

## Activated carbon based supercapacitors

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Frequency dependence of specific capacitance for a carbon material prepared by pyrolysis from styrene-divinylbenzene copolymer has been studied. Experimental samples of supercapacitors have been manufactured basing on electrodes made of the material by compaction. Their parameters were investigated at different charge-discharge conditions. The dependences of some supercapacitor performance parameters on operating conditions have been established. Changes of discharge capacitance and coulombic efficiency on the number of charge-discharge cycles have been found for experimental samples of supercapacitors based on the prepared carbon material.

Исследована частотная зависимость удельной емкости углеродного материала, полученного из стиролдивинилбензольного сополимера методом пиролиза. На основе прессованных электродов из этого материала разработаны опытные образцы суперконденсаторов с водным раствором электролита. Исследованы их параметры при различных условиях заряда и разряда. Установлены зависимости некоторых рабочих характеристик суперконденсаторов от условий эксплуатации. Показано изменение разрядной емкости и кулоновской эффективности опытных образцов суперконденсаторов на основе полученного углеродного материала от количества циклов заряд-разряд.

The phenomenon defining the operation of electric double layer capacitor was discovered by Helmholtz as the volume charge polarization of metallic electrodes as early as 1854. Its application to electrical energy storage was began more than one century later, that is, in 1957 when G.I.Becker and General Electric Co. (USA) patented a device comprising two carbon black electrodes separated by an acid electrolyte. The device was operated as a capacitor with the capacitance of  $0.6 \text{ F/cm}^3$  at the operating voltage 1.5 V. It was referred to as low-voltage electrolytic capacitor [1]. Later, Nippon Electric Co. (Japan) designed a similar device called SUPERCAP with the capacitance of  $2 \text{ F/cm}^3$  [2]. Another Japanese firm, Matsushita Electrical Industrial Co., has also proposed a capacitor called Gold capacitor [3].

The phenomenon of volume charge polarization can be briefly described as capturing of charge carriers able to migrate

through dielectric medium. The carrier capturing takes place at electrode-electrolyte interface, since free discharge on it or change of the carrier kind at electrodes is impossible. As a result, when a voltage is applied, electrons concentrate at the electrode side of the interface while ions, at the electrolyte one. To apply such charged double layer, the conditions assuring a reliable space separation of the carriers should be provided. The condition for it is the "ideal" polarization of electrodes, i.e. the absence of electrochemical reactions related to mass transfer processes. In this case, there will be no charge exchange between the contacting phases resulting in its essential accumulation.

In this work, we have studied the main characteristics of disk-shaped non-polar supercapacitors (SCs) with electrodes made of activated carbon material. A powdered activated carbon material of bimodal structure