Solid-State rGO-PEDOT:PSS Transducing Material for Cost-Effective Enzymatic Sensing

By: Abd-Wahab, F (Abd-Wahab, Firdaus)[1]; Guthoos, HFA (Guthoos, Habibah Farhana Abdul)[1]; Salim, WWAW (Salim, Wan Wardatul Amani Wan)[1]

View Web of Science ResearcherID and ORCID

BIOSENSORS-BASEL
Volume: 9 **Issue:** 1
Article Number: 36
DOI: 10.3390/bios9010036
Published: MAR 1 2019
Document Type: Article

Abstract

Performance of a sensing device is dependent on its construction material, especially for components that are directly involved in transporting and translating signals across the device. Understanding the morphology and characteristics of the material components is therefore crucial in the development of any sensing device. This work examines the morphological and electrochemical characteristics of reduced graphene oxide interspersed with poly(3,4-ethylenedioxythiophene):poly(styrenesulfonate) (rGO-PEDOT:PSS) used as a transducer material deposited on a commercially available screen-printed carbon electrode (SPCE). Electron microscopy shows that PEDOT:PSS is interspersed between rGO layers. Raman and XRD analyses suggest that the graphene crystallinity in GO-PEDOT:PSS and rGO-PEDOT:PSS remains intact. Instead, PEDOT:PSS undergoes a change in structure to allow PEDOT to blend into the graphene structure and partake in the pi-pi interaction with the surface of the rGO layers. Incorporation of PEDOT:PSS also appears to improve the electrochemical behavior of the composite, leading to a higher peak current of 1.184 mA, as measured by cyclic voltammetry, compared to 0.522 mA when rGO is used alone. The rGO-PEDOT:PSS transducing material blended with glucose oxidase was tested for glucose detection. The sensitivity of glucose detection was shown to be 57.3 mu A/(mM center dot cm(2)) with a detection limit of 86.8 mu M.

Keywords

Author Keywords: screen-printed carbon electrode; reduced graphene oxide; PEDOT; PSS; electrochemical reduction; glucose oxidase; cyclic voltammetry; surface characterization

KeyWords Plus: REDUCED GRAPHENE OXIDE; SCREEN-PRINTED ELECTRODE; ELECTROCHEMICAL PROPERTIES; SENSOR; NANOCOMPOSITE; CONDUCTIVITY; REDUCTION

Author Information

Reprint Address: Salim, WWAW (reprint author)

Int Islamic Univ Malaysia, Fac Engn, Dept Biotechnol Engn, Kuala Lumpur 50728, Malaysia.

Addresses:

[1] Int Islamic Univ Malaysia, Fac Engn, Dept Biotechnol Engn, Kuala Lumpur 50728, Malaysia

E-mail Addresses: firdaus@iium.edu.my; habibahfarhana@gmail.com; asalim@iium.edu.my

Funding

Funding Agency	Grant Number
FDNANO VENTURES LTD.	SP18-110-0372
INTERNATIONAL ISLAMIC UNIVERSITY MALAYSIA	RPDF18-002-0002 RIGS17-011-0586

View funding text

Publisher

MDPI, ST ALBAN-ANLAGE 66, CH-4052 BASEL, SWITZERLAND

Categories / Classification

Research Areas: Chemistry

Web of Science Categories: Chemistry, Analytical

See more data fields

Cited References: 53

Showing 30 of 53 **View All in Cited References page** *(from Web of Science Core Collection)*

1. **Fast and fully-scalable synthesis of reduced graphene oxide** — **Times Cited: 179**
   By: Abdolhosseinzadeh, Sina; Asgharzadeh, Hamed; Kim, Hyoung Seop
   SCIENTIFIC REPORTS Volume: 5 Article Number: 10160 Published: MAY 15 2015

2. **A stretchable and screen-printed electrochemical sensor for glucose determination in human perspiration** — **Times Cited: 58**
   By: Abellan-Llobregat, A.; Jeerapan, Itthipon; Bandodkar, A.; et al.
   BIOSENSORS & BIOELECTRONICS Volume: 91 Pages: 885-891 Published: MAY 15 2017

3. **RECOMMENDATIONS FOR THE DEFINITION, ESTIMATION AND USE OF THE DETECTION LIMIT** — **Times Cited: 177**
   By: [Anonymous]
   ANALYST Volume: 112 Issue: 2 Pages: 199-204 Published: FEB 1987

