Current Status of Lithium-ion Battery in Japan

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Introduction

This paper describes the market trend of the commercial lithium-ion battery, the R & D trend from the battery symposium in Japan and the current status of "Dispersed Type Battery Energy Storage Technology". The 10years national project on lithium battery for load-leveling and electric vehicle is conducting since FY-1992 in the New Sunshine Program by the Agency of Industrial Science and Technology (AIST), Ministry of International Trade and Industry (MITI).

Market Trend of Commercial Lithium-ion Battery

Regarding power sources for portable electric devices such as cellular phone, note-book personal computer, Video and others, the lithium-ion battery and the nickel-metal hydride (Ni-MH) battery are increasing their share of the battery market in Japan after 1990. The sales value of small secondary battery such as Li-ion, Ni-MN and Ni-Cd is increasing year by year and over 500 Billion yen/year at the 1997. The shipment volume of Li-ion battery in the world is also increasing year by year and about 20 million cells at 4th quarter of 1997. The shipment value of Li-ion battery is about 20 Billion yen/M January 1998. Main supriers of Li-ion battery are SONY, SANYO, Matusita Battery Industry, AT Battery, GS Melcotec, Moli Energy, Hitachi Maxwell, Shinkobe, and so on.

Current R&D Trend of Lithium-ion Battery

The 9th international lithium battery meeting (IMLB9) was held at Saint Andrews in last June. The total presented papers are 328. The 137 presentations on cathode materials are on Mn-oxide(79), $LiNiO_2$(16), $LiCoO_2$(9), Vanadium-oxide and other(33). The papers on Mn-oxide are more than half and concerning spinner manganese-oxide. The 92 presentations on anode materials are on carbon (45), alloy system includes SnO_2(28), lithium metal(6), oxide and other. It seems strange that the Fuji-film Co. may already stop the R&D on SnO_2. On the electrolytes, 99 papers are presented. The list of items is on organic electrolytes (32), the presentation on the gel polymer (15) and dry polymer(38) which seems to be increasing,

inorganic solid electrolytes(14).

On the other hand, the 39th Battery Symposium in Japan which held in this November at Sendai City, the presented papers on lithium battery is 138(Anode(32), Cathode(50), Electrolyte(26), Battery and other(14)). The R&D on the lithium-ion battery are actively on going by universities, national institutes, private sectors and other organizations. The paper is almost on the materials such as cathode, anode and electrolytes. The R&D on cathode is mainly $LiCo_xNi_{1-x}O_2$ and spinner $LiMnO_2$. The anode materials are almost on carbon material. The R&D of electrolytes seems to shift on non-flammable organic electrolytes and polymers. The high-power Li-ion cells for Hybrid Electric Vehicle are developing at many battery manufacturers such as SONY, SAFT, VARTA and others. Also, large capacity 70-100Ah cells and 2-3kWh battery modules are successfully developing bye Sanyo, Hitachi-Shinkobe, Japan Storage Battery, Matsushita Battery Industry.

R&D Status of Dispersed Type Battery Energy Storage System

The Lithium Battery Energy Storage Technology Research Association (LIBES) is conducting R&D of the governmental program on "Dispersed Type Battery Energy Storage Technology" which R&D period is 10years since FY1992. The LIBES contracts with the New Energy and Industrial Development Organization (NEDO) on this Program. The members of LIBES share on each R&D fields.

The target of the national program is to develop 2kWh battery module for load leveling and 3kWh battery module for electric vehicle. The technical targets of energy density, specific energy, power density, cycle life for each usage shown in Table 1 are very severe. And also, the economic target is very severe.

Table 1 R&D Targets

Item	Stationary Type	EV Application Type
Battery	2kWh class module	3kWh class module
Specific Energy(Wh/kg)	120	150
Energy Density(Wh/l)	240	300
Specific Power(W/kg)	-	400
Cycle Life	3,500	1,000
Energy Efficiency(%)	90	85

The achievement of large scale cells and modules in fiscal year 1997 is summarized in Table 2. The improved performance of cells and modules will be demonstrated from November in 1998 by CRIEPI.

Table 2 Design and Performance of experimental large scale cells and Modules

Type	Cell Design	Cell	Module
A(Stationary)	$LiNi_{0.7}Co_{0.3}O_2$ Graphite Cylinder	270Wh 120Wh/kg 240Wh/l	- - -
B(Stationary)	$LiMn_2O_4$ Ag-dispersed Graphite Prism	250Wh 105Wh/kg 239Wh/l	2.0kWh 96Wh/kg 179Wh/l
C(EV Application)	$LiCo_{0.98}Mg_{0.01}Ni_{0.01}O_2$ Graphite Elliptical Cylindrical	396Wh 140Wh/kg 310Wh/l 500W/kg	3.2kWh 132Wh/kg 218Wh/l
D(EV Application)	$LiMn_2O_4$ Graphite Cylinder	370Wh 117Wh/kg 275Wh/l	2.95kWh 102Wh/kg 218Wh/l

(As of March 1998)

CRIEPI's Recent Work

CRIEPI takes part in this project as a member of LIBES and has been studying on Total System Study. Main work is the study on strategies for introduction of Dispersed Battery Energy Storage Systems and the performance and characteristic tests of 2-3kWh modules and 250-350Wh single cells for evaluation. To do this, CRIEPI has constructed the large lithium battery test facility in the Akagi Testing Center which is about 100km northern part from Tokyo.

Testing items are as follows: capacity test, peak power test, life cycle test, constant current discharge test series, thermal performance test, stand test (self-discharge test). The module and single cells are charged in accordance with the developer's recommended procedure within 8 hours. The module and single cells for stationary use are discharged at 8h rate and the ones for EV application are discharged at 5h rate on the standardized condition.

The test equipment for module and single cells is shown in Table 3. They can be operated remotely through optical fiber with the personal computers from the control room. Data can be acquired normally with sampling at 1sec and at 0.1sec in the case of transitional response like peak power test. Power capability of the equipment to test the peak power of the module for EV application is not enough for the final goal of the project. The additional equipment for DST test is planning now.

Table 3 Test Equipment for modules and Cells

Battery	Specifications	Unit number
Module	50V, ±50A 50V,+150A/-400A	4units 2units
Single Cell	10V, ±30A 10V, ±50A 10V,+150A/-500A 10V,+150A/-800A	10units 18units 4units 6units

Four reinforced-concrete rooms which internal size is 4m(L)x3m(W)x2.5m(H) are prepared for module battery tests. The thickness of wall and ceiling is 200mm. The internal walls of each room are equipped with non-flammable and adiabatic boards. Monitor camera is installed in each room that can be remotely supervised from the control room for safety. The temperature in the room is controlled constant between 10°C and 40°C.

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