Organic Radical Battery and Its Technology

Introduction

With the aim of realizing a more affluent world it seems likely that in the future a wide variety of intelligent devices will be widely spread over all corners of society. Energy devices are increasingly becoming a part of the sophisticated input that are supporting this trend. The batteries for the next-generation ubiquitous applications are therefore likely to require a short charging time, a long life cycle, high power and energy densities, and environmental friendliness.

The organic radical battery (ORB) is a new class of rechargeable battery that is being uniquely developed by NEC. It uses the electrochemical reaction of organic radical compounds. This technology was initially proposed by NEC in 2001[1]. Due to the high reactivity and reversibility of the radical reaction, the organic radical battery demonstrates a rapid charging capability and good cycleability[2]. Additionally, organic radical polymer appropriate for forming the flexible thin film battery. ORB contains no harmful heavy metals, and thus opens up a new field of ubiquitous devices with environmentally friendly battery.

Figure 1 shows the positions of several energy devices and the ORB prototype cell. The ORB overcomes the limitations of the conventional energy devices with regard to high power density problems.

This paper describes the properties and the potential applications of the ORB.

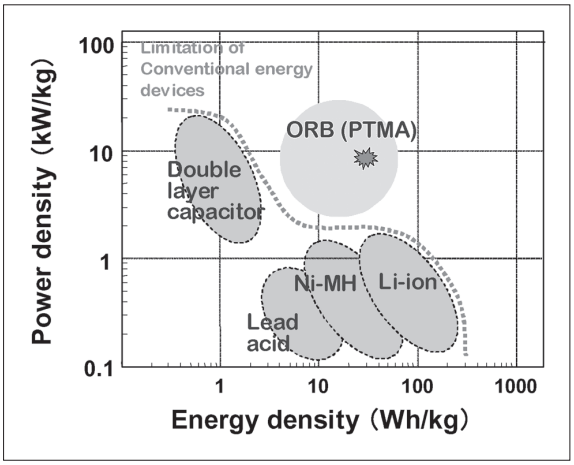

Fig. 1 Positions of the ORB and other energy storage devices on the plots of energy density and power density.

Fundamental Properties of the ORB

(1) Configuration

The ORB consists of cathode and anode active electrodes separated by a porous film immersed in an electrolytic solution. It is similar to the commercialized Lithium ion battery except for the use of organic radical compounds (PTMA) instead of lithionated metal oxide (**Fig. 2**).

(2) Features

One of the unique features of the ORB is its capability to charge large current loads with a good utilization of the capacity, as illustrated in **Fig. 3**. In this figure, C is the value indicating current that is expressed as a multiple of the nominal capacity. It is clearly observed that the ORB is enabled to charge up to 80% within 1 minute (60C). This result means that ORB can be charged whenever and wherever necessary.

Another unique feature of the ORB is its extraordinary cycle life. The ORB is capable of several thousand charging and discharging cycles. Moreover, the ORB has been confirmed to be non-flammable and non-explosive.

Besides these unique properties, the charge storage capacity of the present ORB is lower than that of a conventional battery. The synthesis of new radical compounds with higher capacities, i.e., higher radical concentrations, is the greatest challenge in achieving a high power and high capacity type ORB in the future.

(3) Potential Applications

In the early stages of experiments, our R&D has been focused on the application of the emergency power source, and we have confirmed the development of the built-in type ORB used to protect IT equipment such as the desktop PC from losing

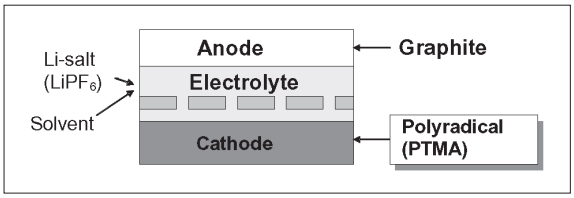

Fig. 2 Schematic representation of organic radical battery.

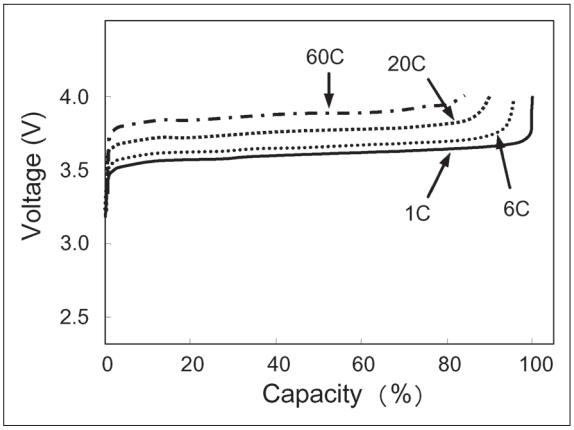

Fig.3 Charging curves of the ORB measured at various current rates.

Fig. 4 100mAh class film packed ORB cell.

data during power supply interruptions[3]. The film packed ORB (size: 55×43mm, 4mm thick, **Fig. 4**) demonstrates a maximum power of 35W and its four series connected cells are capable of driving a 140W class desktop PC, in the event of power failures.

Because of its unique features, the ORB has a wide range of potential applications as a power source not only for laptop PCs and PDAs but also for a variety of ubiquitous appliances such as smart cards, sensors, intelligent papers, radio frequency identification tags and micro-sized devices as shown in **Fig. 5**.

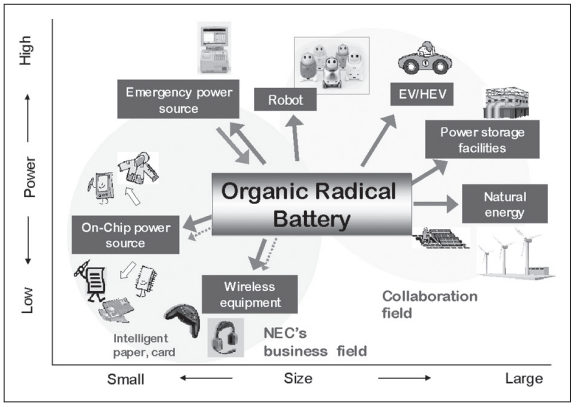

Fig. 5 Potential applications of rapid charge, high power ORBs.

Conclusion

The ORB can be charged and discharged within several ten seconds. The confirmed power density, 10kW/kg, indicates that the cell is capable of driving a various information systems such as desktop PC and PDAs. We believe that the quick chargeability of ORB opens up a new field for the energy device for the next IT society, especially as a ubiquitous power source.

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