THE TREND OF LITHIUM BATTERY TECHNOLOGY IN JAPAN

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Summary

The two types of lithium batteries, *i.e.*, $Li/(CF)_n$ and Li/MnO_2, which were first developed and commercialized in Japan, have now become very popular as typical 3 V lithium batteries throughout the world.

Production of the above two types of batteries has increased quickly and remarkably, in line with the development in Japan of various small consumer electronic appliances such as calculators, LCD watches, etc.

In this report, it is stated that a key to the success of the lithium battery business is the means by which the pertinent lithium battery can be successfully employed as a power source for consumer appliances, and the most important consideration is the safety aspect of the pertinent lithium battery. As an example, the development of the BR-2/3A cylindrical $Li/(CF)_n$ cell as a built-in power source for the Kodak Disc Camera is cited.

It is also emphasized that careful consideration must be paid to safety precautions involving the $Li/SOCl_2$ battery, which has recently been aggressively developed as a power source for memory back-up of microcomputers.

Introduction

It is now ten years since production of lithium batteries began in Japan. The first lithium battery produced in Japan was the $Li/(CF)_n$ battery in 1973.

In 1976, the Li/MnO_2 battery was introduced to the market and various cells were developed to meet each application. At first, cylindrical cells were used for radiosondes, rescue signal lamps, etc. Pin type cells were used for LED fishing floats, and coin type cells were used for calculators and LCD watches. The mass production technique for these 3 V batteries was firmly established and was licensed to battery manufacturers both in the U.S.A. and in Europe. As a result, these two types of lithium battery are now widely used throughout the world.

Generally speaking, lithium batteries provide both high energy density and high reliability during long periods of storage. However, since they

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employ the very reactive lithium metal with an organic electrolyte, they exhibit relatively inferior performance in respect of both safety and high rate discharge.

In this report, the means by which the new Panasonic BR-2/3A cylindrical $Li/(CF)_n$ cell has overcome these deficiences is explained, leading to its successful employment as a built-in power source of the Kodak Disc Camera, which can be regarded as a typical consumer appliance. Trends in lithium battery technology in Japan in the near future will also be briefly explained.

$Li/(CF)_n$ camera battery

When Eastman Kodak Co. decided to develop its new fully automatic camera based on entirely new conceptions, they selected the Panasonic $Li/(CF)_n$ system from the various available types of battery as its built-in power source. The reason was that this battery was found to fulfil many of their requirements, including basic safety.

Eastman Kodak Co. and Matsushita Battery Ind. Co. established a joint development program to improve the battery's high rate performance over a wide temperature range, both initially and after long periods of storage. At the same time, an extensive and thorough study was carried out of its safety characteristics. An example of a short circuit test is shown in Fig. 1. It will be seen that the flash current decreases very quickly on short circuit and the cell temperature does not rise over 140 °C. As a result, neither rupture, ignition, nor explosion was observed and the outside appearance of the cell was unchanged. Such a sudden decrease of flash current is attained by the correct

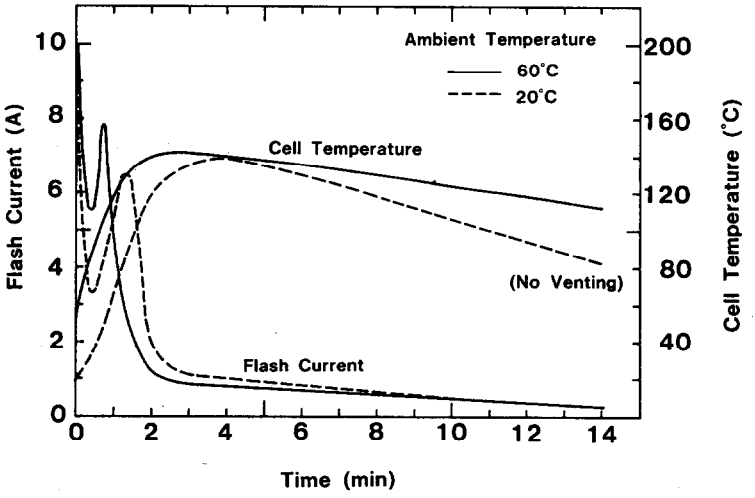
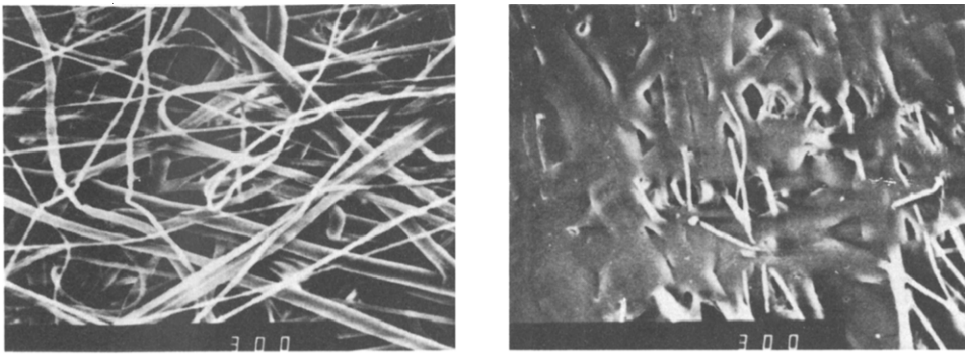


