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Performance study of the $LiCoO_2$/graphite system

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Abstract

Lithium-ion AA battery with $LiCoO_2$ as the cathode and graphite-like carbon as the anode is developed. Performance versus modification of the anode such as copper-foil type, additive, paste-mixing method, material treatment, and electrode treatment, etc., is studied. Finally, an AA battery with 500 mAh capacity and good cycle life is developed. © 1997 Published by Elsevier Science S.A.

Keywords: Lithium-ion batteries; Conductors; Binders

1. Introduction

With the rapid advance in microelectronics, the size and weight of many portable electronic products have been reduced significantly in the last years. High energy density batteries become a key factor in ensuring these products having good performance.

New generation of high energy lithium-ion batteries has attracted a great deal of attention for laptop computers, cellular phone, and camcorders applications [1–4]. For the development of lithium-ion batteries, the cathode, anode and electrolyte are three important components for improving their performance. In this work, modification of the anode [5–7] such as copper-foil type, additives, paste-mixing method, material treatment, and electrode treatment are studied to improve the performance of lithium-ion batteries, and an $LiCoO_2$/graphite AA battery was developed with 500 mAh capacity and good cycle life.

2. Experimental

Lithium–cobalt oxide ($LiCoO_2$) powder was mixed with poly(vinylidene fluoride) (PVDF) binder and a conductor, then dispersed in NMP solvent to produce a slurry. The slurry was coated on both sides of a web of aluminum-foil current collector, then dried, and compressed to shape by a roll press, thereby producing a cathode electrode. Graphite powder was mixed with the PVDF binder and additives, then dispersed in NMP solvent to produce a slurry. The slurry was coated on both sides of a copper-foil current collector, then dried, and compressed to shape by roll press, thereby producing a anode

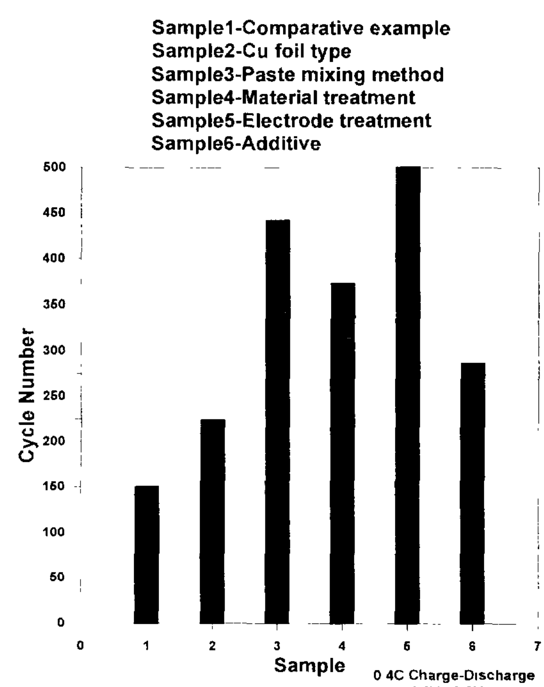

Fig. 1. Change in cycle life of samples 1 to 6.

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electrode. A lithium salt dissolved in a mixture of carbonate solvents ($LiPF_6$/EC + DEC) was used as electrolyte. Microporous polyolefin (PP, PE) was used as separator. An AA-size lithium-ion battery was made by spirally wound anode, cathode, and separator together into a jelly roll, then inserted into a 14500 can. After addition of electrolyte and cap, the cell was sealed with crimping. The AA-size lithium-ion battery was charged with a constant current followed by constant voltage charging to 4.1 V, then discharge with a constant current to 2.8 V. The current rate was 0.4 C and 1 C.

3. Results and discussion

Fig. 1 shows the change of cycle life in an $LiCoO_2$/graphite system lithium-ion battery of samples 1 to 6. As compared with a comparative example, the cycle life of other samples are improved from 150 cycles to 300–400 cycles with a current rate of 0.4 C. So, the selection of copper foil, paste-mixing method, additives, material treatment, and electrode treatment are very important for the anode electrode to achieve better cycle life of a lithium-ion battery. Summarizing the results, an $LiCoO_2$/graphite lithium-ion battery is developed. Fig. 2 shows the charge/discharge characteristics of MRL's lithium-ion battery. The standard charge pattern for lithium-ion battery is constant current then constant voltage. The charge voltage and current profiles are shown in Fig. 3 with 0.4 C and Fig. 4 with 1 C. Using this method, the battery can be charged to approximately 90% of full charge capacity in 1 h with 1*C* rate. The discharge rate capability of MRL's lithium-ion battery is shown in Fig. 5. At a high rate the voltage and capacity is depressed. However, it still has 95% capacity to the low rate capacity. Fig. 6 shows the cycle-life characteristics for MRL's lithium-ion battery at a 500 mA

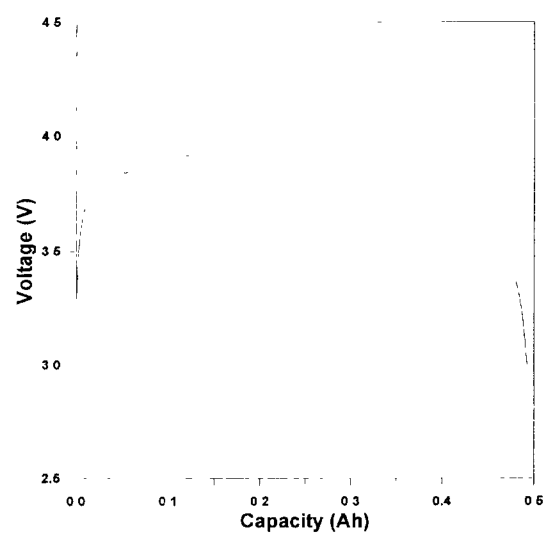

Fig. 2. Charge/discharge characteristics for MRL 14500 lithium-ion battery.

