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Biosensors and Bioelectronics

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A bioinspired ionic liquid tagged cobalt-salophen complex for nonenzymatic detection of glucose

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ABSTRACT

The development of efficient and cost effective nonenzymatic biosensors with remarkable sensitivity, selectivity and stability for the detection of biomolecules, especially glucose is one of the major challenges in materials- and electrochemistry. Herein, we report the design and preparation of nonenzymatic biosensor based on an ionic liquid tagged cobalt-salophen metal complex (Co-salophen-IL) immobilized on electrochemically reduced graphene oxide (ERGO) for the detection of glucose via an electrochemical oxidation. The bioinspired Co-salophen-IL complex has been synthesized and immobilized on ERGO, which was previously deposited on a screen printed carbon electrode (SPE) to form the Co-salophen-IL/ERGO/SPE nonenzymatic biosensor. The electrochemical behaviour of this modified electrode was studied using cyclic voltammetry (CV) and electrochemical impedance spectroscopy (EIS). Notably, the Co-salophen-IL/ERGO/SPE biosensor exhibited excellent electrocatalytic activity towards glucose oxidation in 0.1 M NaOH, based on which an amperometric sensor has been developed. The modified electrode has shown prominent performance towards glucose detection over a wide linear range from 0.2 μ M to 1.8 mM with a detection limit and sensitivity of 0.79 μ M and 62 μ A mM⁻¹ respectively. The detection was carried out at 0.40 V and such a less working potential excludes the interference from the coexisting oxidizable analytes. The role of Co-salophen, IL and ERGO in the electrocatalytic activity has been systematically investigated. Furthermore, the biosensor demonstrated high stability with good reproducibility.

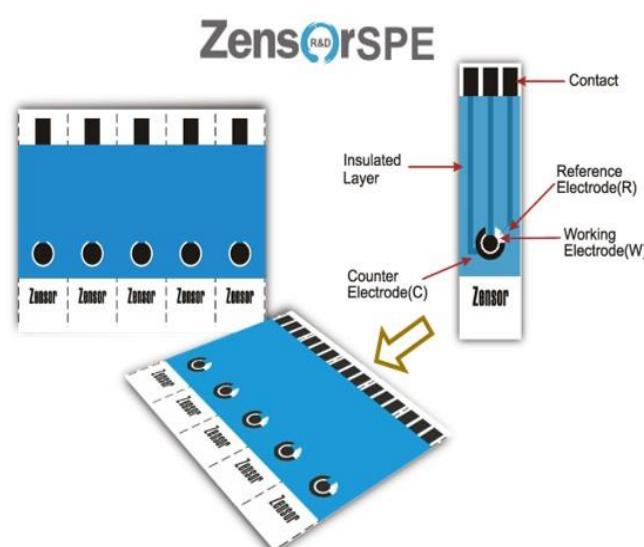
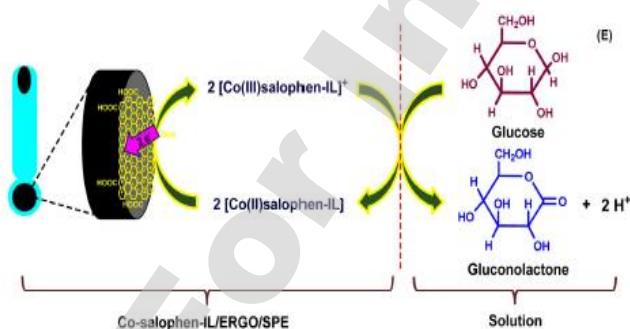


Fig. 3. (E) Schematic representation of the electrocatalytic oxidation of glucose at Co-salophen-IL/ERGO/SPE. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)





A simple preparation of graphite/gelatin composite for electrochemical detection of dopamine

