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Carbon Electrode Materials for Supercapacitors

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Abstract : Supercapacitors are one of the most promising devices for energy storage applications as they can provide higher power density than batteries and higher energy density than conventional dielectric capacitors. Carbon materials with various microtextures are considered as main candidates for supercapacitors in terms of high surface area, interconnected pore structure, controlled pore size, high electrical conductivity and environmental friendliness. The specific capacitance (C) of the electrode material of the Electrochemical Double Layer Capacitors (EDLC) is known to depend on the specific surface area (Ss) and the pore structure. Activated carbons are most commonly used in supercapacitors because of their high surface area (Ss ≥ 1000 m2/g), good adhesion to electrolytes and low cost. In this work, electrochemical properties of new microporous and mesoporous carbon electrode materials were studied. The aim of the work was to investigate the relationship between the specific capacitance and specific surface area in a series of materials prepared from different organic precursors.. As supporting matrixes different carbon samples with Ss = 100-2000 m2/g were used. The materials were modified by treatment in acids (H2SO4, HNO3, acetic acid) in order to enable surface hydrophilicity. Then nanoparticles of transition metal oxides (for example NiO) were deposited on the carbon surfaces using methods of salts impregnation, mechanical treatment in ball mills and the precursors decomposition. The electrochemical characteristics of electrode hybrid materials were investigated in a symmetrical two-electrode cell using an impedance spectroscopy, voltammetry in both potentiodynamic and galvanostatic modes. It was shown that the value of C for the materials under study strongly depended on the preparation method of the electrode and the type of electrolyte (1 M H2SO4, 6 M KOH, 1 M LiClO4 in acetonitryl). Specific capacity may be increased by the introduction of nanoparticles from 50-100 F/g for initial carbon materials to 150-300 F/g for nanocomposites which may be used in supercapacitors. The work is supported by the по SC-14.604.21.0013.

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