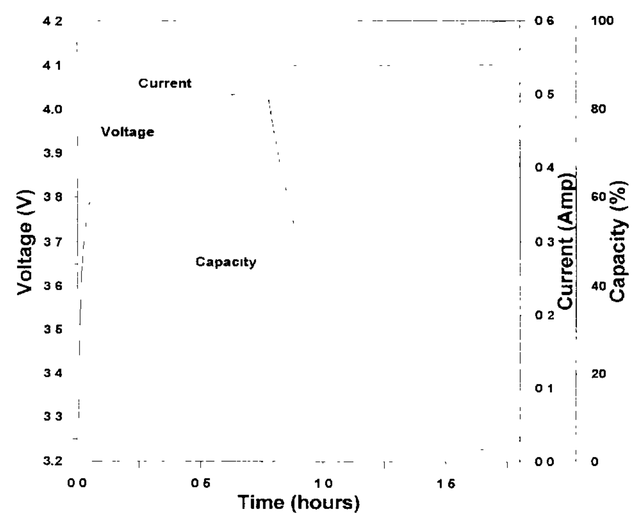

Fig. 4. Charge characteristics for MRL 14500 lithium-ion battery at 1 C

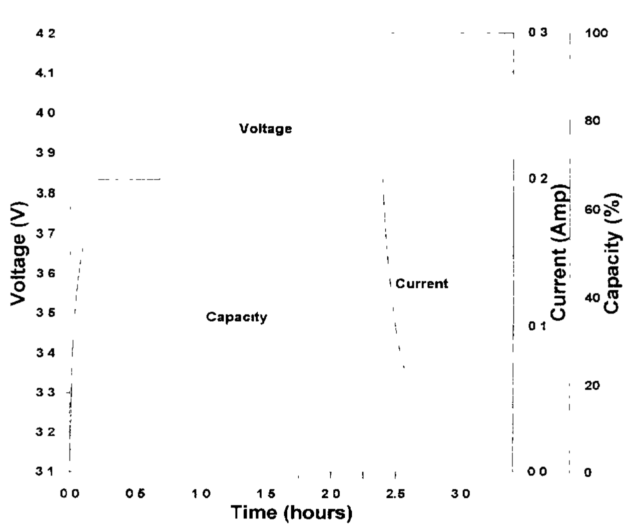

Fig. 3. Charge characteristics for MRL 14500 lithium-ion battery at 0.4 C

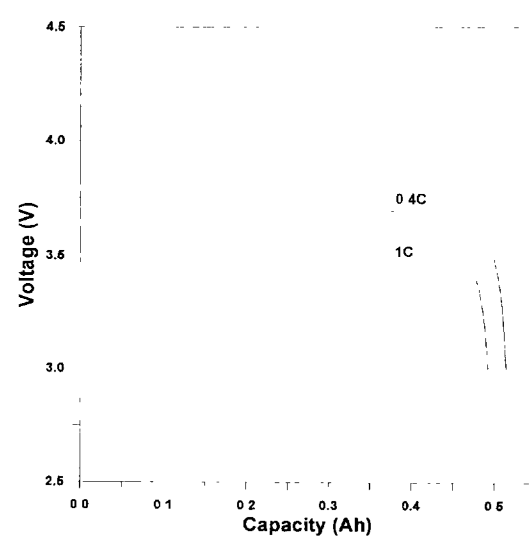

Fig. 5. Discharge characteristics for MRL 14500 lithium-ion battery

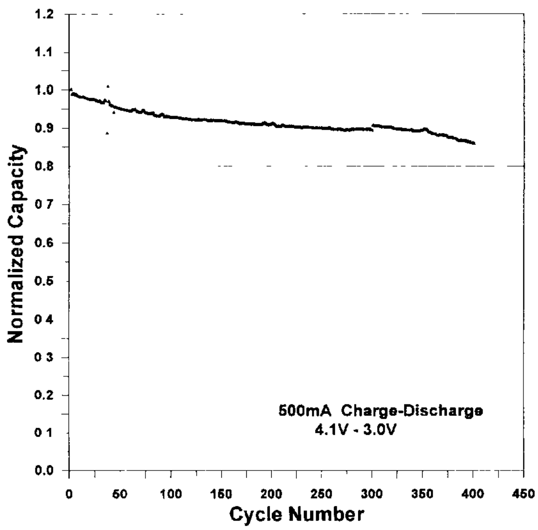

Fig. 6. Cycle-life characteristics for MRL 14500 lithium-ion battery

or 1*C* rate with 100% depth-of-discharge. After 400 cycles, the battery still retains 85% of their initial capacity.

4. Conclusions

An $LiCoO_2$/graphite AA battery is developed with 500 mAh capacity and a 400 cycle life. More works such as cathode/anode balance and formation method are going to improve the battery performance. Also, other performance tests and environmental and safety tests will be the next important work in our laboratories.

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