Development of High Energy and High Power Density Li-ion Batteries

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Lithium-ion batteries have been widely used for lap-top PC, cellular phones, and DSC applications as they have high energy density. Rising of environmental awareness, lithium-ion batteries are expected to be applied to automobile applications and electric energy storage use. For Hybrid Electric Vehicle (HEV) and Battery Electric Vehicle (BEV) applications, longer calendar life and higher power density are necessary compare to the conventional usage.

We launched the lithium-ion battery with graphite anode and $Li(Ni,Co,Al)O_2$-based cathode in 2006. The battery has the energy density of $620Wh/dm^3$ (18650-type 2.9Ah cylindrical cell). [1] Recently, We commercialized a higher capacity 3.1Ah lithium-ion battery with graphite anode and $Li(Ni,Co,Al)O_2$-based cathode. The battery has the high energy density of $675Wh/dm^3$. [2]

Figure 1 shows the results of the storage test at 45°C of the $Li(Ni,Co,Al)O_2$-based cathode / graphite cell (18650-type 2.9Ah cylindrical cell) and the $LiCoO_2$-based cathode / graphite cell (2.6Ah). The $Li(Ni,Co,Al)O_2$-based cathode / graphite cell has better storage performance than the $LiCoO_2$-based cathode / graphite cell. 90% of the initial capacity remained even after the 2 years storage test at 45°C. Therefore, the $Li(Ni,Co,Al)O_2$-based cathode may be a promising cathode for the HEV and BEV applications.

In this report, the power capability of the $Li(Ni,Co,Al)O_2$-based cathode with different particle properties has been investigated.

We prepared the several $Li(Ni,Co,Al)O_2$-based cathode samples by using the different synthesis methods, such as conventional solid-state method, molten-salt method and ionic exchange from $Na(Ni,Co,Al)O_2$-based oxide to $Li(Ni,Co,Al)O_2$-based oxide[3]. The $Li(Ni,Co,Al)O_2$-based cathode samples with different primary particle sizes (0.1 μm – 20 μm) and morphologies of secondary particle (the specific BET surface area: $0.5m^2g^{-1} – 3m^2g^{-1}$) were obtained. (Fig. 2)

High-resolution electron back scatter diffraction pattern (EBSP) measurements were performed to determine the local crystal orientation of the $Li(Ni,Co,Al)O_2$-based cathode samples. From the results, few grain boundaries in the primary particles of each sample were observed.

We will discuss in detail about the particle properties affecting the electrochemical characteristics of the $Li(Ni,Co,Al)O_2$-based cathode.

References
[1] A.Nagasaki, H.Matsuno, K.Kinoshita, and T.yao, The 23th International Battery Seminar, Florida, March 14th (2006).
[2] A.Nagasaki, Y.Inaba, Y.Hina, M.Nakanishi, The 5th Annual International Conference LITHIUM MOBILE POWER 2009, November 12th (2009).
[3] K.Kang, Y.S.Meng, J.Bréger, C.P.Grey, G.Ceder, Science, 311, 977(2006).

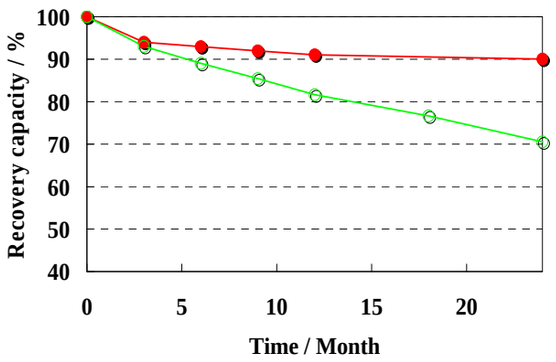

Fig.1 Storage test at 45°C of the cells charged to 4.1V. Closed and open circles indicate the $Li(Ni,Co,Al)O_2$-based cathode / graphite cell (2.9Ah) and the $LiCoO_2$-based cathode / graphite cell (2.6Ah), respectively. The vertical axis indicates the recovery capacity in percent with respect to the initial discharge capacity. The type of these batteries is 18650 cylindrical cell.

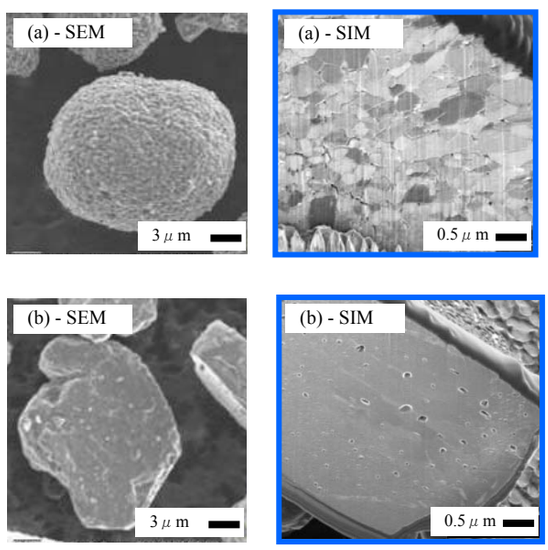

Fig.2 SEM images and Cross-sectional SIM images of the $Li(Ni,Co,Al)O_2$-based cathode particles obtained from (a) conventional solid-state method and (b) ionic exchange method.