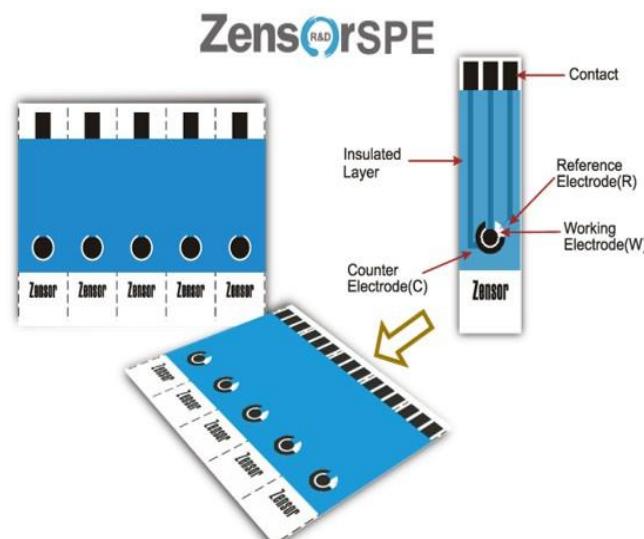
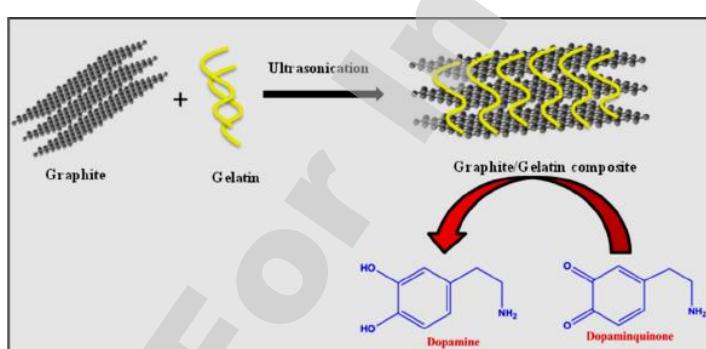
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ABSTRACT

In this study, we demonstrate a simple preparation of graphite (GR) sheets assisted with gelatin (GLN) polypeptide composite was developed for sensitive detection of dopamine (DA) sensor. The GR/GLN composite was prepared by GR powder in GLN solution (5 mg/mL) via sonication process. The prepared GR/GLN composite displays well dispersion ability in biopolymer matrix and characterized via scanning electron microscope (SEM), Fourier transform infrared (FTIR) spectroscopy and electrochemical impedance spectroscopy (EIS) studies. The GR/GLN modified electrode showed an excellent electrocatalytic activity toward the oxidation of DA, suggesting that the successful formation of GR sheets crosslinked with the functional groups of GLN polypeptide. In addition, the GR/GLN modified electrode achieved a wide linear response ranging from 0.05 to 79.5 μ M with a detection limit of 0.0045 μ M. The calculated analytical sensitivity of the sensor was $1.36 \pm 0.02 \mu\text{A } \mu\text{M}^{-1} \text{ cm}^{-2}$. Conversely, the modified electrode demonstrates a good storage stability, reproducibility and repeatability. In addition, the sensor manifests the determination of DA in human serum and urine samples for practical applications.

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ARM-microcontroller based portable nitrite electrochemical analyzer using cytochrome c reductase biofunctionalized onto screen printed carbon electrode



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ABSTRACT

Nitrite (NO_2^-) supplementation limits hypoxia-induced oxidative stress and activates the alternate NO pathway which may partially account for the nitrite-mediated cardioprotection. So, sensitive and selective biosensors with point-of-care devices need to be explored to detect the physiological nitrite level due to its important role in human pathophysiology. In this work, cytochrome c reductase (CcR) biofunctionalized self assembled monolayer (SAM) functionalized on gold nanoparticles (GNPs) in polypyrrole (PPy) nanocomposite onto the screen printed carbon electrode (SPCE) was investigated as a biosensor for the detection of nitrite based on its electrochemical and catalytic properties. CcR was covalently coupled with SAM layers on GNPs by using EDC and NHS. Direct electrochemical response of CcR biofunctionalized electrodes showed a couple of well-defined and nearly reversible cyclic voltammetric peaks at -0.34 and -0.45 vs. Ag/AgCl. Under optimal conditions, the biosensor could be used for the determination of NO_2^- with a linear range from 0.1 – $1600 \mu\text{M}$ and a detection limit of 60nM with a sensitivity of $0.172 \mu\text{A} \mu\text{M}^{-1} \text{cm}^{-2}$. Further, we have designed and developed a novel and cost effective portable electrochemical analyzer for the measurement of NO_2^- in hypoxia induced H9c2 cardiac cells using ARM microcontroller. The results obtained here using the developed portable electrochemical nitrite analyzer were also compared with the standard cyclic voltammetry instrument and found in agreement with each other.

