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OXIDATION DEGREE EFFECT ON ACTIVATED CARBON FIBER FELT FOR SUPERCAPACITOR ELECTRODE

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Introduction

Activated carbon fiber felt (ACF) is a very attractive material to be used as supercapacitor electrode and others applications. ACF has limited application because it is normally produced from especial polyacrylonitrile fiber (PAN) used as raw material to produce aeronautic carbon fiber, meaning that, it is a relative expensive material. Based on this fact, as an alternative, an inexpensive textile PAN fiber has been studied as raw material for ACF production.

The first step towards conversion from textile PAN felt to ACF is the oxidation stage. In the literature, the oxidation process is related as an important step to a structure carbon material formation[1]. Based on this fact, it was investigated the relationship between oxidation PAN felt degree and final activated carbon fiber characteristics aim supercapacitor electrodes application.

Materials and Methods

The study was carried out with a 5.0 dtex heavy tow that was oxidized in a laboratorial furnace at 250 °C at three different times. The samples were converted in felt contemning 200 g/m^2 and it were carbonized, in argon atmosphere, at 900 °C for 20 min. After carbonization, argon gas was shifted to carbon dioxide (200 sccm) and temperature was increased to 1000 °C, the activation process takes about 2 h.

The samples were characterized structural, morphological and electrochemically.

Results and Discussion

Table 1 presents the results for density, surface area, total pores volume and micropores volume. Figure 1 shows the N_2 isotherms at 77 K for activated carbon fiber felt. The oxidized textile PAN data point to an increase of density in function of time process. This result was expected because the oxidation degree increases as a function of time process. N_2 isotherm (Figure 1) shows a typical type I isotherm for the ACF, that indicates micropores presence for all activated samples.

Table 1. Textural characteristics

	Oxidized PAN fiber		Activated carbon fiber felt		
Sample	Oxidation time (min)	Density (g/cm^3)	BET (m^2/g)	V.micro (cm^3)	V.total (cm^3)
1	50	1.30	209	0.10	0.12
2	110	1.42	675	0.25	0.28
3	170	1.47	100	0.04	0.05

* V. micro by NLDFT

The pore size distribution was determined by NLDFT methodology as showed in Figure 2. The pores distribution confirms the isotherms and displays, for sample 1 and 3, two regions with porosity among 1.2 and 3.0 nm. For sample 2 it is observed that the porosity is under 2.0 nm with a narrow pick at 1.2 nm.

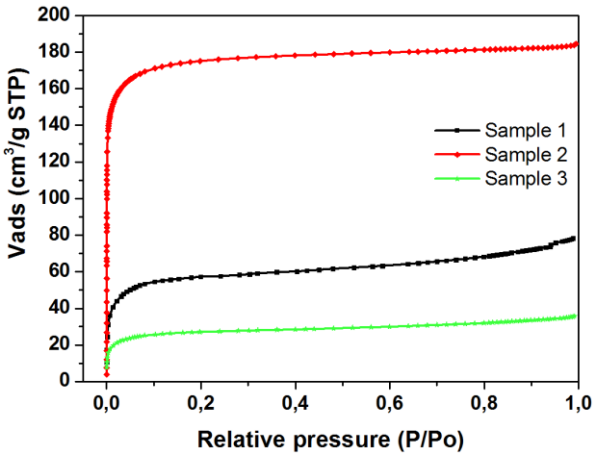

Figure 1. Activated carbon fiber felt N_2 isotherm at 77K

The capacitive performance of the samples was evaluated in 2 M H_2SO_4 electrolyte with three-electrode cell configuration. Figure 4 shows CV curves of the samples. Rectangular shape was obtained at a scan rate of 10 mV/s within the 0.0−1.0 V voltage window, demonstrating that the nature of energy storage is mainly due to electrochemical double layer capacitance[2].

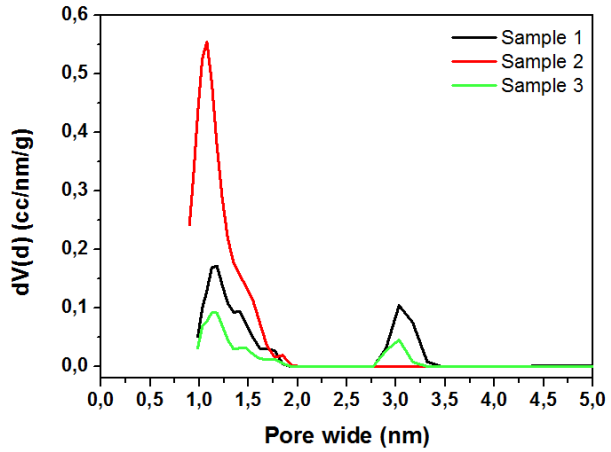

Figure 2. Pore size distribution by NLDFT

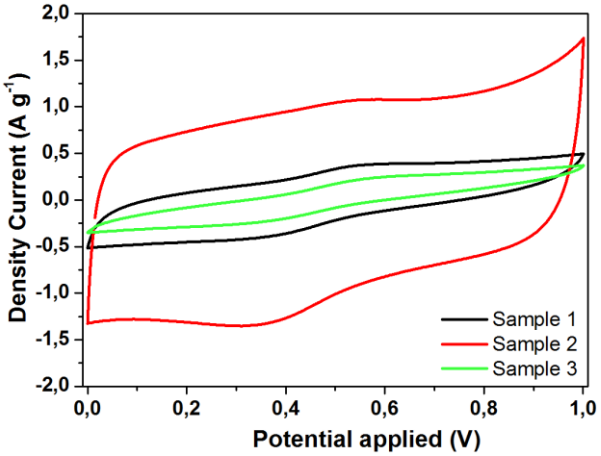

Figure 4. Cyclic voltammogram curves.

The integral area surrounded by the CV curve of sample 2 is much larger than samples 1 and 3, indicating a higher specific capacitance for sample 2, which is related with the large specific surface area[3].

Conclusions

This work demonstrates that the oxidation/stabilization time process for textile PAN fiber has strong influences in the final activate characteristics and consequently in the capacitance. The oxidation/stabilization parameter have to be considerate to obtain the maximum electrode performance.

Acknowledgment

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