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The status of Sony Li-ion polymer battery

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Abstract

Sony developed a new thin and lightweight battery by replacing the conventional electrolyte with a new gel polymer electrolyte.

Because gel polymer electrolyte has a superior advantage of anti-leakage characteristics, the batteries need to be enclosed with hybrid laminated films. This helps modify the battery shape fixation due to conventional metal enclosure and create a variety of battery sizes. Consequently Sony was able to achieve a 3.8 mm — an ideal shape for portable use. Hybrid laminated film enclosure is lighter than metal enclosure of conventional battery, and allows additional weight-energy density when compared to conventional batteries of equal capacity.

Keywords: Gel polymer electrolyte; Lithium-ion polymer battery

1. Introduction

The appearance of lithium-ion rechargeable battery 10 years ago comes now supporting an epoch of mobile telecommunication, mainly because of the high energy density. From the viewpoint of reliability, the leakage of organic solvents used in the electrolyte may cause undesirable matters, such as the inflammable vapor of organic solvents and so on. The authors have been developing polymer electrolytes for several years to apply to the lithium-ion battery with the purpose of enhancing the reliability. Solidified electrolyte spread into an entire cell with ingenious polymer gel technology (Fig. 1), the authors succeeded in developing an ultra thin and light battery suitable for mobile phones.

2. The features

2.1. No solvent leakage makes battery thin and light

A gel polymer electrolyte with an advantage of anti-leakage characteristics makes it possible for the laminated film to enclose a lithium-ion polymer rechargeable battery. Unlike conventional liquid-electrolyte batteries that have a fixed shape due to metal enclosure, Lithium ion polymer rechargeable batteries are thinner (3.8 mm) and more suitable for cellular phones. Further, because the laminated film enclosure is lighter than conventional batteries, lithium-ion polymer rechargeable batteries achieve higher weight-energy density than conventional lithium ion batteries of equal capacity.

2.2. Enhanced safety

As the result of polymer gel method, the authors could eliminate liquid or fluid. Thus there is no fear of electrolyte leakage even if cell cases are broken. In addition there is no increase in internal vapor pressure. Therefore, it is possible to utilize thin film of Al and plastic layers for cell cases as commonly used in retort food packs. Since there is no significant solvent vapor, there is no chance to cause a fire, resulting in enhanced reliability and safety [1,2].

2.3. Performance similar to a conventional Li-ion battery

2.3.1. Ionic conductivity

As known in general, the ionic mobility in a gel was supposed to be insufficient to perform practical battery functions. The major breakthrough is no doubt due to the improvement in ionic conductivity of a gel electrolyte, as shown in Fig. 2. It is speculated that trapped ions stabilized with solvents in the matrix of polymer molecules

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Fig. 1. The outside of Sony's gel electrolyte.

