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Graphene-Based Materials: Synthesis, Chemistry and Applications

J. Barkauskas*, J. Gaidukevič

Vilnius University, Institute of Chemistry, Naugarduko 24, LT-03225, Vilnius, Lithuania

**Corresponding author, e-mail: jurgis.barkauskas@chf.vu.lt*

Graphene-based materials (GBM) comprise an important class of materials including graphene itself, graphene oxide (GO), reduced graphene oxide (rGO), exfoliated graphene flakes, graphene nanoplatelets, as well as chemically functionalized versions of all these. GBM attracts the attention of many researchers due to their exceptional properties (high electric and thermal conductivity, mechanical strength and flexibility, chemical stability, biocompatibility), and thereof emerging fields of application (electronics, energy conversion and storage, light processing, biomedicine, environmental cleaning, composite production, etc.).

In this research, the expertise of the Laboratory of Carbonaceous Materials in synthesis, investigation and application of different GBM is presented. rGO is among the most often used GBM for application. Using thermal shock equipment, rGO fractions were produced from GO, and applied as electrode materials for amperometric glucose biosensors with direct electron transfer capacity [1]. Hybrid single-walled carbon nanotube and GO coatings also demonstrate the same effect of direct electron transfer [2]. The C_3O_2 additive used during the process of thermal reduction of GO improves the electrical conductivity of the product. The rGO obtained this way was used as effective component in dopamine biosensor [3]. Based on the fact that GO is especially hydrophilic material, GO synthesized by modified Hummer‘s method was applied for surface acoustic wave humidity sensors [4]. The GO nanocomposites with organic dye molecules are suitable to prepare coatings, which can be further used for laser scribing and biosensor application [5]. Another promising application for GO coatings is their antimicrobial properties. We used direct oxidation of graphene layer coated on the polypropylene surface [6]. Functionalized rGO tailored with appropriate functional groups was used as efficient catalyst in transestherification reaction [7]. Another preparation protocol was based on the reduction of graphite oxide in the melt of boric acid to produce reduced graphene oxide with the structure favorable to fast ion transport in the bulk of carbon network. This sort of rGO was applied as electrodes in supercapacitor [8]. GO nanocomposite with inorganic polymer – parathiocyanogen – was used as prospective electrode (cathode) material in fuel cells. It works as metal-free catalyst, and thus makes it possible to dispense with the use of expensive platinum [9]. We also performed detailed studies of the mechanism and kinetics of thermal decomposition of GO. This study revealed the ways which may be used to produce rGO with controllable properties [10]. Low-defective graphene may be produced by using GIC. In our study we used the GIC with sulfuric acid for this purpose [11]. In each case, the relationship between the structure of GBM and its properties is discussed in detail.

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