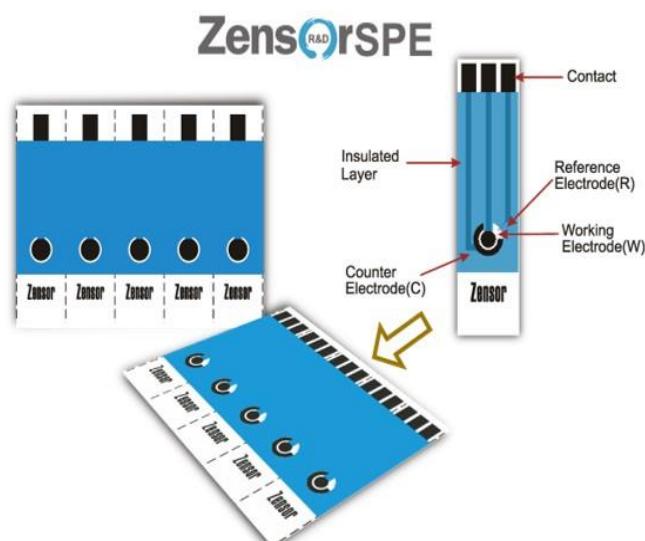
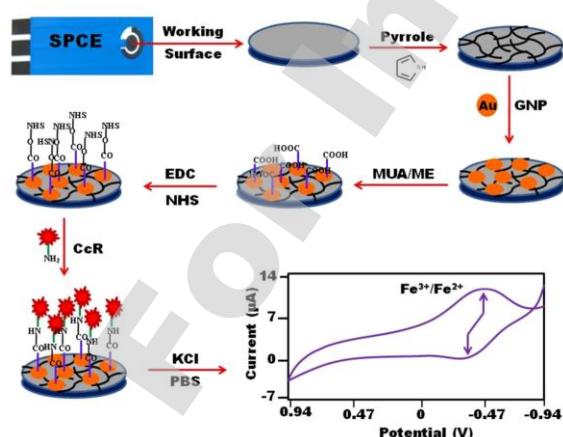


Fig. 1. Schematic representation of the step-wise fabrication of nitrite biosensor using CcR immobilized onto miniaturized disposable screen printed carbon electrode.





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Boron-doped carbon nanotubes with uniform boron doping and tunable dopant functionalities as an efficient electrocatalyst for dopamine oxidation reaction

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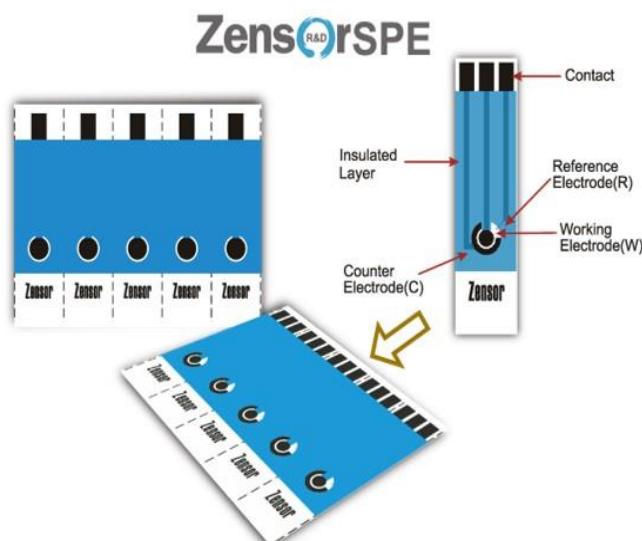
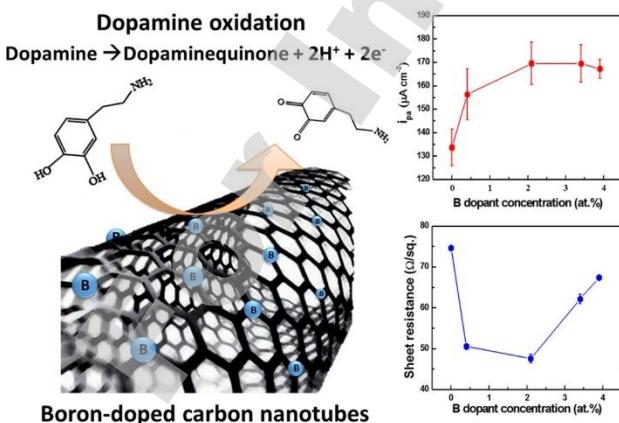
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ABSTRACT

An atmospheric pressure, solution-assisted substitution process has been developed to produce boron-doped carbon nanotubes (BCNTs) with tunable boron dopant concentrations precisely from atomic percent of 0.4–3.9% by controlling the reaction conditions. The systematic material characterizations and detailed electrochemical sensor applications were studied. The electrochemical detection of dopamine (DA) can be improved by the enhanced electrocatalytic activity and reduced electron transfer resistance of BCNTs due to the boron doping. The effects of boron dopant concentrations on the electrocatalytic activity and electron transfer resistance of the BCNTs were investigated thoroughly in this study. It was found experimentally that the anodic peak current density (i_{pa}) of DA is the highest ($169.6 \pm 8.9 \mu\text{A cm}^{-2}$) on the BCNTs (B 2.1 at.%) modified screen printed carbon electrode (SPCE). In this study, we have successfully developed a highly efficient and tunable synthesis of BCNTs in bulk quantities as the potential electrocatalysts for DA oxidation reaction. Also, it is noteworthy from a practical point of view that the developed atmospheric-pressure BCNTs synthesis method is amenable to industrial-scale production since it avoids the need for a vacuum system.

