Rate Capability of Nano-size LiCoO₂ Cathode for Li-Ion Cells

M. Makidera¹, T. Kawamura², S. Okada¹, J. Yamaki³
¹ Interdisciplinary Graduate School of Engineering Sciences, Kyushu University
² Japan Science and Technology Agency
³ Institute for Materials Chemistry and Engineering, Kyushu University
Kasuga Koen 6-1, Kasuga 816-8580, Japan

Introduction
Currently, lithium-ion cells are widely used in many portable electric devices such as cellular phones and notebook computers. This is because of their longer cycle life and higher energy density than those of other rechargeable cells. However, their power density is not sufficient for use in electric vehicles. In the present study, the effect of LiCoO₂ particle size and cathode sheet thickness on the rate capability was investigated by using a Li/LiCoO₂ coin-type cell.

Experimental
We used four kinds of LiCoO₂ of different particle sizes (5 µm, 25 nm, 23 nm in diameter, 5 (width) × 60 (length) mm)¹. LiCoO₂ powder was mixed with acetylene black (AB) (5 wt.%) and poly (vinylidene fluoride) (PVdF) (5 wt.%) in N-methyl-2-pyrrolidinone (NMP) and stirred for 3 h. The slurry was then coated onto aluminum foil and dried. The cathode electrode of 1.5 cm in diameter was cut from the sheet. The cathode electrode was pressed and then dried at 110 °C under a primary vacuum. The dried cathode was transferred into an argon-filled dry box. A Celgard 3501 (Celanese Co) was used as a separator and lithium foil (Honjo Metal) was used as anode. The electrolyte used was 1M LiPF₆ in EC+DMC (1:1 in vol. %) (Tomiyama Pure Chemical Industries, LTD.). The cells were fabricated using a coin-type cell R2032. The cells were cycled galvanostatically at current densities ranging from 0.1 mA cm⁻² to 30 mA cm⁻². The cycling voltage range was in the range of 2.6 V to 4.2 V.

Result and discussion
Three kinds of the electrodes of different thicknesses were made using LiCoO₂, which particle size is about 5 µm. Because the densities are nearly 1.56 g cm⁻³, the porosities of the sheet electrodes were almost the same. As shown in Fig. 1, the capacity increased with the order of the thickness, 60(m) < 40(m) < 80(m), while nano-sized LiCoO₂ (25 nm, 23 nm, 5 × 60 nm) showed very large capacities compared with the 5 µm LiCoO₂.

Figure 2 shows the discharge curves at 12 mA cm⁻². The nano-size LiCoO₂ showed a higher discharge voltage compared with the 5 µm LiCoO₂.

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Reference