Facile synthesis of aliovalent vanadium doped high voltage $LiNi_{0.5}Mn_{1.5}O_4$ cathode with extraordinary high temperature performance

Min-Chul Kim, Won-Hee Jang, Hyo-Sang Kim, Kwang-Jin Kim and Yun-Sung Lee*

Faculty of Applied Chemical Engineering, Chonnam National University, Gwang-ju 500-757, Korea

*E-mail :leeys@chonnam.ac.kr

$LiNi_{0.5}Mn_{1.5}O_4$ cathode material for lithium secondary battery has high energy density and high stability. At high temperature operation, this material has less performance with material decomposition being the main reason for less stability[1-2].Here, we tried to improve the electrochemical performance of $LiNi_{0.5}Mn_{1.5}O_4$ cathode materials, which have poor high temperature performance, using vanadium doping route. V-doped $LiNi_{0.5}Mn_{1.5}O_4$material was obtained by adipic acid assistedsol-gel method[3]. The XRD patterns of the prepared materials suggested cubic spinel structure and absence of impurities. Particle morphology and size are observed using SEM analysis, the V-doped $LiNi_{0.5}Mn_{1.5}O_4$ phase have slightly higher size than pristine$LiNi_{0.5}Mn_{1.5}O_4$(figure 1).V-doped $LiNi_{0.5}Mn_{1.5}O_4$delivered the reversible capacity of ~130 and ~142 mAh g^{-1} at room and high temperature (50 ^oC) conditions. Furthermore, V-doped $LiNi_{0.5}Mn_{1.5}O_4$rendered ~94 and 84 % of capacity retention compared to ~85 and ~3 % for $LiNi_{0.5}Mn_{1.5}O_4$atroom and hightemperature conditions(figure 2), respectively.The enhancements are mainly due to the suppression of Mn dissolution and unwanted side reaction with electrolyte counterpart, which promotes the electrochemical profiles for V-doped phase.In order to study dissolution properties of Mn, both powders are stored in electrolyte solution for a week time in room conditions and subjected to ICP analysis.(Table 1) As expected Mn dissolution is found severe for native phase compound (41.9 ppm) compared to V-doped phase (18.6 ppm). Hence, it is concluded that the Vanadium doping suppressed the Mn dissolution during hightemperature charge-discharge studies and improved the stability of the cell at 50 ^oC. The obtained results will be discussed in detail.

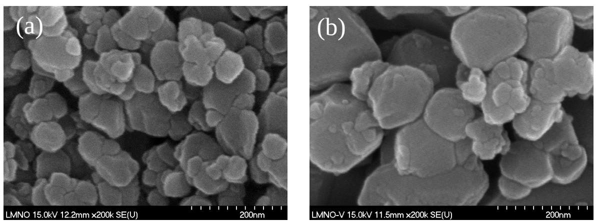

Figure 1: SEM images of$LiNi_{0.5}Mn_{1.5}O_4$ materials. (a) pristine, (b) V-doped $LiNi_{0.5}Mn_{1.5}O_4$ materials.

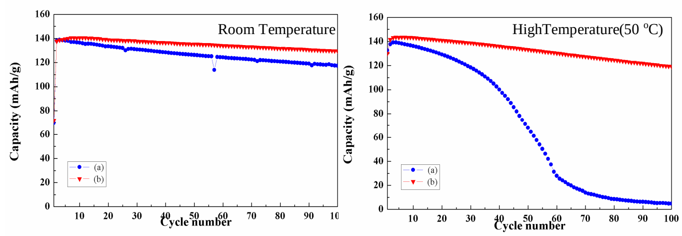

Figure 2: Cycle performance of $LiNi_{0.5}Mn_{1.5}O_4$ materials. (a) pristine and(b) V-doped $LiNi_{0.5}Mn_{1.5}O_4$ materials.

Table 1. ICP analysis of pristine and V- doped $LiNi_{0.5}Mn_{1.5}O_4$.

Sample	Element	Concentration (ppm)
LMNO	Ni	3.02
	Mn	41.9
LMVNO	Ni	3.23
	Mn	18.6

References

1. Ali Eftekhari, J. Power Sources, 130, 260-265(2004)
2. Santhanam, R.; Rambabu, B. Journal of Power Sources 2010, 195, 5442.
3. Y.S.Lee, Y.K.Sun, S.Ota, M.Yoshio Electrochemistry Communications, 4 (12) (2002) 989.