4. **Improved continuity of reduced graphene oxide on polyester fabric by use of polypyrrole to achieve a highly electro-conductive and flexible substrate** — **Times Cited: 24**
   By: Berendjchi, Amirhosein; Khajavi, Ramin; Yousefi, Ali Akbar; et al.
   APPLIED SURFACE SCIENCE Volume: 363 Pages: 264-272 Published: FEB 15 2016

5. **Conducting polymer-based solid-state ion-selective electrodes** — **Times Cited: 241**
   By: Bobacka, J
   ELECTROANALYSIS Volume: 18 Issue: 1 Pages: 7-18 Published: JAN 2006

6. **A Third Generation Glucose Biosensor Based on Cellobiose Dehydrogenase Immobilized on a Glassy Carbon Electrode Decorated with Electrodeposited Gold Nanoparticles: Characterization and Application in Human Saliva** — **Times Cited: 13**
   By: Bollella, Paolo; Gorton, Lo; Ludwig, Roland; et al.
   SENSORS Volume: 17 Issue: 8 Article Number: 1912 Published: AUG 2017

7. **Direct electrodeposition of reduced graphene oxide on glassy carbon electrode and its electrochemical application** — **Times Cited: 471**
   By: Chen, Liuyun; Tang, Yanhong; Wang, Ke; et al.
   ELECTROCHEMISTRY COMMUNICATIONS Volume: 13 Issue: 2 Pages: 133-137 Published: FEB 2011

8. **Ultra high permittivity and significantly enhanced electric field induced strain in PEDOT:PSS-RGO@PU intelligent shape-changing electro-active polymers** — **Times Cited: 24**
   By: Chen, Tian; Qiu, Jinhao; Zhu, Kongjun; et al.
   RSC ADVANCES Volume: 4 Issue: 109 Pages: 64061-64067 Published: 2014

9. **Effect of pre-treatment on the surface and electrochemical properties of screen-printed carbon paste electrodes** — **Times Cited: 66**
   By: Cui, G; Yoo, JH; Lee, JS; et al.
   ANALYST Volume: 126 Issue: 8 Pages: 1399-1403 Published: AUG 2001

10. **Polymer/Graphene Hybrids for Advanced Energy-Conversion and -Storage Materials** — **Times Cited: 19**
    By: Cui, Linfan; Gao, Jian; Xu, Tong; et al.
    CHEMISTRY-AN ASIAN JOURNAL Volume: 11 Issue: 8 Pages: 1151-1168 Published: APR 20 2016

11. **Review on Conducting Polymers and Their Applications** — **Times Cited: 199**
    By: Das, Tapan K.; Prusty, Smita
    POLYMER-PLASTICS TECHNOLOGY AND ENGINEERING Volume: 51 Issue: 14 Pages: 1487-1500 Published: 2012

12. **Interpretation of Raman spectra of disordered and amorphous carbon** — Times Cited: 8,154
By: Ferrari, AC; Robertson, J
PHYSICAL REVIEW B Volume: 61 Issue: 20 Pages: 14095-14107 Published: MAY 15 2000

13. **Highly activated screen-printed carbon electrodes by electrochemical treatment with hydrogen peroxide** — Times Cited: 8
By: Gonzalez-Sanchez, I.; Gomez-Monedero, B.; Agrisuelas, J.; et al.
ELECTROCHEMISTRY COMMUNICATIONS Volume: 91 Pages: 36-40 Published: JUN 2018

14. **Poly(3,4-ethylenedioxythiophene) and its derivatives: Past, present, and future** — Times Cited: 1,775
By: Groenendaal, BL; Jonas, F; Freitag, D; et al.
ADVANCED MATERIALS Volume: 12 Issue: 7 Pages: 481-494 Published: APR 4 2000

15. **New Developments in Electrode Materials for Electrochemical Sensors** — Times Cited: 1
By: Guth, U.; Zosel, J.; Riedel, J.; et al.
Advancement in Sensing Technology. Smart Sensors, Measurement and Instrumentation Pages: 181-189 Published: 2013
Publisher: Springer, Berlin/Heidelberg, Germany
[Show additional data]

16. **Glucose Sensing Using Capacitive Biosensor Based on Polyvinylidene Fluoride Thin Film** — Times Cited: 3
By: Hartono, Ambran; Sanjaya, Edi; Ramli, Ramli
BIOSENSORS-BASEL Volume: 8 Issue: 1 Article Number: 12 Published: MAR 2018

17. **Disposable Screen Printed Electrochemical Sensors: Tools for Environmental Monitoring** — Times Cited: 137
By: Hayat, Akhtar; Marty, Jean Louis
SENSORS Volume: 14 Issue: 6 Pages: 10432-10453 Published: JUN 2014

