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Test Method and Technique of Safety Test for Light Electric Vehicle (LEV) Battery Packs

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Abstract

Due to several incidents regarding lithium batteries in recent years, there are growing doubts about safety issues among industrials and consumers. For vehicle applications, safety requirements are more emphasized than consumer electronics; however, it still lacks of test method and abilities. In this article, a summary of existing safety test method and BATSO (BATtery Safety Organization) are shown, including BATSO01 test manual for LEV. Test equipment and laboratories of MCL/ITRI are also introduced. This will be the base of safety confirmation for LEV battery packs, in coordination with electric scooter promotion policy of Taiwan Government.

Keywords: Battery, Safety, Scooter, Regulation, LEV (Light Electric Vehicle)

1 Introduction

Light Electric Vehicle (LEV) becomes popular during past years, due to urbanization, traffic/parking problems, oil crisis and environmental issue. For urban personal transportation and short range commute, LEV could be an alternative solution instead of cars, and easy to combine with public transportation system. In addition, LEV growth also appears in some economy growing areas, where people are seeking for new mobility not as expensive as cars. As a result, global sales amount of LEV, including electric bicycle, moped and electric scooter, is estimated to more than 22 million in 2008 [1].

Due to several public aware incidents regarding lithium batteries in recent years, there are growing doubts about safety issues among industrials and consumers.

1.1 Introduction of BATSO [2]

BATSO is a cooperation project between ExtraEnergy e.V., ITRI, TUV Rheinland Taiwan and Underwriters Laboratories (UL). BATSO is not a formally independent organization at this moment. Structure and milestones of BATSO is shown in Fig. 1. BATSO trade mark (test seal) is shown in Fig. 2. The goal of BATSO is to increase safety of new battery technologies. Standardized testing methods will guarantee a fast and economic way of battery testing. Finally, in the future BATSO test seal will help all parties involved in the LEV business to find and use safe and reliable batteries.

1.2 BATSO01 test manual

In March 2008, BATSO01 Manual for Evaluation of Energy Systems for Light Electric Vehicle (LEV) – Secondary Lithium Batteries, or BATSO01 for short, was finalized and went public on 2008 LEV Conference, HsinChu, Taiwan [3] [4].

The scope of BATSO01 specifies test methods and requirements for secondary lithium battery packs for the safe use in LEV. Performance and functional characteristics are not covered. [5].

2 Test Items

Test Categories and items in BATSO01 are shown in Table 1. Test items are selected to simulate conditions likely to occur during the transport of batteries or during the operation of LEV. They cover conditions of normal operation, rough handling and likely conditions of misuse or negligent handling. Detailed test method and parameters could be found in BATSO01 test manual, which is free for downloading on BATSO website [2].

3 Test facility and test results

3.1 Test facility

Fig.3 and Fig.4 show the appearance and interior of test laboratory in ITRI, Hsinchu, Taiwan. Based on the experience of ExtraEnergy and cooperation with ITRI, the container-style laboratory was built under a contract between ITRI and Hannes Neupert Consulting.

The laboratory was finished on April 2007, and capable of doing 4 test items of BATSO01, including overcharge, external short circuit, partial short circuit and crush. Testing equipments of this laboratory are capable for battery pack with nominal voltage of 48V and rated capacity of 30Ah.

3.2 Test results

Test results of 3 critical items in BATSO01, including overcharge, external short circuit and crush test are shown in Fig.5, Fig.6 and Fig.7.

3.2.1 Overcharge test

This test evaluates the ability of a rechargeable battery to withstand under overcharge condition, in the absence of active protection devices, e.g. MOSFET or IC. The battery cells with excess energy would result in heat, possible vent, leakage, smoke, fire or explosion, depending on the nature of chemistry, design of single cell, and structure of battery pack. Left side of Fig. 4 shows the overcharge result of a 24V-5Ah e-bike battery pack. Cells with soft package design end up in volume expansion and the case of battery pack was ruptured, without fire or explosion. However, right side of Fig.4 shows an extreme violent result with fire and explosion of a 36V-10.5Ah battery pack.

