Optimization of activated carbon of electric double layer capacitor for negative or positive electrode with different properties

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Abstract

The electric double-layer capacitor (EDLC) using activated carbon as the electrode has been recognized as an efficient storage device for the electric power because of its better rate capability and longer cycle life as compared to secondary batteries. Recently, new applications utilizing such performances have been attempted as an energy device for electric vehicle or pulse-current supply. In order to meet the specification for new applications, it is necessary to develop a particular activated carbon of much higher energy densities per both weight and volume than those of the conventional ones at the large power densities. Conventional activated carbon for EDLC was applied for same activated carbon between positive and negative electrodes. Activated carbon for EDLC should be optimized to correspond to positive or negative electrode because the size of anion or cation is very different. In this study, their charge and discharge profiles on positive or negative electrode were individually investigated. In this study, the electrode was consisted of 2 type activated carbon. One activated carbon had high surface area (3000 m^2/g), another one was medium surface area (600 m^2/g). And then, optimization of activated carbon for positive or negative electrode was achieved to get stable cycle property.

1. Introduction

EDLC using activated carbon as electrodes has been recognized as an efficient storage device for the electric power because of its better rate capability and longer cycle life as compared to secondary batteries Recently, new applications utilizing such performances have been attempted as an energy device for electric vehicle or pulse-current supply. It is necessary to develop a particular activated carbon of much higher energy densities per both weight and volume than those of the conventional ones. The conventional EDLC was applied for same activated carbon between positive and negative electrodes. Activated carbon for EDLC should be optimized to correspond to positive or negative electrode because the size of anion or cation is very different. In this study, their charge and discharge profiles on positive or negative electrode were individually investigated by using various activated carbons. Optimization of activated carbon for positive or negative electrode was carried out using different properties of carbon such as optimized pore size and controlled carbon surface.

2. Experimental

2.1. Preparation of activated carbon

Optically anisotropic spherical carbon prepared from coal based isotropic pitch was activated with 4 times of NaOH (M600) and KOH (M3000) in weight at 700℃ or 800℃ for 1h, respectively. The obtained activated carbons (M600 and M3000) showed the specific BET surface areas of 600m^2/g (M600) and 3000m^2/g (M3000), respectively.

2.2. Measurement of capacitance

The electrode was a roll-pressed disc (M3000:10mg, M600:20mg) prepared from a mixture of M600 or M3000, carbon black conductor (Ketjen-black E) and polytetrafluoroethylene (PTFE) binder (8:1:1 weight ratio). The specific capacitance was measured by the two-electrode system using tetraethylammonium tetrafluoroborate (Et_4NBF_4 1M) in propylenecarbonate (PC) as an electrolyte. The test cell was charged to 2.7 V at a constant current (100mA/g) and voltage, and then discharged at a constant current to 0 V. Furthermore, The monitoring system of positive and negative elecrode was shown in Fih. 1in order to measure separately positive or negative electrode.

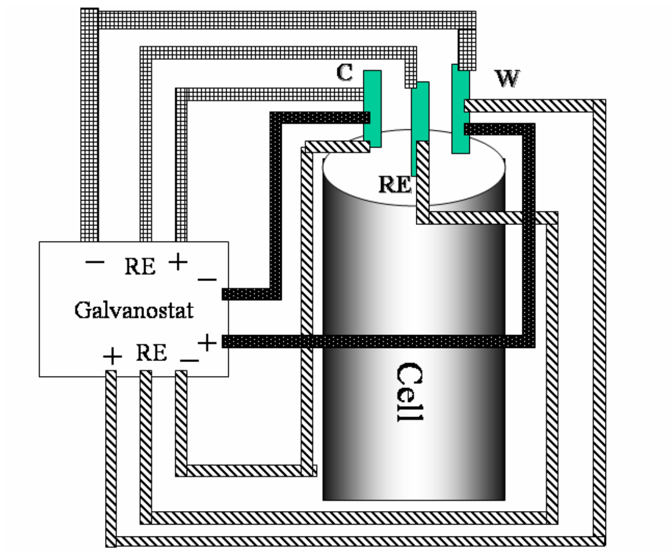

Fig.1 Monitoring system of positive and negative electrode.

