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Calendar Life Studies of Li-ion Batteries for FCEVs

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Development of a high efficiency and long life lithium secondary battery is expected as an auxiliary power supply of clean energy vehicles, such as fuel cell electric vehicles (FCEVs). In NEDO project "R&D on Li-ion Batteries for FCV and HEV"[1], "15 years-life under the practical use condition" is one of the development targets. However, intricately various factors are participating in life evaluation for FCEVs, the techniques of life estimating with practical sufficient accuracy within a short period of time is not yet established. In this work, in order that we develop the accelerated life test method which can be presumed in 1 - 1.5 years for "15 years-life", we studied the test conditions including various parameters. We examined the acceleration factors valid for battery life evaluation.

1.5 Wh-class cylindrical prototype cells (nickel oxide cathode / carbon anode) were fabricated by a battery manufacture using high power design. These cells were tested by three types of aging test. A cycle test, a preservation test and a practical use simulated test were carried out.

(1) The cycle test; we adopted cc (constant current) discharge / cc+cv (constant voltage) charge as a pulse profile. A pulse discharge/charge of 3 % DOD width centering on 50 % SOC is assumed to be a typical profile for FCEVs auxiliary power sources battery. The pulse current of the profile had 10C discharge rate and 5C charge rate. The 3 % of DOD width is based on "power assist" battery speculation.

(2) The preservation test; this test is similar to shelf-life test except but periodical performance tests and starting at a certain SOC, typically 50 % SOC.

(3) The practical use simulated test; we assumed that the practical use conditions for FCEVs auxiliary power sources battery is pulse cycle run of about several hours per day. In this work, we carried out the test which simulated the practical use conditions : including 2.4 h cycle test and 21.6 h preservation test per day.

Each test includes periodical performance tests such as a capacity test using 0.33 C charge-discharge rate, AC impedance and DC-IR measurement at 50 % SOC in the chambers of 25 ^{o}C.

A result of the examination of the relationship between the data of the preservation test, the cycle test and the practical use simulated test is shown in Fig.1. In order to examine the degradation tendency, we compared at the same test days section (50 and 100 days) about the above three tests. We estimated capacity and power retention under the practical use condition from the cycle test and the preservation test results. Here, we assumed that the sum of the degradation rate of the cell performance by the cycle test and the preservation test is equivalent to that in the practical use condition. So we compared the value calculated by the equation shown below with the practical use simulated test data.

[Degradation rate of the cell performance in the practical use condition] = 0.1 x [Degradation rate of the cell performance by the cycle test] + 0.9 x [Degradation rate of the cell performance by the preservation test]

Fig.1 shows the practical use simulated data and the calculated data have a good agreement about capacity retention. The SOC dependency of the power retention at 40 ^{o}C preservation test is shown in Fig.2. Power decreases more largely at higher SOC. This result suggests that high SOC preservation accelerate degradation of battery.

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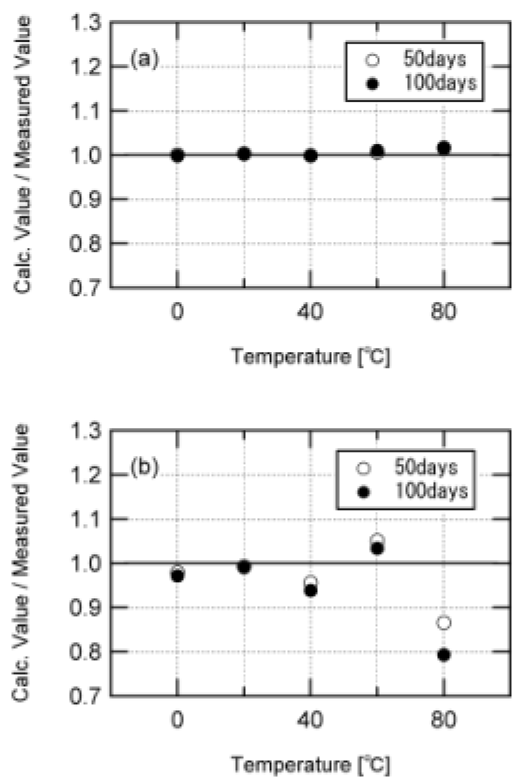

Fig.1 The temperature dependency of the ratio of the practical use simulated test data and the value calculated from the preservation and the cycle test data. (a) Capacity retention, (b) Power retention

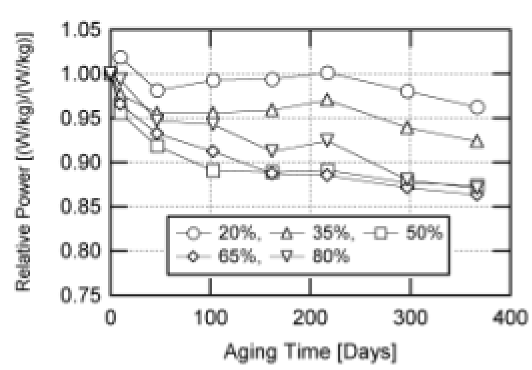

Fig.2 The SOC dependency of the power retention at 40 ^{o}C preservation test.

Reference

[1] K.Nakui, IMLB-12 Abstract No.54 (2004)