

Swelling Mechanism of the Lithium Ion Batteries at High Temperature

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Introduction

Prismatic Li-ion batteries have been developed in order to achieve progress in terms of higher capacity, lighter weight, thinness, and safety. Recently thin Li-ion batteries with a laminated film bag as a casing were developed.[1-2] These batteries have the advantages of thinness and light weight due to the use of the laminated film bag. However, thin Li-ion batteries with a laminated film bag are subject to some problems in that they are swollen when they are stored at high temperature. This swelling behavior at high temperature results in the decline in the battery performance at high temperature, and consequently, put restriction on the commercialization of Li-ion batteries with the laminated film bag.

These considerations have motivated us to study the swelling mechanism of the Li-ion batteries at high temperature. In this work, the reason for the swelling behavior of the Li-ion batteries at high temperature was investigated.

Experimental

The thin Li-ion batteries were constructed by using the carbon anode, LiCoO_2 cathode, an organic liquid electrolyte, a separator, and an aluminum-plastic laminated film bag as the case. The electrolyte used for the thin Li-ion batteries was a 1.3M LiPF_6 in a mixture 3:7 by volume of ethylene carbonate(EC) and diethyl carbonate(DEC).(1.3M LiPF_6 -EC/DEC)

Swelling properties were investigated by measuring the thickness change of the Li-ion batteries after the storage for 4hrs at 90°C.

The composition of the gas obtained from the thin Li-ion batteries after the high-temperature storage at 90°C was analyzed by gas chromatography.

Result and Discussions

To investigate the swelling properties of the Li-ion batteries with a laminated film bag, the Li-ion batteries at different state-of-charge were stored for 4hrs at a high temperature of 90°C, and then their thickness change before and after storage was measured. Fig.1 shows the results for the thickness change of Li-ion batteries after 4hrs-storage at 90°C as a function of state-of-charge.

Below the 80% of SOC, the thickness changes of the Li-ion batteries are almost constant as a function of SOC and the values is about 10%. The thickness of the Li-ion batteries, however, abruptly increases above 80% of SOC.

The swelling behavior of the Li-ion batteries must be considered in terms of the distinctive two regions : one is the region below 80% of SOC, and the other is above 80% of SOC. In case of the region above 80% of SOC, the swelling behavior of the Li-ion batteries is expected to be attributed to the side of cathode. In case of the region below 80% of SOC, the reason for the swelling of the Li-ion batteries is concerned with the side of anode.

The cell containing the cathode swells above the certain voltage, namely, 4.0V versus Li/Li^+ , indicating that the swelling behavior of the cell containing the cathode is attributed to the oxidation of electrolytes on the cathode.

References

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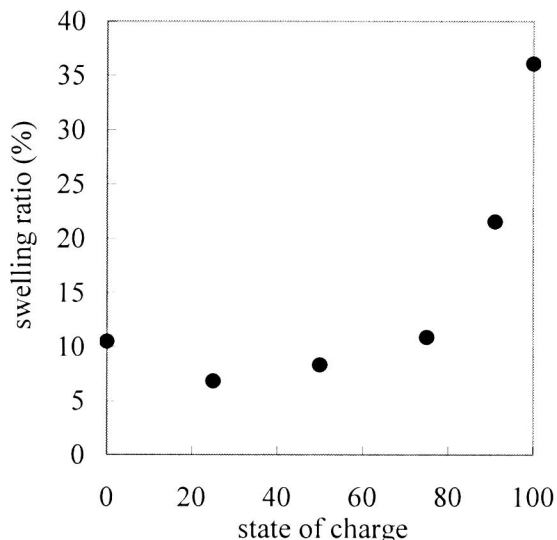


Fig. 1. The swelling ratio of the Li-ion batteries after storage for 4hrs at 90°C