

Lithium anode supported by porous template for lithium secondary battery

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The need to increase the energy density of rechargeable cells has become more urgent as a result of the recent rapid development of new applications, such as electric vehicles, load leveling and various types of portable equipments. Moreover, a lithium metal anode is an attractive way of delivering the high energy density from such cells. The lithium-metal anode has a very large theoretical capacity of 3860 mAh/g, in contrast to the value of 372 mAh/g for a graphite anode. This high energy encourages an attempt to realize a practical lithium-metal anode cell.

There are, however, some disadvantages of the lithium metal anode, such as poor cycling efficiency, safety problem, etc. In order to solve these problems, there have been many attempts, mostly concentrated on electrolytes and/or additives to modify the solid-electrolyte interface (SEI) and/or the morphology of deposited lithium[1].

In this study, we focused on physical structure of anode substrate where lithium deposits. Adapting porous template inert to lithium, we tried to modify the deposition morphology of lithium as well cycling efficiency and safety.

Working electrode was prepared by sputtering a current collector layer on porous polymer template. Inert metal layer was deposited by dc magnetron sputtering on a side of porous fiber template as a current collector. Backside of current collector and Ni lead were blocked with poly propylene tape to prevent the undesirable lithium deposition.. Electrochemical experiments were performed using EG&G potentiostat/galvanostat model 273A, and a typical three-electrode system (lithium counter-electrode, lithium reference-electrode, and porous working electrode) was employed. EC:DEC (1:1 by volume) with 1 M LiPF<sub>6</sub> was used as an electrolyte without any other additives. All the cycle tests were performed under constant current condition with 1 V of anodic cutoff voltage.

Typical voltage profiles of selected cycles are shown in Fig. 1. As shown in this figure, initial overpotential for lithium deposition is about 65 mV which is a typical value for LiPF<sub>6</sub> salt system. As the cycle goes on, stripping overpotential increases. Cycling efficiency is defined as follows.

$$E = 100 \times \frac{(Q_r - \frac{Q_{ex}}{N})}{Q_c}$$

where Q<sub>s</sub> is reversibly reacting lithium and Q<sub>ex</sub> is remaining lithium after initial extraction., respectively. With this definition, tested system achieved about 100 % cycling efficiency until 75 cycles without any additives. This improvement is probably due to the supporting effect of the inert template.

Further investigations on the physical nature of template, such as porosity, template material, and the effect of organic/inorganic additives would be presented.

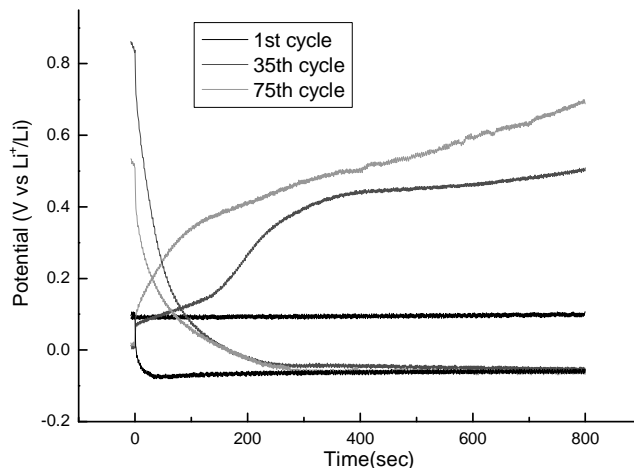


Figure 1) Selected voltage profiles of lithium anode

References

[1] J.O.Besenhard ed. Handbook of Battery Materials, Wiley-VCH, 1999