

ELECTROCHEMICAL DOUBLE LAYER CAPACITANCE PROPERTIES OF CARBON IN AQUEOUS AND NON-AQUEOUS ELECTROLYTES

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Abstract

Electrochemical capacitors are of high interest in hybrid electric vehicle in conjunction with batteries and fuel cells and as backup memory application in many electronic devices because of its high cycle life and short term pulse [1-4]. Electrochemical capacitors can be classified into two types, electrochemical double layer capacitors (EDLC's) and capacitors based on pseudocapacitance. In EDLC, when an electronic conductor is brought in contact with an ionic conducting electrolyte, a charge accumulation is achieved electrostatically on either side of interface, leading to the development of an electrochemical double layer. Carbon electrode is a viable choice for EDLC as it can be prepared with surface area as high as 3000 m²/g. High electrochemical window electrolytes like ionic liquids are attractive as electrolytes. However, pore size distribution, conductivity of electrolyte, size of the ions and their transport within the pores of carbon are expected to play a major role in the overall performance of electrochemical double layer capacitor.

In this study carbon from commercial source (Carbat) is studied as electrode utilizing both aqueous and non-aqueous electrolytes. Carbon electrode surface is characterized using NOVA 1200 gas sorption analyzer from Quantachrome instruments. Multi point surface area of carbon was found to be 1516 m²/g. Carbon electrode was electrochemically characterized using cyclic voltammetry (CV). CV experiments were carried out using a beaker type electrochemical cell containing saturated calomel electrode (SCE) for aqueous and Ag/AgCl for non-aqueous electrolytes as reference electrode, platinum mesh as a counter electrode. Working electrode was prepared from Carbon mixed with 9 wt% of Teflon (binder). They were mixed using mortar and pestle. H₂SO₄ and imidazolium based ionic liquid were utilized as electrolytes. Hexyl methyl imidazolium hexafluorophosphate (C₆MIm PF₆) was prepared in our laboratory.

The CVs were recorded at different sweep rates using EG&G PARC 273A Potentiostat/Galvanostat. All experiments were carried at room temperature. Specific capacitance in F/g was calculated from average anodic current recorded at different voltages divided by potential sweep rate and weight of active electrode material taken in grams. Figure 1 shows CV curve of carbon in 1M H₂SO₄ electrolyte at 10 mV/s scan rate up to 1500 cycles. A specific capacitance of 115 F/g was obtained and capacitance remained constant up to 1500 cycles. Figure 2 shows CV curve of carbon in C₆MIm PF₆ ionic liquid at 2 mV/s scan

rate in the voltage range of up to 3 V. Carbon yielded a specific capacitance of 60 F/g.

References:

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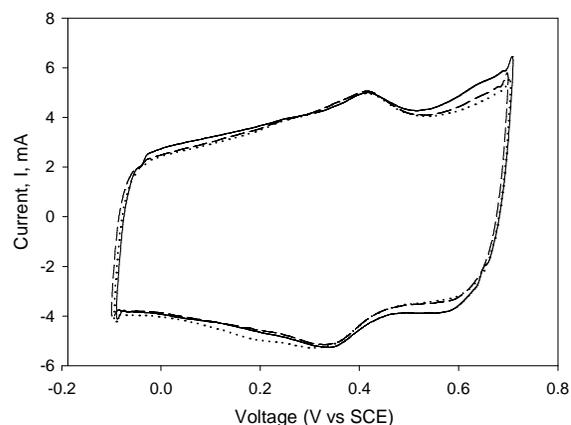


Fig. 1. CV curves of carbon in 1M H₂SO₄ electrolyte at 1st cycle (—), 500th cycle (- - -), and 1500th cycle (- · ·) at 10 mV/s scan rate.

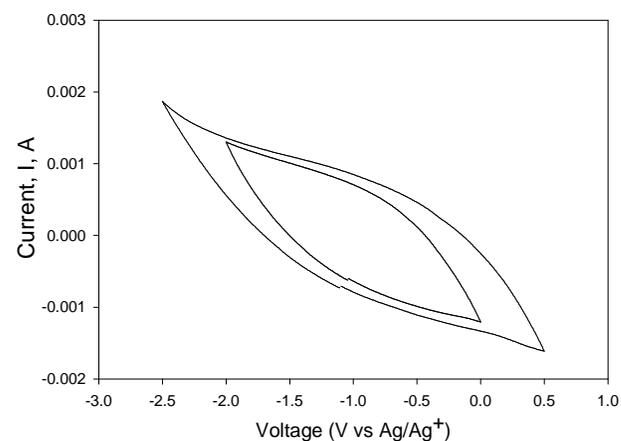


Fig. 2. CV curves of carbon in C₆MImPF₆ ionic liquid at 2 mV/s scan rate.