New Method of Producing Nano-sized $LiCoO_2$ Particles for Li-ion Batteries

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Introduction

Li-ion cells are widely used in many portable devices. However, their power density is not sufficient for use in electric vehicles. One of the most effective ways to improve power density is to use very fine cathode particles. We report here on a new method of preparing nano-sized $LiCoO_2$ powder, that is finer than that produced by standard methods[1,2].

Experiment

A nanodiameter lithium cobaltate sample was prepared using the new excess-lithium method. Reagent grade $CH_3COOLi \cdot 2H_2O$ and $(CH_3COO)_2Co \cdot 4H_2O$ (Wako Pure Chemical Industries) were mixed in water at a molar ratio of 5, 9, 13 and 21 to 1 (4, 8, 12 and 20 molar ratio of lithium being the excess). After the water evaporated, the mixture was calcined at 600℃ for 6h in air. The calcined product was washed with distilled water to remove impurities and the samples were dried at 80℃ in air for 24h. Finally, we obtained very fine $LiCoO_2$ particles.

The sample structure was characterized by X-ray diffraction (RINT2100HLR/PC, Rigaku). The particle morphology of the samples was observed using a scanning electron microscope (JSM-6340F, JEOL).

Results and discussion

When the molar ratios of $CH_3COOLi \cdot 2H_2O$ and $(CH_3COO)_2Co \cdot 4H_2O$ were 1:1 (calcined at 600℃ for 6h), the $LiCoO_2$ particle size was about 500 nm (see Fig. 1). This method is the conventional sol-gel method.

When the molar ratios of $CH_3COOLi \cdot 2H_2O$ and $(CH_3COO)_2Co \cdot 4H_2O$ were 9:1, the $LiCoO_2$ particles were smaller than those compounded by the conventional sol-gel method. The $LiCoO_2$ particle size was about 25 nm, and the particles were almost uniform in size (see Fig. 2). Added excessive lithium acetate becomes lithium carbonate by calcining. It seems that lithium carbonate separates $LiCoO_2$ particles and suppresses sintering of the particles.

When molar ratios of $CH_3COOLi \cdot 2H_2O$ and $(CH_3COO)_2Co \cdot 4H_2O$ were 21:1, the $LiCoO_2$ particles became needle-like, with a thickness of about 5 nm and a length of about 60 nm (see Fig. 3).

References
[1] Z. S. Peng, C. R. Wan, C. Y. Jiang, J. Power Sources, 72 (1998) 215.
[2] H. Chen, X. Qiu, W. Zhu, P. Hagenmuller, Electrochemistry Communications, 4 (2002) 488.

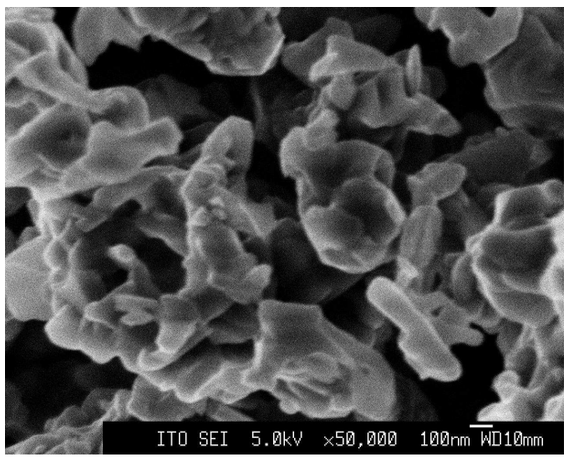

Fig. 1 SEM image of $LiCoO_2$ sample formed with a 1:1 molar ratio of $CH_3COOLi \cdot 2H_2O$ and $(CH_3COO)_2Co \cdot 4H_2O$.

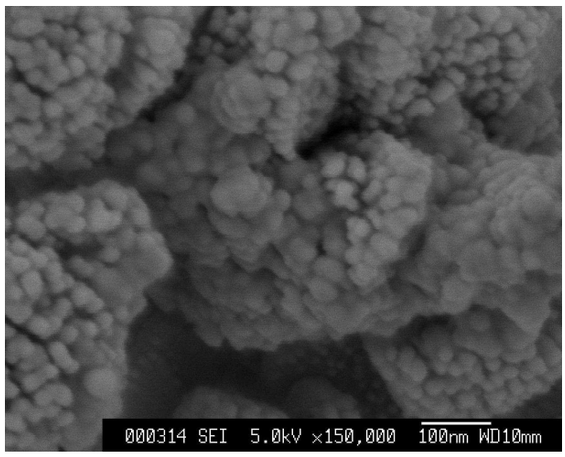

Fig. 2 SEM image of $LiCoO_2$ sample formed with a 9:1 molar ratio of $CH_3COOLi \cdot 2H_2O$ and $(CH_3COO)_2Co \cdot 4H_2O$.

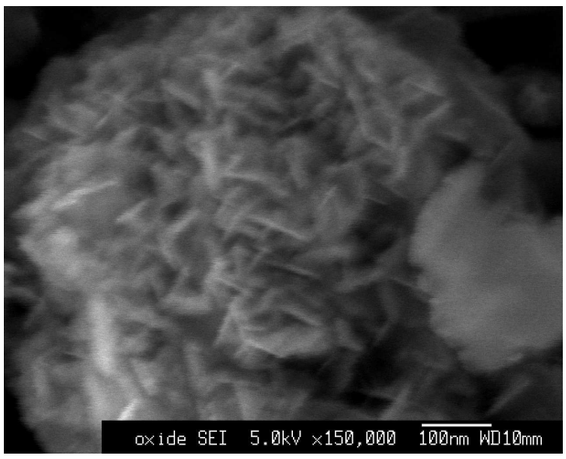

Fig. 3 SEM image of $LiCoO_2$ sample formed with a 21:1 molar ratio of $CH_3COOLi \cdot 2H_2O$ and $(CH_3COO)_2Co \cdot 4H_2O$.