

Nanocomposites and nanomaterials

Redox properties of graphene obtained by electrochemical exfoliation of graphite in presence of carboxylic acid salts

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The possibility of obtaining few-layered partially oxidized graphene (POG) by means of electrochemical exfoliation of graphite in presence of salts of carboxylic acids via electrolysis with a pulse-changing of the electrode polarization was established. Interpretation of Raman spectra and atomic force micrographs allowed us to found out, that the number of layers in such graphene clusters with a lateral size up to several microns, is ranging from 7 to 15 depending on the type of electrolyte used. For example, POG particles, obtained using electrolyte based on $C_6H_4(COONa)_2$ contain ~7-8 layers (with one-layer sheet thickness on about 0,4 nm), $C_6H_5CH_2COONa$ – ~10, and C_6H_5COONa – ~15. FTIR, UV-vis and cyclic voltammetry data indicate a low degree of oxidation state of POG. At the same time, the use of different electrolytes in the exfoliation process of graphite electrode, allows a certain variation of POG oxidation state.

Obtained POG, consisting of 7-15 layers, may be very promising materials for electrochemical applications, because, as it is clearly known [1], that multilayered graphene is not a critical material in this case. It was established, that POG as electrode materials possess high electrocatalytic activity in processes of electrochemical oxidation of ascorbic acid and nicotinamide adenine dinucleotide (NADH), exceeding those for films of electrochemically reduced graphene oxide (obtained by means of modified Hummers method [2]).

1. Ambrosi A., Chua C.K., Bonanni A., Pumera M. Electrochemistry of Graphene and Related Materials // Chem Rev.–2014.–**114**.–P. 7150–7188.
2. Kovtyukhova N., Ollivier P., Martin B., Mallouk T., Chizhik S., Buzaneva E., Gorchinskiy A. Layer-by-Layer Assembly of Ultrathin Composite Films from Micron-Sized Graphite Oxide Sheets and Polycations // Chem Mater.-1999.–**11**.–P. 771-778.