R3m ($LiNi_{0.5}Mn_{0.5}O_2$) and C2/m (Li_2MnO_3). This patterns were compare with JCPDS database, #84-1634 for Li_2MnO_3 and #09-0063 for $LiNi_{0.5}Mn_{0.5}O_2$, which have been well indexed on the basis of $LiNiO_2$ structure.[1]

SEM measurements are presented in Figure 2, they show highly dense particle agglomerations, particle size lies to 0.5-2 μm, while agglomerations around 10-20 μm. Smaller particles are strongly related with a good electrochemical behavior.

Electrochemical properties will be study using Cyclic Voltammetry, Charge-Discharge Curves, and Electrochemical Impedance Spectroscopy (EIS). These measurements are still in progress.

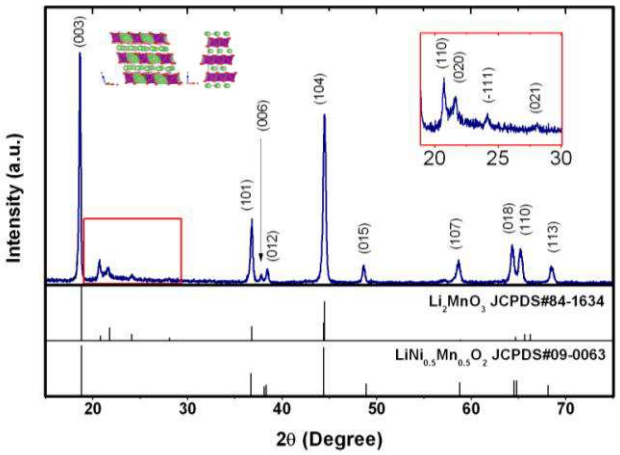

Figure 1. XRD patterns of as prepared LNMO powder. Inset shows the small picks between 20-30 degrees related to the monoclinic Li_2MnO_3 structure,

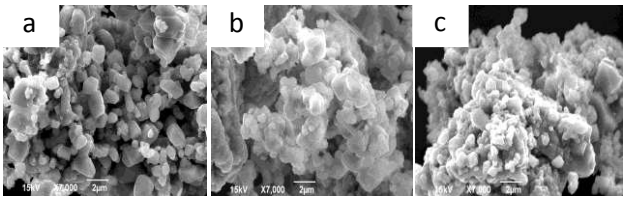

Figure 2. SEM micrographs of (a) not doped LNMO, (b) 1.5% MgO doped LNMO and (c) 3% MgO doped LNMO.

References

[1] Haijin Yu et al., J.Phys. Chem. Lett.,**4**, 1269 (2013)

[2] Gurpreet Singh et al., J. Electrochem. Soc.,**159** (4), A3 (2012)