Electrochemical properties of carbon nanostructures modified by oxygen containing groups

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Carbon nanomaterials (graphene, nanotubes, etc.) are promising for use in electronics, energy storage devices, sensors, catalytic systems, etc. due to high conductivity, large surface area, chemical inertness and physical stability. Functional groups on the carbon surface are able to accumulate additional energy due to oxidation-reduction processes in the electrodes of supercapacitors, by increasing of the hydrophilicity and changing the mesoporous structure of the carbon nanomaterial. In addition, oxygen-containing functional groups can be used to attach more complex macromolecules. The cyclic voltammetry method is used to study of the oxidation-reduction processes in the electrode material and this method clearly demonstrates the ongoing reactions. However, despite the importance of studying of the functionalization processes of the carbon nanostructures surface and studying the behavior of oxygen-containing functional groups during electrochemical cycling, this issue has not been studied sufficiently

The methods for oxidizing of the carbon nanostructures surface (double-layered carbon nanotubes, multiwall carbon nanotubes [1], and reduced graphite oxide) were investigated. Nanostructures were functionalized with oxygen-containing functional groups in the process of hydrothermal treatment, heat treatment and chemical modification of the surface. Morphology and functional composition of the surface were studied using SEM and TEM microscopy and IR, Raman spectroscopy, and X-ray photoelectron spectroscopy. The electrochemical behavior of the initial and modified materials was studied using cyclic voltammetry and electrochemical impedance spectroscopy

Using the method of cyclic voltammetry, half-reaction potentials were obtained and correlated with the reactions occurring on the nanotube or graphene surface. When the concentration of functional groups on the surface increases, the capacity increases due to the contribution of the pseudo-capacity. In addition, the relationship between the morphology of the material, its conductivity and the features of the diffusion processes was demonstrated using the method of spectroscopy of electrochemical impedance.

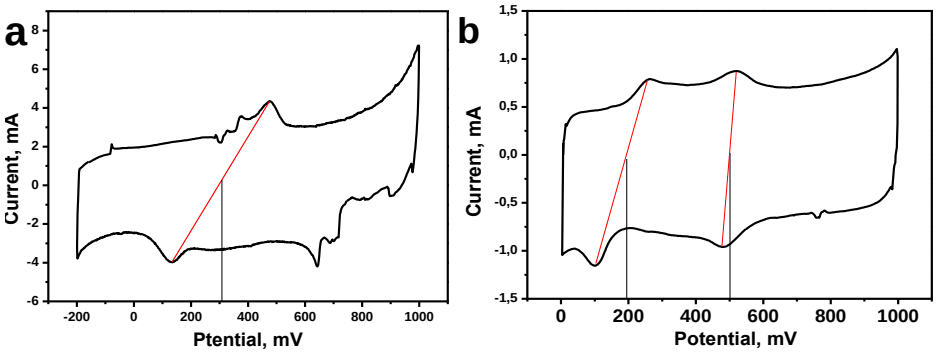

Fig. 1. *Cyclic voltammograms of double-layered carbon nanotubes after oxidative treatment with mineral acids (a) and multiwall carbon nanotubes after hydrothermal treatment (b). The peaks on the CV curves correspond to the oxidation and reduction processes of oxygen-containing functional groups*

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[1] E.O. Fedorovskaya, L.G. Bulusheva, A.G, Kurenya, I.P. Asanov, A.V. Okotrub. Effect of oxidative treatment on the electrochemical properties of aligned multi-walled carbon nanotubes // Russian Journal of Electrochemistry 2016. V. 52, No. 5, P. 441-448