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Preparftion of a flexible supercapacitor electrode materials based on modified carbon fiber

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Abstract

In this study, carbon fiber (CF) was prepared using high-temperature pyrolysis of rayon fibers pretreated with phosphoric acid, followed by activation with carbon dioxide. Optimal concentrations of phosphoric acid and a temperature range of heat treatment were determined.

In order to increase the active surface area of carbon fibers to obtain a higher specific capacity and electrical conductivity, surface modification by heat treatment of the precursor gas (propane) was performed. To evaluate the electrochemical performance of carbon fiber electrodes, cyclic voltammetry (CV) and galvanostatic charge/discharge tests were performed using two-electrode cell with tetraethylammonium tetrafluoroborate (Et_4NBF_4) in acetonitrile as an electrolyte (BASF, Germany). The measurements were carried out using a potentiostat-galvanostat Elins P30S (LLC "Elins", Russia). 20 μm thick paper monolayer material (NKK, Japan) was used as a separator. Scanning electron microscopy (SEM) was performed with JSM-6700F (JEOL, Japan) and SUPRA 50VP (Germany) microscopes.

The specific capacitance of the electrode material based on modified CF was 103 F/g with the energy efficiency of 84%. Near-rectangular shape of CV curves indicates the absence of faradaic redox reactions (which corresponds to absence of pseudocapacitance). Flexible electrodes based on nanostructured carbon materials were fabricated and used in supercapacitor cells which demonstrated specific energy values as high as 28 Wh/kg. The electrodes lost 14% of their specific capacity after 10000 charge-discharge cycles.

Electrodes based on modified carbon fiber exhibit highly stable characteristics. New carbon fiber is very promising as a binder free and flexible electrode material for high-energy symmetric supercapacitors.