3.2.2 External short circuit test

This test simulates a short circuit external to the battery pack, in the absence of active protection devices, e.g. MOSFET or IC. Additionally, certified passive protection devices, e.g. fuse or current breaker, could be included or excluded in BATSO01 test. Large current would occur at the instant of external short circuit, resulted in large amount of heat. Similar to overcharge test, possible vent, leakage, smoke, fire or explosion, depending on the nature of chemistry, design of single cell, and structure of battery pack. Left side and right side of Fig. 5 shows safe result of a 24V-10Ah battery pack and large smoke result of a 36V-10.5Ah battery pack respectively.

3.2.3 Crush test

This test evaluates the ability of a rechargeable battery to withstand a mechanical damage, e.g. traffic accident, transportation accident, or rough handling. With direct damage of battery pack caused by the test stamp, this test would be one of the most critical items in BATSO01. Left side and right side of Fig. 6 shows safe result of a 24V-10Ah battery pack and large fire of a 36V-10.5Ah battery pack respectively. Once again, the nature of chemistry, design of single cell, and structure of battery pack all played important roles in crush test.

4 Conclusion

In this article, BATSO, BATSO01 test manual, test facility in ITRI and test result is introduced.

For vehicle applications, safety requirements are more emphasized than consumer electronics; however, it’s a lack of test method and abilities worldwide, including Taiwan. In this article, a summary of existing safety test method and BATSO01 test manual for LEV are shown. Test equipment and laboratories of MCL/ITRI are also introduced. This will be the base of safety confirmation for LEV battery packs, in coordination with electric scooter promotion policy of Taiwan government.

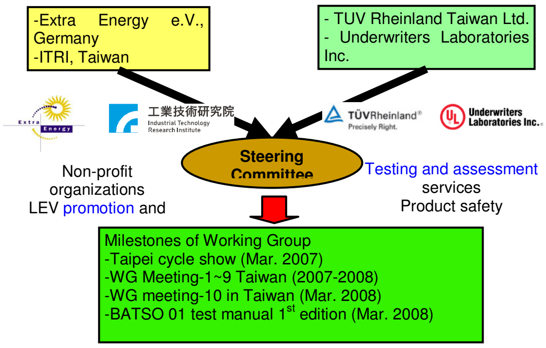

Figure1: Structure and milestones of BATSO

Figure2: Trade mark of BATSO

Figure3: Appearance of test laboratory in MCL/ITRI.

Figure4: Interior of test laboratory in MCL/ITRI.

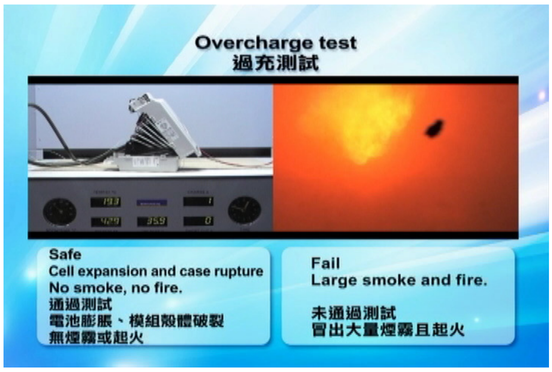

Figure5: Overcharge test

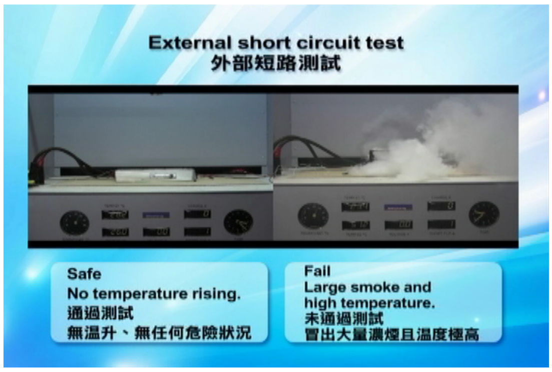

Figure6: External short circuit test

Figure7: Crush test

Table1:Test categories and items of BATSO01

Category	Sub-clause	Test item (Type test)
Electrical	5.1.1	Overcharge
	5.1.2	External Short Circuit
	5.1.3	Vibration Endurance
	5.1.4	Partial Short Circuit
Mechanical	5.2.1	Crush
	5.2.2	Shock
	5.2.3	Drop
Environmental	5.3.1	Low Pressure
	5.3.2	Thermal

References

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Authors

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