Unique Electrochemical Properties of CH900 Activated Carbon Cloth

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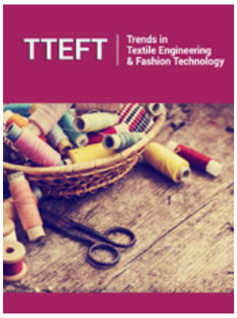

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Opinion

In recent years, numerous studies have been carried out on the creation and improvement of electrochemical supercapacitors [1-3]. Carbon electrodes with a high specific surface area of ~500-2500m^2/g are usually used as supercapacitor electrodes. For such electrodes, specific capacitance values from 50 to 300F/g have previously been obtained. Supercapacitors are used in electric vehicles, electric buses, cars (for starting) and in various electronic devices.

In this work, activated carbon cloth (ACC) CH900 manufactured by Kuraray Co. (Japan) was used as efficient supercapacitor electrodes [2-4]. Using the method of standard contact porosimetry, it was shown that this ACC has hydrophilic-hydrophobic properties. Its total specific surface area is 1520m^2/g, and the hydrophilic specific surface area is 870m^2/g [5]. Electrochemical studies of ACC CH900 were carried out in a wide range of potentials from -0.8 to 1.0V relative to the hydrogen reference electrode [2,6].

On Figure 1 compares the cyclic Volt- Farad curves measured in 48.5% H_2SO_4 at different potential sweep rates in two potential regions: in the reversibility region (from 0.1 to 0.9V) and in the deep charging region (from -0.8 to 1V). From curve 4, measured in the reversibility region, it follows that practically only the charging of the electric double layer (EDL) takes place here. It follows from this curve that the EDL capacitance is 160F/g. In the region of negative potentials (<-0.1 V) (curves 1-3), Faraday processes occur with a very large pseudo capacitance. In [6], on the basis of electrochemical measurements and Faraday's law, it was shown that with deep cathodic charging of ACC, hydrogen intercalates into carbon of ACC with the formation of a new chemical compound C_xH, and in the limit C_6H. The intercalation process depends on the solid-phase diffusion of hydrogen into the carbon of the carbon cloth CH900.

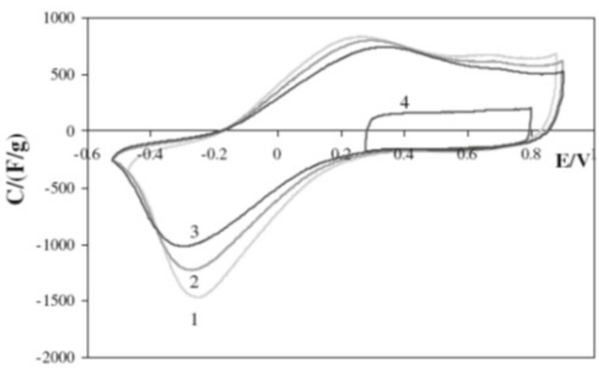

Figure 1: Capacitance-voltage cyclic curves for CH900-20 for 48% H_2SO_4 at potential rates: 1-0.5mV/s, 2-1mV/s, and 3, 4-2mV/s.

Figure 2 shows the dependence of the electrical resistance on the charging time of the tissue electrode measured by the impedance method. As you can see, as the charge increases, the resistance increases. This is explained by the change in time of the chemical composition of the electrode from carbon to C_6H. Figure 3 shows the structural formula of this new chemical compound, which can be called carbon hydride or hydrogen carbide. The maximum capacitance obtained in [6] for the cloth electrode CH900 is 1110F/g, which is much higher than the values obtained earlier for carbon electrodes (maximum 300F/g).

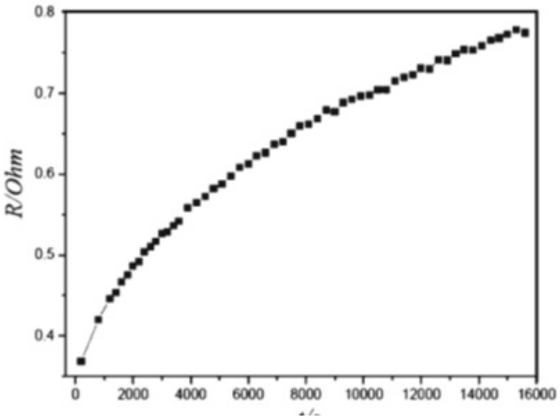

Figure 2: Dependence of active resistance of the electrode on the charging time at E= -400mV measured using the impedance technique in 40% sulfuric acid.

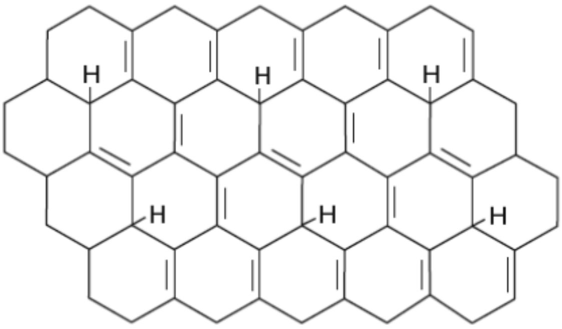

Figure 3: Structural formula of compound C_6H.

In [5], a mathematical model of the ACC electrode discharge was developed, which takes into account its specific surface area, EDL charging, hydrogen intercalation into carbon, solid-state diffusion of hydrogen in carbon, and diffusion of ions in an electrolyte solution. Figure 4 shows the model-calculated discharge curves for various currents, as well as the experimental curve for current density 2mA/cm^2. This figure shows that the model-calculated discharge curve almost coincides with the corresponding experimental curve. This indicates the correctness of the developed model of ACC electrode charging. Thus, in this work, an ultrahigh capacity of 1110F/g was obtained for the CH900 tissue electrode, which is much higher than the previously obtained values for carbon electrodes.

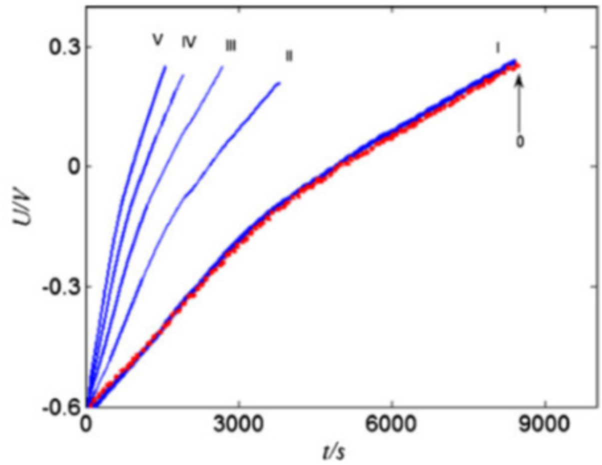

Figure 4: The discharge curves for various current densities. (0) The experimental curve 2mA/cm^2 and the calculated curves (I) -2mA/cm^2 , (II) -4mA/cm^2, (III) -6mA/cm^2, (IV) -8mA/cm^2, (V) -10mA/cm^2.

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