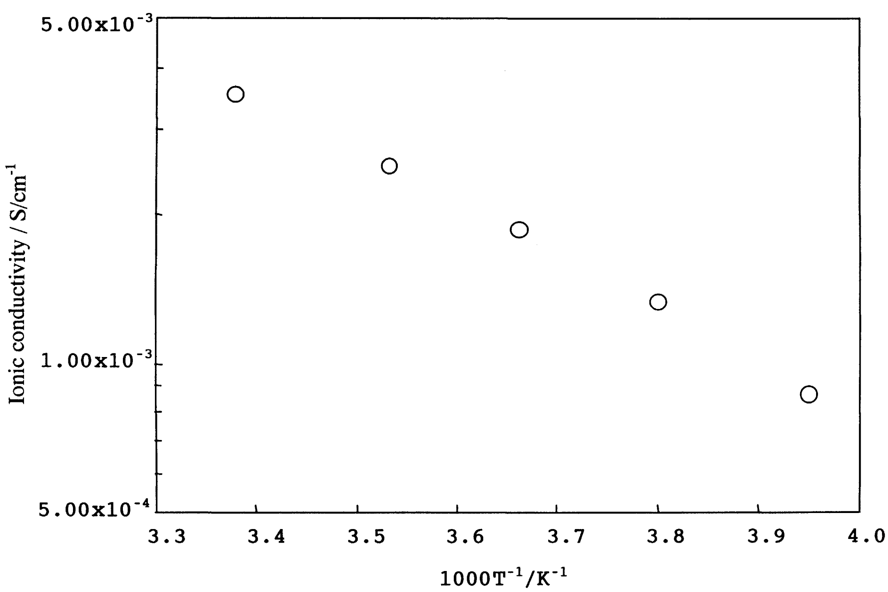

Fig. 2. Ionic conductivity of Sony's gel electrolyte.

work elaborately in the high drain condition and at low temperature.

2.3.2. Cell performance

High drain, low temperature capability and durability in high temperature storage are shown in Table 1 (from latest R&D).

Even at 3C rate, the batteries can load 90% (versus 0.2C) of the retention capacity at room temperature and also keep GSM pulse load operation stable at the applied device (Fig. 3). Also, at -10°C, the batteries can secure 60% of the retention capacity at room temperature and keep good operational stability of the applied device.

Table 1
Updated result in R&D

Size ($D \times W \times H$)	$3.8 \times 35 \times 62(54)$ mm
Weight	15.5 g
Nominal capacity	690 mAh
Nominal voltage	3.7 V
Charge voltage	4.2 V
Charge time	90 min
Energy density (volume)	375 Wh/L
Energy density (weight)	165 Wh/kg
Cycle performance	83% @ 1000 cycle
Temperature range	-20–60°C
Cathode	$LiCoO_2$
Anode	Graphite

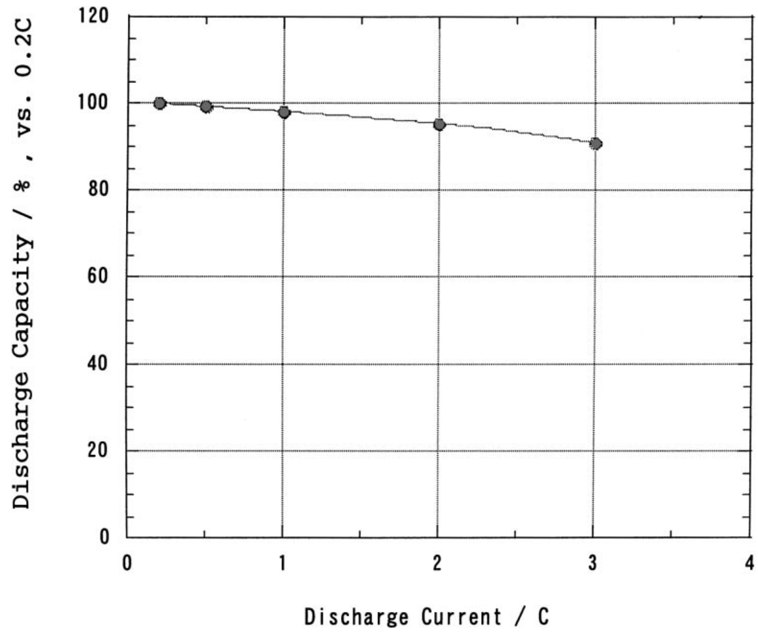

Fig. 3. The drain capacity of Sony's lithium-ion polymer battery. Charge: 0.5 C max, 4.2 V max, 6 h or 0.005 C cut. Discharge: 3 V cut. Temperature: 23°C.

3. Conclusions

The lithium-ion polymer battery developed by Sony has thin and lightweight property as its characteristics. Increment of ionic mobility is not dependent on the physical shape. This gel polymer electrolyte has also achieved the superior electrochemical stability that is required in the lithium ion charged-discharge conditions. The batteries can perform 83% (versus first discharge capacity) of the retention capacity even after 1000 cycles of 1C charge/1C discharge at room temperature. This battery also indicated the energy density of 1200 W/kg at 50% DOD. In R&D facility, we are still continuing to improve the performance of this battery.

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