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Research on Consistency of Power Li-ion Batteries Storage

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Abstract. The consistency of power Li-ion batteries storage was researched at 20°C and 40°C environment temperatures. The results showed that the self-discharge rate of monomers of similar initial performance in storage will lead to inconsistency of monomer battery voltage after storage. That is to say, the battery self-discharge rate relates to the cathode materials, battery manufacturing process, electrolyte property and purity, temperature and storage time and other factors. And the difference of each monomer battery environment in the battery pack will inevitably exist based on the battery assembly design characteristics and operating environment characteristics.

Introduction

The research and development of electric vehicles is considered the most effective and most realistic ways currently to solve the world energy crisis and global environmental pollution. And the battery for electric vehicles is very important. The power Li-ion batteries with high specific energy, high specific power, long service life, wide operating range and other characteristics, has been successfully used in electric vehicles. Therefore, the consistency of power Li-ion batteries storage was researched at 20°C and 40°C environment temperatures in this paper.

The Consistency Tests

Test Sample.

The model and the parameters of cell in this paper as follows:

1) The model: domestic battery, rated voltage 3.7 V, rated capacity 10 Ah, internal resistance < 6 mΩ, weight < 320 g

2) Dimensions: 133 mm×66 mm×18 mm.

3) The composing of the battery: the cathode material is $LiMn_2O_4$, the anode material is graphite, the electrolyte is $LiPF_6$, EC and DMC, and battery separator is celgard 2325.

Test Instrument.

Integrated battery tester, model Xin Wei TC53 High-precision battery performance test systems. Thermostat box, model SPHH-101; the test is shown in Fig. 1.

Test Method.

The method of consistency tests in this paper as follows:

1) The charge and discharge tests were carried out, and every cell voltage was monitored.

2) The SOC100% battery was put in the thermostat box which temperature is set 20℃ and 40℃, and was laid aside for 5 days.

Results and Discussion

The self-discharge accelerating experiment by placing the battery at 40ºC was conducted. Select a batch of samples of basically consistent initial performance before storage, store them for 5 days and record the voltage changes daily. The initial state of monomer batteries and the battery state after 5-day storage monomer batteries as shown in Table 1 and Table 2, and the voltage changes of monomer batteries in the storage period are as shown in Figure 2.

The self-discharge refers to the natural loss of capacity when the battery is in storage, reflecting by open-circuit voltage drop after a period of storage. According to Table 1, Table 2 and fig. 2, the self-discharge rate of monomers of similar initial performance in storage will lead to inconsistency of monomer battery voltage after storage. In a word, the battery self-discharge rate relates to the cathode materials, battery manufacturing process, electrolyte property and purity, temperature and storage time and other factors.

According to the battery assembly design characteristics and operating environment characteristics, the difference of each monomer battery environment in the battery pack will inevitably exist. For example, in square lithium-ion battery pack, the ambient temperature of the batteries in the middle and the surrounding batteries, and the stress condition of the battery are different from each other (Fig. 3). The most significant factor is the temperature difference, if the active thermal balance and thermal management are not used, the temperature of batteries in the middle is often 5-15ºC higher than that of the surrounding batteries, even the temperature difference is much higher, at this moment, the battery charge rate, aging speed and other characteristics have been changed fundamentally, thus lead to battery decay rate difference becoming larger, and further accelerate the termination of system service life.

Summary

Based on the foregoing test results, analysis and discussions, the conclusion can be obtained as follows: 1) the self-discharge rate of monomers of similar initial performance in storage will lead to inconsistency of monomer battery voltage after storage. That is to say, the battery self-discharge rate relates to the cathode materials, battery manufacturing process, electrolyte property and purity, temperature and storage time and other factors. 2) According to the battery assembly design characteristics and operating environment characteristics, the difference of each monomer battery environment in the battery pack will inevitably exist.

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Table 1 initial state of monomer batteries

	S101	S102	S103	S104	S105
voltage /V	4.20	4.20	4.19	4.19	4.19
Internal resistance / mΩ	5.90	5.98	5.97	6.09	6.13

Table 2 the battery state after 5-day storage monomer batteries

	S101	S102	S103	S104	S105
voltage /V	4.18	3.19	3.39	3.20	3.95
Internal resistance / mΩ	5.89	6.13	6.01	6.00	5.78

Fig.1 The consistency tests

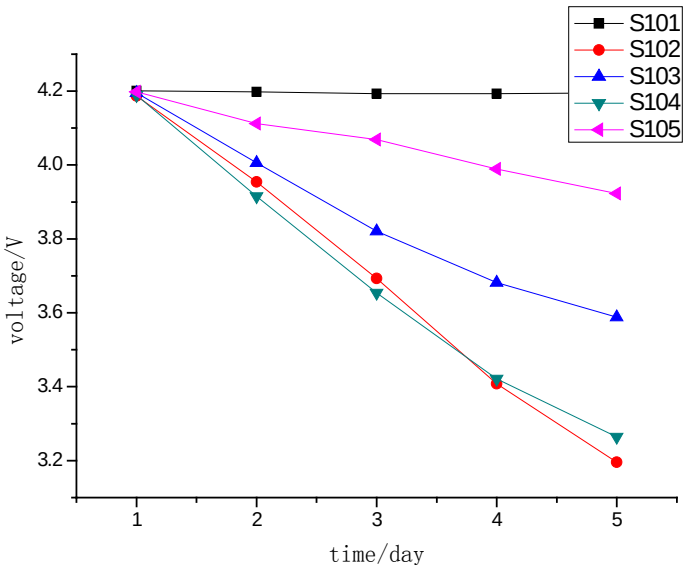

Fig. 2 voltage changes of monomer batteries in the storage period

Fig. 3 the diagram of battery assembly