Synthesis and electrochemical behavior of Li-rich based cathode materials for lithium ion battery

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INTRODUCTION

Recent year, the development of cathode materials with a high energy density for a large sized lithium ion battery has been performed for electric vehicle and energy storage system [1]. It is reported that the Li-rich based Li_2MnO_3 composite material represented by general formula $xLi_2MnO_3 \cdot (1-x)LiMO_2$ has high capacity of above 200mAh/g in the range of 3V to 5V [2]. Therefore, it is very important to develop the synthesized process of Li_2MnO_3-based composite and solid solution.

In this work, we introduce the characteristics of synthesized the $xLi_2MnO_3 \cdot (1-x)LiMO_2$ powder via the modified co-precipitation process and the electrochemical behaviors were studied.

EXPERIMENTAL

The $Li(Li_xNi_yCo_zMn_wO_{2+\alpha})$ materials were synthesized via the modified co-precipitation. As the starting materials, the stoichiometric amount of nickel nitrate, cobalt nitrate and manganese nitrate were dissolved in distilled water, and dropped slowly into the NaOH solution simultaneously with dropping a complex agent. The pH level was kept to 9~12 by controlling the amount of NaOH and kept stirring for homogeneous precursor. The precipitation filtrate was washed with distilled water to remove the residual impurity and dried at 110℃ for overnight. The excess of lithium hydroxide was ground with precursor and then annealed at 500~1000℃ for a period time.

To investigate the crystal structure and morphology, the characteristics of synthesized power was investigated using the X-ray diffraction and SEM analysis. The cathode electrode was fabricated using the synthesized powder, carbon black and PVDF binder at a certain ratio of 80: 10: 10. The cells were assembled in an dry room with the electrolytes of 1M $LiPF_6$ dissolved in EC:DEC (1:1 volume ratio), lithium metal as anode electrode and microporous polypropylene film as seperator

The cycle voltammetry was performed at a constant scan rate of 0.05mV/s with a range of voltage window between 4.9V and 2V. The charge–discharge test was performed at the two different cut off voltage window 2V to 4.5V and 4.9V.

RESULTS AND DISCUSSION

The XRD patterns of synthesized $Li(Li_xNi_yCo_zMn_wO_{2+\alpha})$ showed the complex phase of the typical layered-type structure with R-3m and the super lattice reflection with the C2/m in the 20-34˚ 2θ [2]. The huge reflection indicating the Li/Mn ordering in the slab, (020), (110), (11-1) and (111) was observed to the C2/m phase.

The cycle voltammogram curves of sample A and B showed new oxidation peaks at 3.25V that can be explaned as being due to the extraction of lithium ions in the layered composite structure. Moreover, the oxiduction and reduction peaks at around 3.75V and 3.25V were observed more clearly as compared with sample A and B, which will make increasing of capacity and cycle durability on cell.

The discharge capacity of sample A and B showed about 269 and 247mAh/g at 1st cycle, respectively. Moreover, the preservation capacity of cell showed a great value of about 93%.

Therefore, It is concluded that the electrochemical characteristics of Li_2MnO_3-based materials could be improved through the optimized material composition and synthesis process.

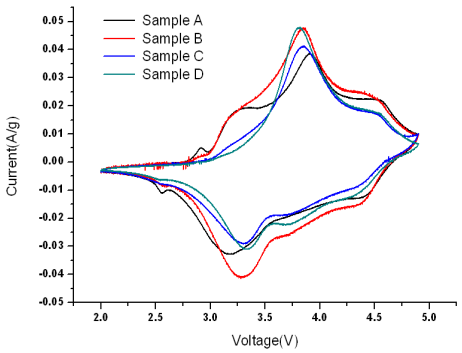

Figure 1. Cyclic voltammograms of Li_2MnO_3-base composite elecetrode at scan rate 0.05mS/s

REFERENCES

[1] Thackeray MM, Progress in Solid State Chemistry, 25:1, 1997.
[2] J.H. Jeong, B.S. Jin, W.S. Kim, G. Wang, H.S. Kim, J. Power Source, 196 (2011) 3439–3442.