W: Working electrode, C: Counter electrode RE: Reference electrode

3. Results and discussion

Fig. 2 and 3 showed charge and discharge profile of M3000 and M600, respectively M3000 showed steady increase of voltage with the time. Linear increase of voltage with time of M3000 indicates proportional increase of adsorption with the charged voltage. In contrast, M600 showed rapid increase of charged voltage to 2V and then very gradual increase above 2V to 2.7V. The gradual increase may indicate the change in pore structure of M600 at above 2V. It was implied that deformation of pore structure was caused under electric field condition [1].

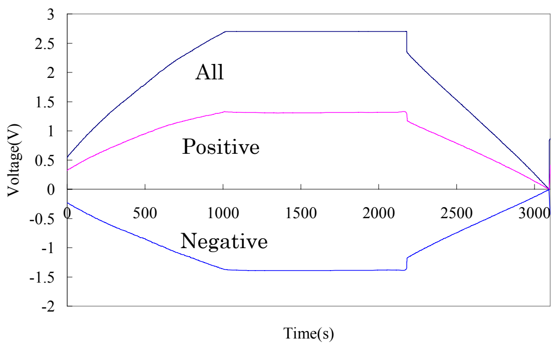

Fig. 2 Charge and discharge profile of M3000

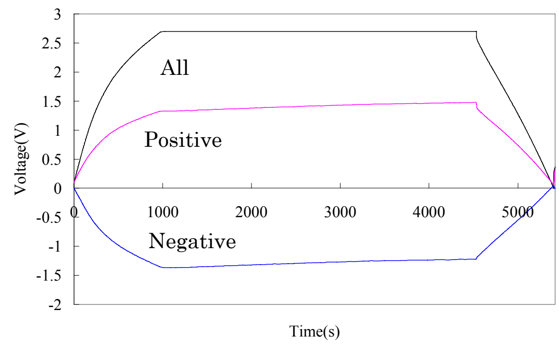

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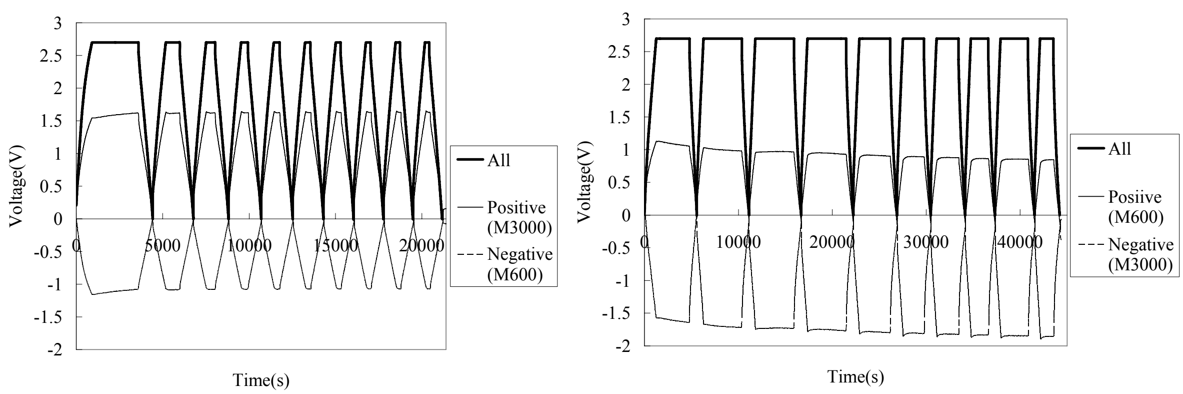
Fig. 3 Charge and discharge profile of M600

Fig. 4 shows charge and discharge profiles combined electrode with 1 to 10 cycles. In Fig. 4(a), positive or negative electrode was consisted of M3000 or M600, respectively. In contrast; in Fig. 4 (b), positive or negative electrode was consisted of M600 or M3000 respectively. The profile of Fig. 4 (a) suggested stable charge and discharge, however, the profile of Fig. 4 (b) was shown to decrease voltage on positive electrode. This is why, optimization of activated carbon for positive or negative electrode was required for improvement of EDLC. Various activated carbons were attempted to be combined to find good properties of capacitor.



(a)Positive (M3000) Negative (M600)

(b)Positive (M600) Negative (M3000)

Fig. 4 .Charge and discharge profile of combined electrode

Reference

〔1〕 S. Mitani, S-I. Lee, K. Saito, Y. Korai, I. Mochida Electrochimica Acta, **2006,** 51, 5487