PREPARATION OF ELECTRODES FOR ELECTRIC DOUBLE LAYER CAPCITOR FROM EXFOLIATED MCMB/CARBON COMPOSITES WITH PYRENE-BASED COPNA RESIN

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1. Introduction

Performance of electric double layer capacitor (EDLC) depends on the properties of carbon materials such as porosity, electrochemical activity on the surface, and electrical conductivity[1]. Large surface area of carbon materials and edge sites of graphite like basal plane are expected to contribute the increasing in capacitance[2].

Here we will report the effect of edge sites on increasing in capacitance of EDLC with exfoliated MCMB(Ex-MCMB). As MCMB consists in stacking structure of polycyclic aromatic planes with small area size, the edge sites of the plane would effectively contribute to increase in the capacitance of EDLC by exfoliation of MCMB.

Two kinds of electrodes were prepared, that is, one was prepared from Ex-MCMB, carbon black, and PTFE and another was prepared by carbonization of the film preformed from Ex-MCMB and pyrene-based COPNA resin. The latter electrode was expected to decrease the electric resistance generated between Ex-MCMB powders or between Ex-MCMB powder and current collector. In the case of the latter one, the effect of electrochemical oxidation of the electrode surface on increasing in capacitance will be also reported because the edge surface of Ex-MCMB particle may have the possibility of coating by pyrolitic carbon based on COPNA resin.

2. Experimental

2.1. Materials.

Ex-MCMB was made by rapid heat-treatment of intercalated MCMB prepared with mixed acids of sulfuric and nitric acids. Pyrene based COPNA resin was prepared by heating the mixture of pyrene and 1,4-benzene dimethanol with acid catalyst at 130℃.

2.2. Instrumentation.

Specific surface area of MCMB before and after exfoliation was measured with an automatic adsorption instrument at 77K. The surface of the samples was observed with a scanning electron microscope (SEM). Crystal structure was measured with an X-ray powder diffractometer.

2.3. Preparation of electrode for EDLC.

Ex-MCMB was impregnated with chloroform solution of pyrene-based COPNA resign. Ex-MCMB/carbon composites were made by casting the above chloroform solution on aluminum foil before heating at 1000 ℃.

2.4. Electrochemical oxidation with KOH.

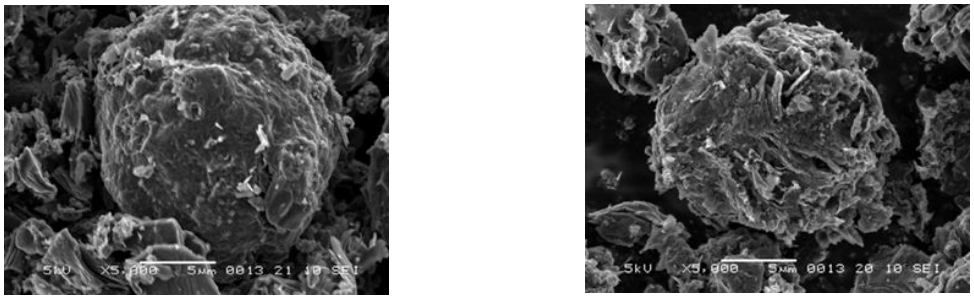
Electrochemical oxidation was carried out in 30wt% of KOH electrolyte solution under 1.2V of applied voltage.

3. Results and Discussion

3.1. Exfoliated MCMB particles.

Figure 1 shows typical SEM images of MCMB particles before and after rapid heat-treatment at 1000℃. Intercalated MCMB in Fig.1 (a) did not contain any expanded structure but Ex-MCMB in Fig.1 (b) produced the accordion-like structure by thermal decomposition of intercalated MCMB. Specific surface area calculated by BET

equation increased through exfoliation. However the surface of Ex-MCMB in the Ex-MCMB/carbon composites was covered with COPNA resign char and the accordion-like structure was not observed.



(a) MCMB particle before exfoliation (b) MCMB particle after exfoliation

Figure 1. SEM images of MCMB powder before and after exfoliation.

XRD profiles of MCMB before and after rapid heat-treatment showed the formation of intercalation compounds and the revival of layer structure after thermal decomposition of intercalated MCMB.

3.2. Effect of Electrochemical oxidation

Electrostatic capacitance from Ex-MCMB/carbon composites electrode before electrochemical oxidation treatment was very low as shown in Fig.2. However, the capacitance was improved as the COPNA resign char coating was removed by electrochemical oxidation from the surface of Ex-MCMB/carbon composites electrode.

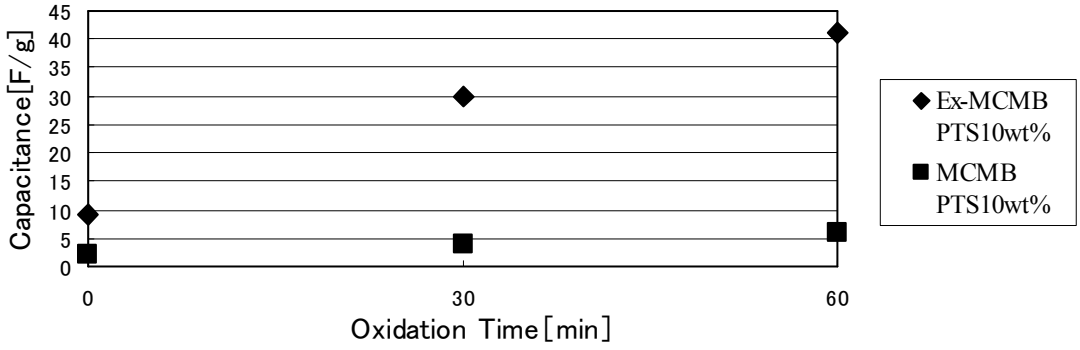


Figure 2. Improvement of electrostatic capacitance by electrochemical removing of carbon coating.

4. Conclusion.

Ex-MCMB was prepared by rapid heat-treatment and the accordion-like structure was observed in SEM images. Electrode for EDLC molded with Ex-MCMB and COPNA resin showed very small electrostatic capacitance but the value was improved through electrochemical oxidation. Further devising of exfoliation and electrochemical oxidation would lead to increasing in electrostatic capacitance.

5. References.

[1] Bleda-Martinez M.J.,Macia-Agullo J.A., Lozano-Castello D., Morallon E., Cazorla-Amoros D., Linares-Solano A., Role of surface chemistry on electric double layer capacitance of carbon materials, Carbon 43, 2977-2684(2005).

[2] Soneda Y., Toyoda M., Hashiya K., Yamashita J. , Kodama M., Hatori H., Inagaki M., Huge electrochemical capacitance of exfoliated carbon fibers, Carbon 41, 2653– 2689 (2003).