Fig. 1. Changes of temperature and flash current for fresh BR-2/3A cells on short circuit test.



(a) (b)

Fig. 2. Separator melted down in short circuit test (a) before test; (b) after 3 minutes.

selection of both the denier and the density of the polypropylene separator fibre which covers the cathode and anode, respectively.

As can be seen from the scanning electron microscope photograph, Fig. 2, the temperature inside the cell is increased by the high current flow on short circuit and, as a result, the thermoplastic polypropylene separator melts to form a film, thus preventing easy current flow between cathode and anode. Also, since the outside of the BR-2/3A cell is covered with thermoplastic polypropylene, the cell does not explode but vents gently, even when disposed of in a fire. As a result of the co-operation between the two companies, the safest and most reliable high rate type lithium battery in the world has been developed. The world's largest mass production facility for this type of battery was also completed.

The Kodak Disc Camera was marketed in 1982.

Recent trends in lithium batteries in Japan

Table 1 shows the various types of lithium batteries which are now being produced and/or developed by Japanese manufacturers. From the standpoint of safety in power sources for consumer appliances, cells up to the R14 size are produced in designs of the safest Li/$(CF)_n$ system. The production of Li/MnO_2 system cells, which employ organic electrolyte with explosive $LiClO_4$, should be limited, from the safety aspect, to small cells.

Recently, the hermetically sealed Li/$SOCl_2$ battery has been aggressively developed as a back-up power source for long period memory retention of CMOS static RAMs. Since this type of battery never fails to explode when heated, and also because it appears difficult to insure safety since it employs a toxic material, this type of battery is not regarded as a suitable power source for consumer appliances.

In 1983, the production of lithium batteries in Japan exceeded 81 million cells. For the future, there would seem to be a large market for a 1.5 V lithium battery to be used in analog-type men's watches. It is expected that

TABLE 1

Lithium batteries produced by Japanese manufacturers

Voltage Class / Battery System / Shape / Manufacturer	3V										1.5V		
	Li/(CF)n				Li/MnO_2				Li/$SOCl_2$		Li/CuO	Li/FeS_2	Li/$Bi_2Pb_2O_5$
	Cylind	Coin	Pin	Wafer	Cylind	Coin	Pin	Prism	Cylind	Disc	Button	Button	Button
Matsushita Battery (Panasonic/National)	(M)	(M)	(M)	(D)		(M)					(D)		
Sanyo Electric					(M)	(M)	(S)				(D)	(D)	
Hitachi Maxell						(M)			(S)			(D)*1	
Toshiba Battery						(M)			(D)			(D)	
Sony Eveready						(S)			(D)*2			(D)*2	
Seiko Electronic						(S)							
Fuji Electrochem. (Novel)						(S)			(D)				(D)
Japan Storage Batt. (GS)									(D)	(D)			
Yuasa Battery								(D)					

(M) : Mass Production, (S) : Small Scale Production, (D) : under Development or Sample Delivery

※1 Cathode Mixed FeS_2 and CuO, ※2 Import from Union Carbide Corp.

the technology of lithium batteries will be further developed to include rechargeable systems, in line with the development of a society demanding a high level of communication. In conclusion, the most important key factor in the further development of lithium batteries is that safety should be fully assured.