Synthesis of Water-Resistant Thin TiO_x Layer-Coated High-Voltage and High-Capacity $LiNi_aCo_bAl_{1-a-b}O_2$ (a > 0.85) Cathode and Its Cathode Performance to Apply a Water-Based Hybrid Polymer Binder to Li-Ion Batteries

Futoshi Matsumoto [a], Takashi Tsuda [a], Yubin Liu [a], Yuta Irii [b], Fumihiko Maki [b], Takao Gunji [a], Shingo Kaneko [c], Shinsaku Ugawa [d], Hojin Lee [d], Takeo Ohsaka [c]

[a] *Faculty of Engineering, Kanagawa University, 3-27-1 Rokkakubashi, Kanagawa-ku, Yokohama, Kanagawa 221-8686, Japan*
[b] *Nihon Kagaku Sangyo Co., Ltd., 1-28-13 Nakane, Soka, Saitama 340-0005, Japan*
[c] *Research Institute for Engineering, Kanagawa University, 3-27-1 Rokkakubashi, Kanagawa-ku, Yokohama, Kanagawa 221-8686, Japan*
[d] *JSR Corporation, 100 Kawajiri-cho, Yokkaichi, Mie 510-8552, Japan*

E-mail: fmatsumoto@kanagawa-u.ac.jp

Recently, water-soluble and aqueous polymers (water-based polymers) have attracted much attention as binders for lithium ion batteries (LIBs) because of the need for low-cost materials and environmentally compatible electrode fabrication processes [1,2]. In order to apply the water-based polymer binder to LIBs, the dissolution of Li^+ and transition metal ions from the cathode material surfaces have to be inhibited. Therefore, we think that the surface coating of the particle surface is only fundamental solution for applying water-soluble cathode materials to water processes with water-based polymer binders in the fabrication of LIBs. Until now, we have reported the surface coating of $LiNi_{0.5}Mn_{1.5}O_2$ [3] and $LiNi_aCo_bAl_{1-a-b}O_2$ (a > 0.85, NCA) [4] that contain Ni ions at high content and that is susceptible to damage by water was examined and confirmed that surface coating with Al_2O_3, NbO_x, carbon [3] and TiO_x [4] could retain charge/discharge cycle performance at low rate of 0.1 C. However, unfortunately, although cathode materials exposed to water can also retain the charge/discharge cycle performance at 0.1 C rate, the cathode material exhibited degradation of discharge capacity at high discharge rate of 1-5 C because of resistance for passing Li^+ ions through the coating layer on the cathode material surfaces. We could not establish the protocol for surface coating which satisfies both water-resistant property and high permeability of Li^+ ions yet. In this study, we tried to find optimal conditions for the surface coating layers on the surface of NCA cathode material by examining the type of TiO_x precursor and the concentration of precursor and the amount of H_2O added to reaction solution for hydrolysis of TiO_x precursor on the particle surfaces. In addition, characterization of a thin TiO_x layer which was formed on the NCA and did not pass H_2O molecules but pass Li^+ ions tried with transmission electron microscopy (TEM) and X-ray photoelectron spectroscopy (XPS).

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