The incorporation of carbon allotropes into electrospun fibers

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Devices in nanosize are of great demand in nowadays technology. The focus of the present research work is to incorporate the blend of different carbon allotropes with adding ionic liquid into electrospinning solution for producing composite fibers which can be used as electrodes in supercapacitors. The blending of two cabon allortopes such as carbon black (CB) and carbide derived carbon (CDC) can give inhanced properties of electrospun fibers. Ionic liquid (IL), 1-buthyl- 3-methylimidazolium chloride (BMImCl), has been added to electrospinning solution to enhance the dispersion of carbon allotropes and to increase the conductivity of electrospun fibers. CB has been chosen as one of the carbon family component applied as electrode material due to large surface area, good conductive properties, high thermal stability and corrosion resistance. CDC has highly nonporous structure, a large surface area and good mechanical properties. To achieve the complete incorporation of CDC particles into fibers the pretreatment of carbon samples by grinding with planetary ball mill has been applied during different time, 1h, 3h, 6h, and 10h. Polyacrylonitrile (PAN) has been used as a polymer matrix due to its good mechanical properties for preparing the electrospinning solutions in dimethylsulfoxide (DMSO)/ acetone (9/1, w/w). The ratio of carbon fillers to polymer matrix was 50/50, w/w.

It was found that the applied grinding had shown a decrease in aggregation and complete disruption of the carbon particle structure. It has been also investigated that extended grinding has a low impact of the carbon particles structure retaining the initial conductivity of the carbon sample. With increasing the time of grinding CDC particle size decreases from intial size of 1.2 μm to below 100 nm after 10 h of grinding. The morphology has been also improved when 10 h grinded CDC sample was used. The fibers have been produced with smoother surface and without agglomerates. The adding 5% IL to CB/CDC blend has shown a great effect on the conductivity of the electrospun fibers. The conductivity of electrospun electrode increases many times, from 0.07 μS without IL to 0.740 μS with using IL in CDC/CB blend in electrospinning solution.