ABSTRACT

The aim of this study is to produce carbide-derived carbon (CDC) and polyacrylonitrile (PAN) containing composite fibers by electrospinning that can be used as electrodes in electrical double-layer (EDL) capacitors. In purpose to achieve the fiber based electrospun electrodes with good mechanical properties, the relatively high polymer concentration and grinding of CDC particles is needed. As the large amount of polymer reduces the specific surface area of carbon particles, the CDC particles were filled with ionic liquids, buthyl-3-methylimidazoliumchloride or 1-ethyl-3-methylimidazolium tetrafluoroborate prior of electrospinning.

As the grinding process has great influence on the surface area of CDC, the discussion of optimizing the grinding parameters in different atmospheres is provided. The results of experimental work have shown that the grinding process has the lowest influence on the specific surface area of CDC by using planetary ball mill, where CDC is milled in N_2 atmosphere with zirconium oxide based balls. With previous method, only 1% loss of the specific surface area of grinded CDC was obtained.

Electrochemical characteristics of produced electrodes were studied in two-electrode test cells containing electrolyte, triethylmethylammonium tetrafluoroborate in anhydrous acetonitrile ($TEMABF_4$/ACN). For the EDLC evaluation, the cyclic voltammetry, impedance spectroscopy and galvanostatic methods were used.

The effects of various contents and fractions of CDC on the surface area and conductivity of produced electrodes are discussed. The results of the experimental work have demonstrated that the maximum specific capacitance is achieved, when the electrodes are produced from the composites with low concentration of polymer matrix, high degree of carbide-derived carbon content and with the presence of ionic liquids. As the electrical double-layer capacitors are providing long cycle life compared to the secondary batteries, cycle life of the produced fibrous electrodes was also evaluated.