Characteristics of supercapacitor using carbon electrodes with reduced graphene oxide coated mesocarbon microbeads

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1. Background

With the rapid expand upon science and technology, people are projected to develop new energy sources, and effective methods must be established for energy-stored systems. Supercapacitor (SC) is a new charge storage device positioned between traditional capacitors and batteries, which use electrochemical activated materials or porous materials for storage. The advantages of supercapacitors are high power density, high energy density, good cycle life, and fast charge/discharge times. Therefore, supercapacitors could improve the disadvantages of the traditional batteries and capacitors.

In this study, the mesocarbon microbeads (MCMB) are mixed with various content of reduced graphene oxide (rGO), and the influence on characteristics of supercapacitors are discussed.

2. Methods

First, adding 1 g MCMB to the solution of rGO which content is ranged from 0 to 4 w.t.% and stirring the solutions evenly. Then the solutions were heated in an oven at 200°C for 6 h and grinding the baked carbon block to powders. Finally, the composite carbon powders were added to a solution of 2 w.t.% polyvinyl butyral (PVB) with dimethylaminoethanol (DMA, 9 g), and the carbon mixtures are obtained. The carbon electrodes were prepared on the ITO
glasses by spin-coating the carbon mixtures and then evaporating the solvent at 150°C for 25 min.

In this study, the surface morphology of the carbon electrode was analyzed using a field emission scanning microscope (FE-SEM) and Raman spectra. Cyclic voltammetry (CV) measurements of the carbon electrodes were performed using an electrochemical analyzer (CH Instruments, 6273E) in two-electrode cells. The CV measurements in 1 M KOH electrolyte from -0.5 to +0.5 V were made using a potential sweep of 25 mV/s.

3. Results/Conclusion

This study focuses on the investigation of addition of rGO, to obtain the optimum compositions of composite carbon electrode. When 3 wt.% rGO is added to the carbon electrode, the optimized specific capacitance of 246 F/g can be obtained. Figure 1 presents SEM micrographs of the MCMB with 3 wt.% rGO electrode. It is showed that the surface of the composite powder was covered with graphene and the granule of MCMB became unobvious. The CV results of adding various graphene contents are shown in Fig. 2. The hysteresis area obviously increased when the graphene content increased. However, when the amount of rGO is increased further, the specific capacitance decreases to 230 F/g. The reason should be attributed to the overlying of rGO on the activated carbon surface, which will decrease the specific surface area and capacitance characteristic. In conclusion, adding of 3 w.t.% rGO to the carbon electrode will improve electrode conductivity and result in enhanced capacitance.

![Fig1. SEM micrographs of the MCMB with 3 wt.% rGO electrode.](image1)

![Fig2. Cyclic voltammograms of MCMB electrodes with various contents of graphene.](image2)

**Keywords:** supercapacitor, mesocarbon microbeads, reduced graphene oxide, cyclic voltammetry