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Stable Charge/Discharge Cycle Performance of $LiFePO_4$ Cathode Prepared with Carboxymethly Cellulose Binder

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1. Introduction

Carboxymethyl cellulose (CMC) have recently attracted much attention as binder in lithium ion batteries (LIBs) because of its hydrophilic nature and has lead to very promising electrochemical performance for Si anode.[1,2] Water-soluble CMC is very attracting interest as a binder in LIBs, which is expected to decrease the cost of LIBs by replacing of conventional organic solvent-based binders. In addition, it has been shown that CMC binder can also be applied to cathode binder. Several interesting papers have already been published.[3-5] Al surfaces of cathode current collector repel water-slurries containing cathode active material, conductive additive, and binder. As a result, homogeneous, adhesive cathode films can not be formed on Al current collector surfaces and therefore, the stable cell performance could not be observed, compared to the conventional cathode binders. In the present study, we applied chemically treated Al foils as cathode current collector to prevent repelling of the cathode slurry as well as cathode films. Charge/discharge cycle performance of the cathodes were compared with chemically and mechanically treated Al foils.

2. Experimental

All slurries were prepared with Milli-Pore water (> 18 MΩ). CMC binder (CMC-2200, Daicel, Japan) was used as received without any further treatment. Electrochemical tests were performed with a CR2032 coin-type cell. The test cell was made of a cathode and a lithium metal anode separated by a porous polypropylene film (Celgard 3401). The electrolyte used in the tests was a mixture of 1 M $LiPF_6$-ethylene carbonate (EC) / dimethylcarbonate (DMC) (1:2 by vol., Ube Chemicals, Japan). Charge and discharge cycling was carried out using a multichannel battery tester (model BTS2004, Nagano Corp., Japan). All tests were performed at room temperature. A constant-current (CC) mode was applied to both the pre-treatment process and cycle tests.

3. Results and Discussion

Figure 1 shows the optical images of a water droplet on chemically- and mechanically-treated Al foil. Although the mechanically treated Al foil with sand paper repels a water droplet, however, chemically treated Al foil in special etching solutions spread a water droplet homogenously on Al surface. The homogeneity of cathode films was much improved with chemically treated Al foils than the mechanically treated Al having many uncoated part in the film (white spots in the picture of Fig. 2(b)). The cathode prepared with chemically treated Al foil showed stable charge/discharge capacity for 100 cycles compared to the un-treated or mechanically-treated Al foils that showed poorly stable charge/discharge capacity.

4. References

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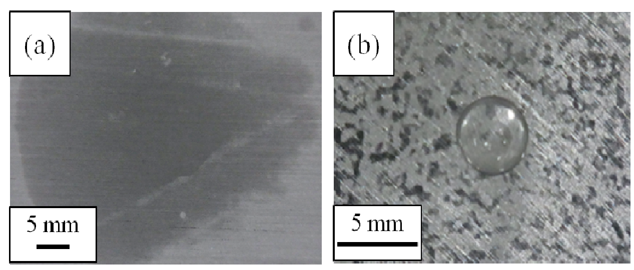

Fig. 1 Optical images of a water droplet on chemically-treated (a) and mechanically-treated Al current collector (b).

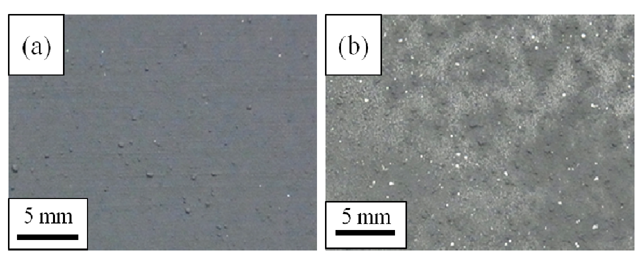

Fig. 2 Optical images of $LiFePO_4$ cathode films on (a) chemically-treated and (b) mechanically-treated Al current collectors.

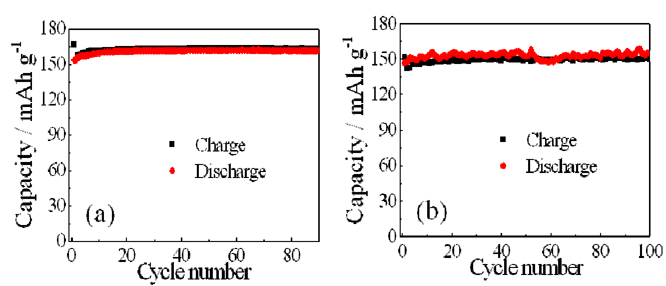

Fig. 3 Charge- and discharge capacities of a $LiFePO_4$ cathode prepared with CMC binder. Cell test condition: charge/discharge rate: 0.1 C, voltage region: 4.2-3.0 V, electrolyte composition: 1 M $LiPF_6$ in EC/DMC (1:2 vol%). (a) Chemically surface-treated Al current collector, (b) mechanically surface treated Al current collector.