proceedings

Abstract

Nitrogen-Doped Reduced Graphene Oxide for Electrochemical Sensing Applications †

Justina Gaidukevič [1,2,*], Rūta Aukštakojytė [1], Mieczysław Kozłowski [3] and Rasa Pauliukaitė [2]

[1] Institute of Chemistry, Faculty of Chemistry and Geosciences, Vilnius University, Naugarduko Str. 24, LT-03225 Vilnius, Lithuania; ruta.aukstakojyte@chgf.vu.lt
[2] Department of Nanoengineering, Center for Physical Sciences and Technology, Savanoriu Ave. 231, LT-02300 Vilnius, Lithuania; rasa.pauliukaite@ftmc.lt
[3] Faculty of Chemistry, Adam Mickiewicz University in Poznan, Uniwersytetu Poznanskiego 8, 61-614 Poznan, Poland; mieczyslaw.kozlowski@amu.edu.pl
* Correspondence: justina.gaidukevic@chf.vu.lt
† Presented at the International Conference EcoBalt 2023 "Chemicals & Environment", Tallinn, Estonia, 9–11 October 2023.

Keywords: nitrogen doping; graphene oxide; dopamine; electrochemical sensor

Graphene-based derivatives, such as graphene oxide (GO) and reduced graphene oxide (rGO), have gained significant attention in the field of electrochemical sensors [1]. These materials offer several advantages, including a time-efficient and cost-effective synthesis procedure and unique chemical, physical, and electronic properties [2]. rGO-based materials, in particular, possess a high surface area, chemical stability, and electrical conductivity [3]. However, despite these favorable characteristics, the development of rGO-based sensors with high sensitivity and rapid response times remains a challenge. One of the promising strategies to meet this challenge is the doping of rGO using heteroatoms. This approach involves introducing certain atoms (e.g., N, B, P, or S) into the graphene lattice, which can modify the structural and electrochemical rGO properties [4]. Therefore, this study focuses on the synthesis and structural characterization of N-doped rGO-based materials and their application to the electrochemical sensing of dopamine and H_2O_2. rGO modification with nitrogen species was achieved using two different synthesis approaches. To functionalize the rGO surface with a cationic Bismarck Brown dye, a hydrothermal synthesis method was employed. Also, the rGO surface was modified using gaseous ammonia at temperatures of 950 °C or 850 °C for 8 or 4 h, respectively. The obtained materials were characterized by different methods (XPS, BET, SEM, and Raman spectroscopy). Electrochemical measurements, such as cyclic voltammetry and chronoamperometry, were used to evaluate the obtained samples toward dopamine or H_2O_2 detection. The results demonstrated that various nitrogen species, including pyridinic-N, pyrrolic-N, and quaternary-N, were detected in the N-doped rGO. Moreover, it was observed that the amount and type of N-species introduced into the rGO surface contribute to the improved performance of the sensing platform, enabling the sensitive and selective detection of analytes.

Author Contributions: Conceptualization, J.G. and R.A.; methodology, J.G. and M.K.; investigation, J.G. and R.A.; resources, J.G.; data curation, J.G. and R.A.; writing—original draft preparation, J.G.; writing—review and editing, R.A., M.K. and R.P.; visualization, J.G.; supervision, R.P. and M.K.; funding acquisition, J.G. All authors have read and agreed to the published version of the manuscript.

Funding: This project received funding from the European Social Fund (project No 09.3.3-LMT-K-712-19-0050) under a grant agreement with the Research Council of Lithuania (LMTLT).

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

check for updates

Citation: Gaidukevič, J.; Aukštakojytė, R.; Kozłowski, M.; Pauliukaitė, R. Nitrogen-Doped Reduced Graphene Oxide for Electrochemical Sensing Applications. *Proceedings* **2023**, *92*, 59. https://doi.org/10.3390/proceedings2023092059

Academic Editors: Monika Mortimer, Anne Kahru, Ivo Leito, Riin Rebane and Villem Aruoja

Published: 29 November 2023

Data Availability Statement: The data presented in this study are available on request from the corresponding author.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Suvarnaphaet, P.; Pechprasarn, S. Graphene-Based Materials for Biosensors: A Review. *Sensors* **2017**, *17*, 2161. [CrossRef] [PubMed]
2. Jiříčková, A.; Jankovský, O.; Sofer, Z.; Sedmidubský, D. Synthesis and Applications of Graphene Oxide. *Materials* **2022**, *15*, 920. [CrossRef] [PubMed]
3. Ray, S.C. Chapter 2—Application and Uses of Graphene Oxide and Reduced Graphene Oxide. In *Applications of Graphene and Graphene-Oxide Based Nanomaterials*; Ray, S.C., Ed.; William Andrew Publishing: Oxford, UK, 2015; pp. 39–55.
4. Arvas, M.B.; Gürsu, H.; Gencten, M.; Sahin, Y. Preparation of different heteroatom doped graphene oxide based electrodes by electrochemical method and their supercapacitor applications. *J. Energy Storage* **2021**, *35*, 102328. [CrossRef]