

"Physico-Chemical nanomaterials science"

One step electrochemical preparation of multilayer graphene functionalized with nitrogen

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The electrochemical exfoliation of graphite is a promising approach to produce graphene and graphene-related materials due to its easy, fast, and environmentally friendly nature [1]. Previously, we have shown that such exfoliation in presence of benzoate anions allows the formation of multilayer graphene (MLG) with slight amounts of oxygen-containing defects [2] – perspective material for using in various electrochemical applications.

In this work, we present the possibility of electrochemical preparation of MLG functionalized with nitrogen (N-MLG) via exfoliation of graphite in presence of azide anions in a pulse-mode of electrolysis in one step. Particles of N-MLG consist of up to 10 individual graphene layers with a low oxidation degree, that is proved by means of TEM, AFM, FTIR, UV-vis and Raman spectroscopy, cyclic voltammetry etc. In particular, functionalization of obtained material by N atoms is confirmed by FTIR spectroscopy (presence of the band at 1164 cm^{-1} $\nu_{\text{C-N}}$) and C,H,N-analysis (nitrogen content $\sim 0.6\%$).

By means of cyclic voltammetry it is shown higher electrocatalytic activity of N-MLG in the oxygen reduction reaction, which is realized on one of electrodes in fuel cells, compared to MLG or electrochemically reduced graphene oxide, that do not contain nitrogen atoms in its structure. Also, N-MLG is proved to be electrochemically active toward oxidation of such important biomarkers as ascorbic acid and dopamine in biological liquids, so it can be considered as a promising candidate for the usage, both - individually and as component of the composites, in electroanalysis of mentioned analytes.

1. *Ambrosi A., Chua C.K., Bonanni A., Pumera M.* Electrochemistry of Graphene and Related Materials // Chem Rev.–2014.–**114**.–P. 7150–7188.
2. *Kurys Ya.I., Ustavytka O.O., Koshechko V.G., Pokhodenko V.D.* Structure and electrochemical properties of multilayer graphene prepared by electrochemical exfoliation of graphite in the presence of benzoate ions // RSC Adv. –2016. –**6**. –P. 36050–36057.