Preparation and characterization of carbon aerogel/polymer composites for supercapacitor

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Supercapacitors have attracted great interest because they combine the advantages of the high specific power of dielectric capacitors and the high specific energy of rechargeable batteries[1]. The energy storage of supercapacitors based on double layer is the accumulation of ionic charges which occur at the electrode/electrolyte interface. So the high specific surface area and the porosity of carbon electrode materials are the basic requirements to achieve high specific capacitance. Carbon aerogel is a kind of novel mesoporous carbon materials with an electrically conductive carbon network, a low density, high specific surface area, and other interesting properties [2-4].

In this study, electrode materials using carbon aerogel/polymer composites were developed to improve the electrochemical performance of supercapacitor. RF aerogels were synthesized via the sol-gel polycondensation of resorcinol(R) with formaldehyde(F) in a slightly basic aqueous solution. Carbon aerogels were obtained by pyrolyzing the RF aerogels at 1173K. The control of mesoporous structure and surface area of the carbon aerogels was studied by changing the amount of resorcinol(R) and sodium carbonate(catalyst, C) used in the polycondensation. The effect of resorcinol-to-catalyst ratio (R/C ratio) on BET surface area, pore size distribution was investigated by changing R/C ratio from 500 to 1500. Physical properties of carbon aerogel prepared at different R/C ratio are listed in Table 1. It is noteworthy that BET surface area showed a volcano-shaped trend with respect to R/C ratio. Among the samples, the carbon aerogel prepared at R/C ratio of 800 showed the highest BET surface area (869.47m2/g) and pore size(7.9353nm). Therefore, we used carbon aerogel prepared at R/C ratio of 800.

Table1. Physical properties of carbon aerogels

	BET surface area	Pore Volume	Pore size
R/C=500	695.92	1.0835	6.2274
R/C=800	869.47	1.7249	7.9353
R/C=1000	727.62	1.3090	7.1959
R/C=1200	622.53	0.5284	3.3953
R/C=1500	621.43	0.4315	2.7774

Carbon nanosheets were prepared by electrospinning of polyacrylonitrile(PAN) and poly(methyl methacrylate)(PMMA) solution with carbon aerogel in N,N-dimethylformamide(DMF). Fig. 1 shows the cyclic voltammograms(CV) of carbon aerogel/polymer composites(scan rate=50mV/sec) with different carbon aerogel content(0,1,3,5, and 7wt%). The carbon aerogel/polymer composite electrodes exhibited excellent electrochemical behavior when the carbon aerogel content is 7%, probably due to PMMA was used as supporting materials. PMMA plays an important role keep pores of carbon aerogel, PMMA phase disappeared after thermal treatment.

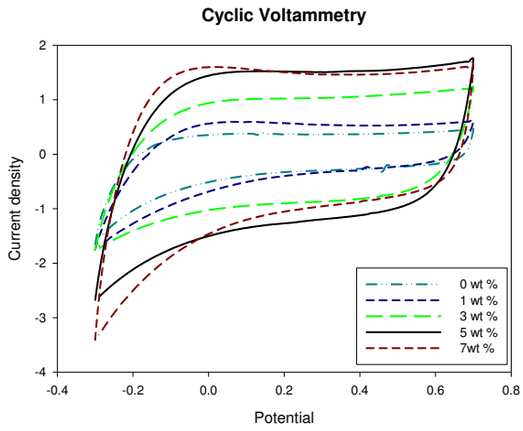

Figure 1. Cyclic voltammogram of carbon aerogel/polymer composites electrodes with different carbon aerogel content

References

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