18. **POLY(ALKYLENEDIOXYTHIOPHENE)S - NEW, VERY STABLE CONDUCTING POLYMERS** — Times Cited: 829
By: HEYWANG, G; JONAS, F
ADVANCED MATERIALS Volume: 4 Issue: 2 Pages: 116-118 Published: FEB 1992

19. **Moderately reduced graphene oxide/PEDOT:PSS as hole transport layer to fabricate efficient perovskite hybrid solar cells** — Times Cited: 18
By: Huang, Xu; Guo, Heng; Yang, Jian; et al.
ORGANIC ELECTRONICS Volume: 39 Pages: 288-295 Published: DEC 2016

20. **Liquid crystalline graphene oxide/PEDOT:PSS self-assembled 3D architecture for binder-free supercapacitor electrodes** — Times Cited: 24
By: Islam, Md. Monirul; Chidembo, Alfred T.; Aboutalebi, Seyed Hamed; et al.
FRONTIERS IN ENERGY RESEARCH Article Number: UNSP 31 Published: 2014

21. **The application of graphene as electrodes in electrical and optical devices** — Times Cited: 205
By: Jo, Gunho; Choe, Minhyeok; Lee, Sangchul; et al.
NANOTECHNOLOGY Volume: 23 Issue: 11 Article Number: 112001 Published: MAR 23 2012

22. **Pancake Bonding: An Unusual Pi-Stacking Interaction** — Times Cited: 11
By: Kertesz, Miklos
CHEMISTRY-A EUROPEAN JOURNAL Volume: 25 Issue: 2 Pages: 400-416 Published: JAN 7 2019

23. **Enhancement of electrical conductivity of poly(3,4-ethylenedioxythiophene)/poly(4-styrenesulfonate) by a change of solvents** — Times Cited: 688
By: Kim, JY; Jung, JH; Lee, DE; et al.
SYNTHETIC METALS Volume: 126 Issue: 2-3 Pages: 311-316 Article Number: PII S0379-6779(01)00576-8 Published: FEB 14 2002

24. **Scientific importance, properties and growing applications of poly(3,4-ethylenedioxythiophene)** — Times Cited: 969
By: Kirchmeyer, S; Reuter, K
JOURNAL OF MATERIALS CHEMISTRY Volume: 15 Issue: 21 Pages: 2077-2088 Published: 2005

25. **A paper disk equipped with graphene/polyaniline/Au nanoparticles/glucose oxidase biocomposite modified screen-printed electrode: Toward whole blood glucose determination** — Times Cited: 114
By: Kong, Fen-Ying; Gu, Sai-Xi; Li, Wei-Wei; et al.
BIOSENSORS & BIOELECTRONICS Volume: 56 Pages: 77-82 Published: JUN 15 2014

26. **High-performing dye-sensitized solar cells based on reduced graphene oxide/PEDOT-PSS counter electrodes with sulfuric acid post-treatment** Times Cited: 7
By: Lan, Zhang; Gao, Suwen; Wu, Jihuai; et al.
JOURNAL OF APPLIED POLYMER SCIENCE Volume: 132 Issue: 41 Article Number: 42648 Published: NOV 5 2015

27. **On the Determination of Uncertainty and Limit of Detection in Label-Free Biosensors** Times Cited: 5
By: Lavin, Alvaro; de Vicente, Jesus; Holgado, Miguel; et al.
SENSORS Volume: 18 Issue: 7 Article Number: 2038 Published: JUL 2018

28. **Preparation and characterization of conducting polymer nanocomposite with partially reduced graphene oxide** Times Cited: 18
By: Lee, Seul Bi; Lee, Seong Min; Park, No Il; et al.
SYNTHETIC METALS Volume: 201 Pages: 61-66 Published: MAR 2015

29. **Genomic insights into the taxonomic status of the Bacillus cereus group** Times Cited: 65
By: Liu, Yang; Lai, Qiliang; Goeker, Markus; et al.
SCIENTIFIC REPORTS Volume: 5 Article Number: 14082 Published: SEP 16 2015

30. **Reduced graphene oxide as a water, carbon dioxide and oxygen barrier in plasticized poly(vinyl chloride) films** Times Cited: 2
By: Ngoc Minh Nguyen Huynh; Boeva, Zhanna A.; Smatt, Jan-Henrik; et al.
RSC ADVANCES Volume: 8 Issue: 32 Pages: 17645-17655 Published: 2018

Showing 30 of 53 **View All in Cited References page**