# Improvement of the Cyclability for the Cathode Containing an Aqueous Binder by a Pressurized $CO_2$ Gas Treatment

Katsuya Kimura [a], Taichi Sakamoto [a], Takashi Mukai[a], Yuta Ikeuchi[a],
Naoto Yamashita[a], Keiichiro Onishi[b], Keiichi Asami[b], Masahiro Yanagida[a]
[a] Research Institute of Electrochemical Energy, National Institute of Advanced Industrial Science and Technology (AIST), 1-8-31 Midorigaoka, Ikeda, Osaka 563-8577, Japan
[b] Nihon Spindle Manufacturing Co., Ltd., 4-2-30 Shioe, Amagasaki, Hyogo 661-8510, Japan

E-mail: *kimura.katsuya@aist.go.jp*

$Li[Ni_xCo_yAl_{1-x-y}]O_2$ (NCA) is some of the promising candidates as a next generation cathode active material for Li-ion batteries. However, NCA particles have a small amount of alkaline spices such as LiOH as a residue from their production process. Therefore, the pH of the slurry using the aqueous binder increases and Al foil collector corrodes. In this study, we have developed a pressurized $CO_2$ gas treatment (PCT) for the cathode slurry [1], and investigated the cyclability.

The NCA slurry was prepared along with acetylene black and acrylic polymer in water using a Jet Paster® (Nihon Spindle Manufacturing Co., Ltd.). The slurry was mixed under $CO_2$ atmosphere at 0.6 MPa for 3 minutes. The slurry was coated on Al foil (NCA electrode). The NCA electrode was the working electrode in the coin cells of the CR2032-type with lithium foil as the counter electrode. The electrolyte consisted of 1 M $LiPF_6$ in a mixture of EC and DEC (1:1 by volume). The cells were cycled between 4.2 V and 2.7 V at 30 ºC.

The pH of the NCA slurry without the PCT was indicated 12.2, but it significantly decreased to 8.3 with the PCT. Fig. 1 shows the TEM images for the NCA particle surfaces with (Fig. 1a) and without (Fig. 1b) the PCT. With the PCT, a part of the coating layers of the surfaces were thickened by use of the PCT. An increase in the thickness of the layers may be caused by formation of the $Li_2CO_3$ due to reaction of LiOH in the NCA particles with $CO_2$ during the PCT.

Fig. 2 shows the discharge capacity of the NCA electrode with and without the PCT. The discharge capacities with the PCT at the initial cycles were nearly the same compared to those without the PCT. However, the cyclability with the PCT was significantly improved after 25 cycles and the discharge capacity at the 50th cycle was achieved to 140 mAh/g. In previous study, it is known that the $Li_2CO_3$ coating layers on the cathode electrode surfaces suppress the electrolyte decomposition and stabilizes the surfaces during the cycles [2]. Therefore, it is suggested that use of the PCT for the NCA slurry improved the cyclability because of formation of the $Li_2CO_3$ coating layers on the NCA particle surfaces.

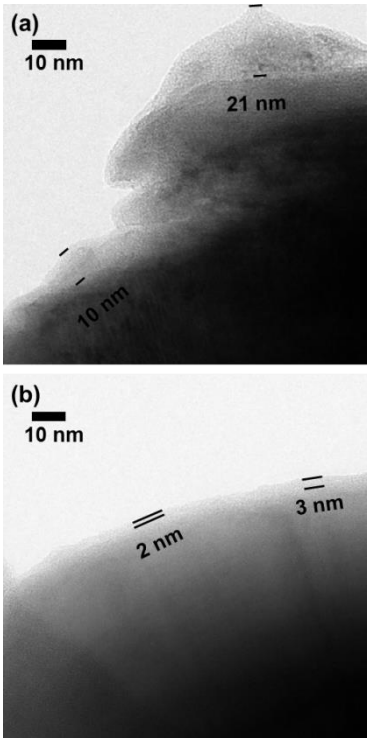


Fig. 1 TEM images for the NCA particles with (a) and without (b) the PCT.

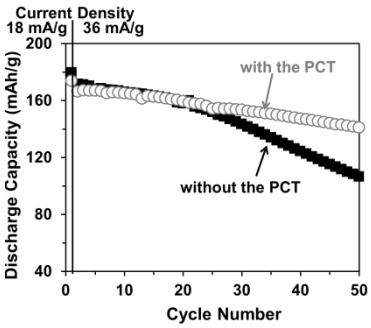


Fig. 2 Discharge capacities of the NCA electrode with and without the PCT.

**References:**
[1] K. Kimura et. al, J. Electrochem. Soc. 165, A16 (2018).
[2] X. Dai et. al, J. Phy. Chem. C 117, 8579 (2013).