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Optimizing the Pair Carbon Xerogels-Electrolyte for High Performance Supercapacitors

Authors : Boriana Karamanova, Svetlana Veleva, Luybomir Soserov, Ana Arenillas, Francesco Lufrano, Antonia Stoyanova

Abstract : Supercapacitors have received a lot of research attention and are promising energy storage devices due to their high power and long cycle life. In order to developed an advanced device with significant capacity for storing charge and cheap carbon materials, efforts must focus not only on improving synthesis by controlling the morphology and pore size but also on improving electrode-electrolyte compatibility of the resulting systems. The present study examines the relationship between the surface chemistry of two activated carbon xerogels, the electrolyte type, and the electrochemical properties of supercapacitors. Activated carbon xerogels were prepared by varying the initial pH of the resorcinol-formaldehyde aqueous solution. The materials produced are physicochemical characterized by DTA/TGA, porous characterization, and SEM analysis. The carbon xerogel based electrodes were prepared by spreading over glass plate a slurry containing the carbon gel, graphite, and poly vinylidene difluoride (PVDF) binder. The layer formed was dried consecutively at different temperatures and then detached by water. After, the layer was dried again to improve its mechanical stability. The developed electrode materials and the Aquivion® E87-05S membrane (Solvay Specialty Polymers), socked in Na2SO4 as a polymer electrolyte, were used to assembly the solid-state supercapacitor. Symmetric supercapacitor cells composed by same electrodes and 1 M KOH electrolytes are also assembled and tested for comparison. The supercapacitor performances are verified by different electrochemical methods - cyclic voltammetry, galvanostatic charge/discharge measurements, electrochemical impedance spectroscopy, and long-term durability tests in neutral and alkaline electrolytes. Specific capacitances, energy, and power density, energy efficiencies, and durability were compared into studied supercapacitors. Ex-situ physicochemical analyses on the synthesized materials have also been performed, which provide information about chemical and structural changes in the electrode morphology during charge / discharge durability tests. They are discussed on the basis of electrode-electrolyte interaction. The obtained correlations could be of significance in order to design sustainable solid-state supercapacitors with high power and energy density. Acknowledgement: This research is funded by the Ministry of Education and Science of Bulgaria under the National Program "European Scientific Networks" (Agreement D01-286 / 07.10.2020, D01-78/30.03.2021). Authors gratefully acknowledge.

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