Electrochemical and Interfacial Reaction Behavior of High-Voltage $LiNi_{0.5}Co_{0.2}Mn_{0.3}O_2$ Cathode for Lithium-ion Batteries

K.-M. Nam,[a] Y.-M. Lee,[a] E.-H. Hwang,[b] Y.-G. Kwon,[b] D.-H. Kang,[c] , S.-W. Song[a*]
[a]Dept. of Fine Chemical Engineering & Applied Chemistry, Chungnam National University, Daejeon 305-764, Korea, [b]Leechem Co., Ltd., Geumsan 271-4, Korea, [c]EMT Co., Ltd., Chungju 380-871, Korea

Multi-component cathode material of $LiNi_{1-x-y}Co_xMn_yO_2$ with layered hexagonal structure has been regarded as a promising cathode material due to lower cost, less toxicity, higher thermal stability and higher operation voltage than the single-component materials.[1] Its performance is however often difficult to be realized, in particular, at high voltage operation (> 4.3 V vs. Li/Li^+), due to severe oxidative decomposition of conventional electrolyte. Understanding the cathode-electrolyte interfacial reaction at high voltage and improving the high voltage stability are highly demanded to obtain a stable cycling performance.[2,3] Here we report a new electrolyte formulation, which withstands at 4.6 V, and its application to the lithium cell with $LiNi_{0.5}Co_{0.2}Mn_{0.3}O_2$ cathode. Correlation of cathode-electrolyte interfacial reaction behavior and cycling ability is discussed.

Cathode active material of $LiNi_{0.5}Co_{0.2}Mn_{0.3}O_2$ was synthesized at 900 ^oC in air using the coprecipitate precursor of $Ni_{0.5}Co_{0.2}Mn_{0.3}(OH)_2$ (EMT). Composition was determined by energy dispersive X-ray spectroscopy. The crystal structure of coprecipitate precursor and cathode material, and the absence of impurity were identified by X-ray diffraction analysis, measured in the 2θ range of 10 - 80^o with the scan rate of 2^o/min. Lithium coin cells, consisted of $LiNi_{0.5}Co_{0.2}Mn_{0.3}O_2$ as a working electrode, a lithium foil as counter electrode, PE separator and electrolyte of 1M $LiPF_6$/EC:EMC with 5 wt% additive was assembled in the Ar-filled glove box. The cells were evaluated for their cycling ability at C/10 rate between 3.0 and 4.6 V.

Fig. 1 shows capacity vs. voltage plots obtained at the 1st, 10th and 30th cycle of $LiNi_{0.5}Co_{0.2}Mn_{0.3}O_2$ cathode with additive. The initial charge and discharge capacities are 276 and 205 mAh/g, respectively, with initial coulombic efficiency of 74 %. After 30 cycles, the cathode exhibits capacity retention of 88 % with the discharge capacity of 188 mAh/g, in contrast to a rapid capacity fade without additive. The use of additive is effective in improving high voltage stability and cycling ability of $LiNi_{0.5}Co_{0.2}Mn_{0.3}O_2$ cathode. Further discussion of formation and stability of solid electrolyte interface (SEI) would be presented in the meeting.

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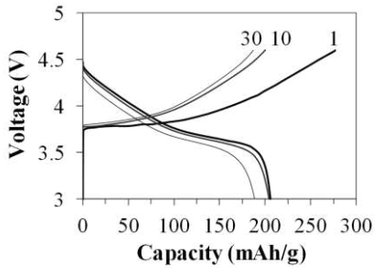

Fig. 1. Capacity vs. voltage plots of $Li(Ni_{0.5}Co_{0.2}Mn_{0.3})O_2$ cathode with electrolyte additive at C/10.