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Conductive polymers and nanostructured carbon materials composites as electrode for supercapacitor

ABSTRACT

Commercially available electrochemical capacitors utilize the electric double layer (EDL) capacitance, which is limited by the porous structure of the carbonaceous material. The solution seems to be a use of pseudocapacitive materials, such as conductive polymers, which capacitance far exceed the values obtained for currently used activated carbons.

The research topic undertaken in the doctoral dissertation concerned the synthesis of the composites based on conductive polymers (aniline and pyrrole copolymer, polyaniline and polypyrrole), nanostructured carbon materials (nanofibers and graphene materials) and in the case of ternary composites, also containing iron oxides and their application as a new generation electrode active material for supercapacitors working in aqueous electrolyte.

As a part of the research work, series of synthesis processes of binary and ternary composites were performed in order to obtain materials with developed porous structure, characterized by high capacitance values and stability of the electrochemical properties. The influence of the individual components and the applied synthesis method on the physical and chemical properties was investigated, focusing on their porous structure, morphology and chemical structure. Subsequently, the obtained results were correlated with the electrochemical characteristics of the composites. Synthesized materials were tested in a two- and three-electrode setup in 1 M H_2SO_4 and 1 M Na_2SO_4 electrolytes as an electrode material of supercapacitor.

The crucial result of the research work was development of the novel, hydrothermal-assisted synthesis of the composites based on conductive polymer and reduced graphene oxide. This approach led to the materials characterized by a unique morphology and a developed porous structure. Electrochemical measurements of the hydrothermal composites presented the most favourable synergy effect between the pseudocapacitive

conductive polymer and electrochemically stable graphene material among all synthesized binary composites. Moreover, hydrothermal approach was used for the synthesis of a ternary material containing conductive polymer, carbon nanomaterial and inorganic compound, which allowed to significantly retain the porous structure of a binary precursor. As a result, the ternary composite exhibited a very good electrochemical performance.

The results presented in the doctoral dissertation indicate new possibilities of designing the composites based on carbon nanomaterials and conductive polymers as potential binder-free electrode materials for supercapacitors working in aqueous electrolytes.