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Synthesis and application of reduced graphene oxide as electrode material for oxygen electrodes of power sources

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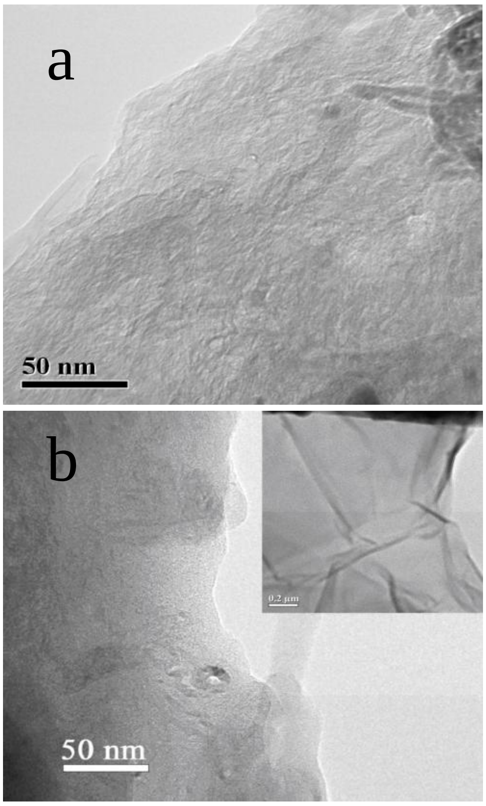

Figure 1. Micrographs of RGO obtained from MWCNT oxidized with $KMnO_4$ and reduced with: (a) sodium sulfite, (b) sodium hypophosphite.

An application of air or oxygen electrode in device generating electrical energy is useful, it does not give rise to environmental problems and allows to save nonrenewable natural resources. The electrode consists of a catalyst and a support; the interaction between them determines mainly the value of generated current. At the present time, platinum is the most efficient oxygen reduction catalyst, but it has a considerable disadvantage– a high price. There are a large number of papers devoted to study of other efficient catalysts [1]. Another important problem is catalytically active and stable support. At the present time, study of a new nanocarbon material, graphene, as an electrode material for lithium-ion batteries [2] and as a support for catalysts in fuel cells [3] are useful.

To obtain reduced graphene oxide (RGO), multiwalled carbon nanotubes (MWCNTs) were applied. Using a suitable oxidant, one can “unzipping” nanotubes to form graphene oxide nanoribbons and then obtain RGO by action with a reductant. To choose oxidant and reductant, standard redox potentials of carboxy groups were used. It has been shown that the required oxidant potential in acid medium should be more + 0.528 V and reductant potential in alkaline medium- less– 1.148 V. Using the proposed approach, we have obtained RGO and studied it as an electrode material for oxygen electrodes of electrochemical power sources. Fig.1 shows micrographs of RGO reduced with sodium sulfite (Fig 1(a)) and sodium hypophosphite (Fig 1(b)) from graphene oxide obtained by the oxidation of MWCNTs with potassium permanganate.

Current-potential curves for oxygen electrodes based on RGO, obtained by using the oxidants $K_2Cr_2PO_2$, Na_2SO_3, have been analyzed. It has been found that the electrochemical characteristics of reduced graphene oxide in the oxygen reduction reaction depend on the redox power of the reagents used (Fig 2). The obtained RGO is a promising material for oxygen electrodes of fuel cells.

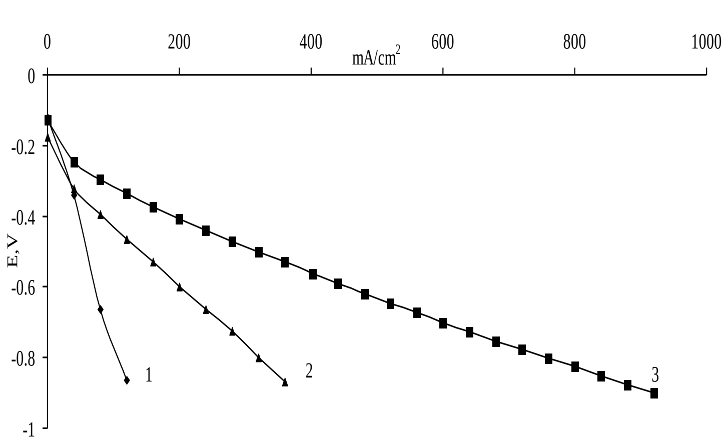

Fig 2. Dependence of potential on current density for oxygen electrodes consisting of RGO obtained by the oxidation of MWCNTs (1) with $KMnO_4$ and reduced with Na_2SO_3(2), NaH_2PO_4(3).

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3. *Shao Y., Zhang S., Wang C., Nie Z., Liu J., Wang Y., Lin Y.* Highly durable graphene nanoplatelets supported Pt nanocatalysts for oxygen reduction // J Power Sources. – 2010. – **195**. – P. 4600–4605.