ELECTROCHEMICAL CHARACTERISTICS OF ACTIVATED CARBON ELECTRODES USING ORGANIC LIQUID ELECTROLYTES BASED ON LITHIUM SALTS FOR ELECTRIC DOUBLE LAYER CAPACITOR

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Introduction

The Specific capacitance and the discharge rate of EDLC(Electric Double Layer Capacitor) were affected by the species of electrolytes and physicochemical properties of activated carbons electrodes. Here we investigated the electrochemical characteristics of the cells for EDLC to find the effects of the properties of activated carbons electrodes and the components of electrolytes on their specific capacitance.

Experimental

Four kinds of commercially available activated carbons, BP-15, BP-20, BP-25(Kuraray Chem. Co.) and MSP-20(Kansai Cokes) were chosen for this study. The BET surface area of carbons was measured by ASAP 2010®. The amount of surface oxygen functional groups was measured with temperature-programmed desorption (TPD). The gases evolved from thermal decomposition of the surface oxygen functional groups were CO and CO_2. Composite working electrodes were prepared by the following procedures: i) mixing of activated carbon, acetylene black and poly vinylidene fuloride binder, making a slurry by adding an acetone solution, ii) coating made on the aluminum mesh by dipping it into the slurry, iii)drying and pressing were carried out to prepare the electrode. Used electrolytes were lithium salt of ClO^{4-} and PF^{6-} dissolved in a mixture of diethyl carbonate(DEC) and propylene carbonate(PC). The manufactured EDLCs were cycled under galvanostatic conditions between 0 and 2V, under a current density of $2mA/cm^2$. The capacitance of the cell was determined by calculating the slope of the V(t) plot.

Results and Discussion

Figure 1 shows the relationship between the surface area and specific capacitance of the electrodes prepared. The capacitance of BP of activated carbons slowly increased with the surface area. However, the BP-20 and MSP-20 that have almost the same surface areas as shown in Figure 1 have a big difference in the specific capacitance. The pore size distribution of BP-20 and MSP-20 was compared in Figure 2. The large fraction of micro pore of BP-20 leads to the decrease in specific capacitance, which is probably due to the hindrance of mass transfer of electrolyte. The TPD profile patterns and the amount of surface functional groups between BP-20 and MSP-20 were almost the same as in Figure 3. So, effect of the surface functional groups on the specific capacitance was insignificant. As shown in Figure 4, the electrode of MSP-20 in 1 M $LiPF_6$ in the mixture of PC and DEC(1:1) showed the highest capacitance in the range studied. This could be attributed to optimum pore size distribution and composition of electrolytes.

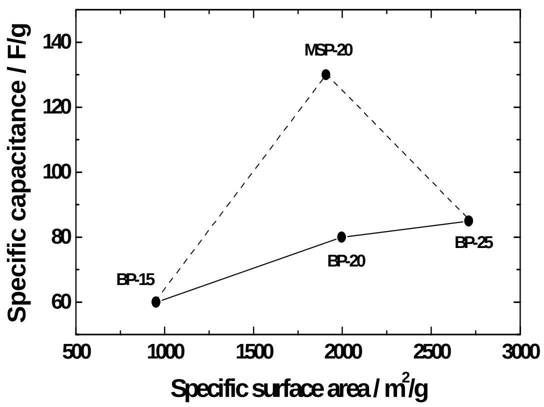


Figure 1. The relationship between the specific capacitance and the surface areas of activated carbons employed.

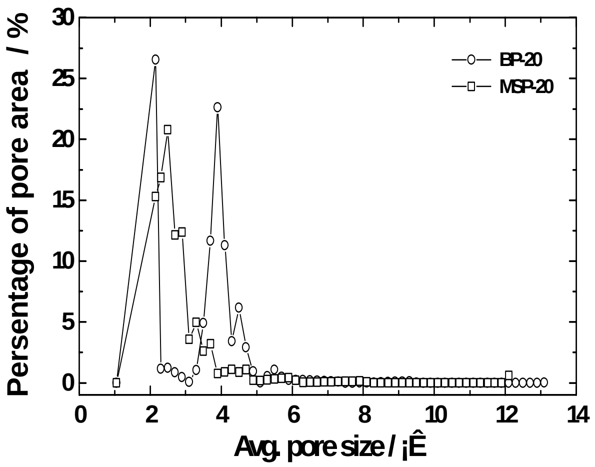
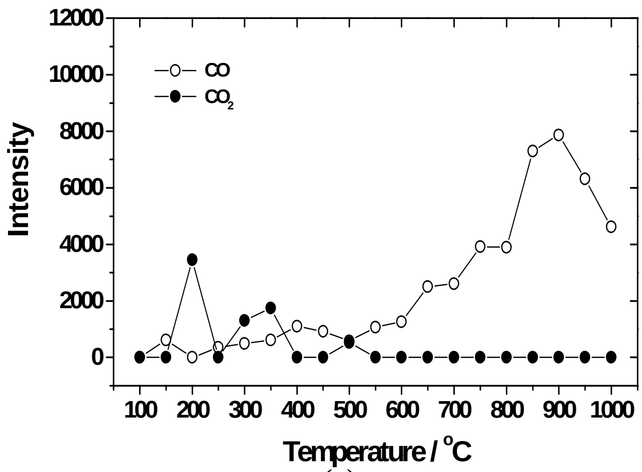
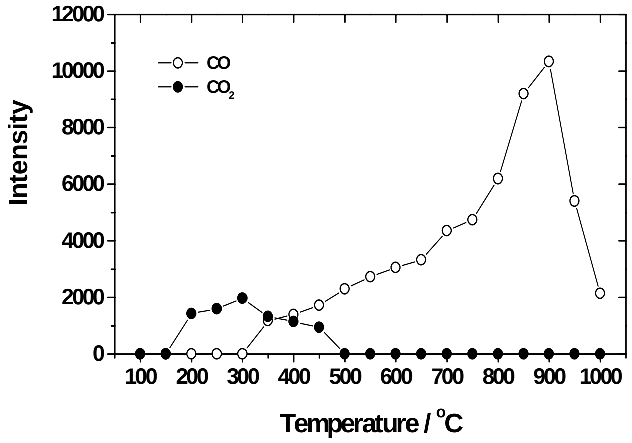


Figure 2. Comparison of pore size distribution between the BP 20 and MSP 20.



(a)



(b)

Figure 3. TPD profiles of activated carbons (a) BP-20, (b) MSP-20. Heating rate of 10°C/min

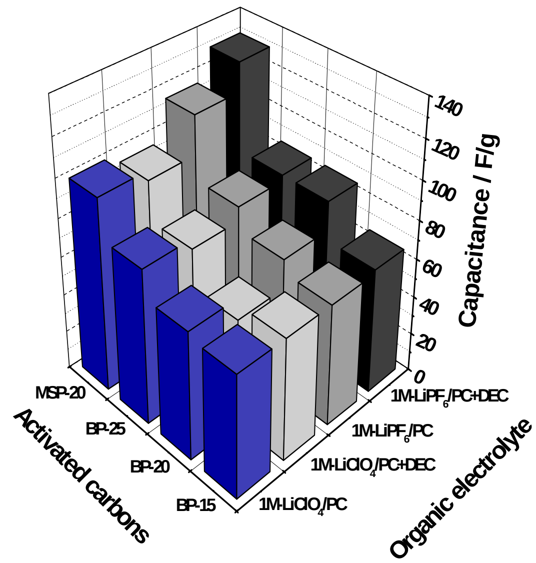


Figure 4. The specific capacitance as a function of different species of the activated carbons and the organic electrolytes based on lithium salt.