Development of Long Life and High Specific Capacity LiBs with Li-rich Layered Oxide Positive Active Material

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1. Introduction

Li-rich layered oxide positive active materials have drawn much attention as a positive active material candidate for automotive application because of its high specific capacity and potential low cost. However, the material requires higher charge potential above 4.5 V vs. Li/Li^+ to obtain the high specific capacity, which will increase capacity fading due to Mn dissolution[1]. In this work, combination of several electrolytes and the additive were investigated for improving charge and discharge cycle life performance by suppressing Mn dissolution from Li-rich layered oxide positive electrode.

2. Experimental

Several Li-rich layered oxide positive electrode/graphite negative electrode test cells were fabricated with different kinds of electrolytes and the additive, as follows; Cell A: 1.2 M $LiPF_6$ in FEC/EMC (0.5/9.5 v/v), Cell B: 1.2 M $LiPF_6$ in FEC/EMC (0.5/9.5 v/v) + additive A, Cell C: 1.2 M $LiPF_6$ in EC/EMC (3/7 v/v) + additive A. The Li-rich layered oxide positive active materials are supplied by BASF TODA Battery Materials LLC. The cycle life tests for these cells have been carried out until 200 cycles at 45ºC between 2.0 and 4.5 V at 3.0 mA cm^{-2}. After the cycle life tests, the graphite negative electrodes of these cells were picked up in Ar purged glove box and rinsed with DMC. Then, Mn contents in these negative electrodes were quantified by ICP-AES analysis.

3. Results and Discussion

Figure 1 shows the results of the cycle life tests. The cycle life performances of Cell B and C, which contain the additive, are superior to that of Cell A. In addition, the cycle life performance of the Cell C with EC-base electrolyte system is almost same as the Cell B with FEC-base electrolyte system. Figure 2 shows the results of ICP-AES. Mn contents in graphite negative electrodes of the cells with the additive are lower than that of Cell A. These results indicated suppression of Mn dissolution from the Li-rich layered oxide positive electrode leads to improve cycle life performance. The additive may suppress the interfacial side reactions for both of EC- and FEC-base electrolytes.

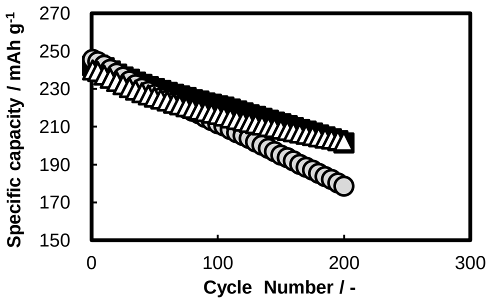

Figure 1 Cycle life performances of Li-rich/graphite cells between 4.5-2.0 V at 45℃: Cell A (●), Cell B (△), and Cell C (■).

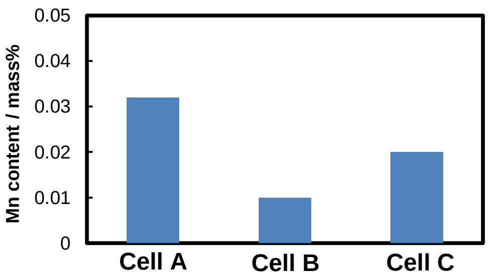

Figure 2 Mn contents by ICP-AES analysis in graphite negative electrodes after the cycle life tests at 45℃.

References:

[1] Martin Bettge et al., Journal of Power Sources 233 (2013) 346-357.