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NANOSTRUCTURED TUNGSTEN CARBIDE-DERIVED CARBON AS ELECTRODE MATERIAL FOR SUPERCAPACITORS

Indrek Tallo, Thomas Thomberg, Alar Jänes, Enn Lust

Institute of Chemistry, University of Tartu, 14A Ravila Street, 50411 Tartu, Estonia

e-mail: indrek.tallo@ut.ee

Continuous interest in the development of different porous carbon materials with high specific surface area and controlled pore size distribution is directly related to the wide area of their potential applications. One of the most promising applications of porous carbon materials is their use in supercapacitors (SC) as electrode material. For improving and varying the energy density — power density properties of supercapacitors, such parameters of porous carbon materials as specific surface area, pore size distribution, electric conductivity, etc. values have to be optimized.

The tungsten carbide-derived carbon (WC-CDC) materials were synthesized from tungsten carbide within the temperature range from 800 to 1100°C. Analysis of X-ray diffraction and Raman spectroscopy data revealed that WC-CDC materials synthesized in the temperature range from 800 to 1000°C were mainly amorphous. High-resolution transmission electron microscopy studies show that WC-CDC prepared at 800°C correspond to the highly disordered carbon material, but WC-CDC prepared at 1100 °C, showed partial graphitization. Based on the low-temperature N_2 sorption experiments relatively high specific surface area 1580 m^2 g^{-1} and total pore volume value 0.89 cm^3 g^{-1} were calculated for WC-CDC synthesized at 1100°C. According to the low-temperature N_2 sorption experiments substantial increase in pore volume and specific surface area values for WC-CDC materials synthesized in the temperature range from 1000°C to 1100°C were observed, explained by increase of ordering and continuous opening of smaller pores inside mainly amorphous carbon particles. The pore size distribution plots have similar shape, however development of larger pores with increasing of synthesis temperatures have been established.

The electrochemical characteristics of the SC based on the WC-CDC electrode materials prepared at different temperatures have been studied in 1 M $(C_2H_5)_3CH_3NBF_4$ acetonitrile solution using cyclic voltammetry, constant current charge/discharge and electrochemical impedance methods. It was found that specific capacitance, time constant, specific energy and power, etc. values depend noticeably on WC-CDC electrode material properties under study. The maximum specific energy 41 W h kg^{-1} and maximum specific power 430 kW kg^{-1} for WC-CDC, synthesised at 1000°C, have been calculated at cell potential 3.0 V. Thus, these WC-CDC electrode materials are suitable for supercapacitors with high specific performance.

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