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Electrochemical preparation of activated graphene oxide for the simultaneous determination of hydroquinone and catechol

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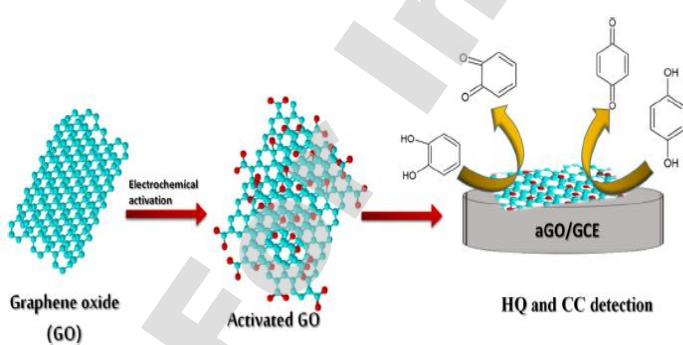
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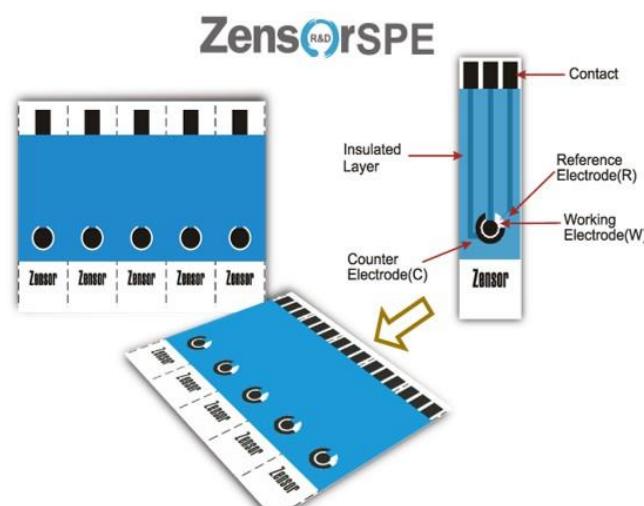
ABSTRACT

This paper describes the electrochemical preparation of highly electrochemically active and conductive activated graphene oxide (aGO). Afterwards, the electrochemical properties of aGO was studied towards the simultaneous determination of hydroquinone (HQ) and catechol (CC). This aGO is prepared by the electrochemical activation of GO by various potential treatments. The resultant aGOs are examined by various physical and electrochemical characterizations. The high potential activation (1.4 to -1.5) process results a highly active GO (aGO₁), which manifest a good electrochemical behavior towards the determination of HQ and CC. This aGO₁ modified screen printed carbon electrode (SPCE) was furnished the sensitive detection of HQ and CC with linear concentration range from 1 to 312 µM and 1 to 350 µM. The aGO₁ modified SPCE shows the lowest detection limit of 0.27 µM and 0.182 µM for the HQ and CC, respectively. The aGO₁ modified SPCE reveals an excellent selectivity towards the determination of HQ and CC in the presence of 100 fold of potential interferents. Moreover, the fabricated disposable aGO₁/SPCE sensor was demonstrated the determination of HQ and CC in tap water and industrial waste water.

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Electrochemical activation of graphene oxide for the effective determination of hydroquinone and catechol





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Graphene-based screen-printed electrochemical (bio)sensors and their applications: Efforts and criticisms



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ABSTRACT

K.S. Novoselov in his Nobel lecture (December 8, 2010), described graphene as "more than just a flat crystal" and summarized the best possible impression of graphene with (i) it is the first example of 2D atomic crystals, (ii) it demonstrated unique electronic properties, thanks to charge carriers which mimic massless relativistic particles, and (iii) it has promise for a number of applications. The fascinating and unusual properties of this 2D material were indeed recently investigated and exploited in several disciplines including physics, medicine, and chemistry, indicating the extremely versatile and polyedric aspect of this nanomaterial.

The utilization of nanomaterials, printed technology, and microfluidics in electroanalysis has resulted in a period that can be called the "Electroanalysis Renaissance" (Escarpa, 2012) in which graphene is without any doubt a forefront nanomaterial. The rise in affordable fabrication processes, along with the great dispersing attitude in a plenty of matrices, have made graphene powerful in large-scale production of electrochemical platforms. Herein, we overview the employment of graphene to customize and/or fabricate printable based (bio)sensors over the past 5 years, including several modification approaches such as drop casting, screen- and inkjet-printing, different strategies of graphene-based sensing, and applications as well. The objective of this review is to provide a critical perspective related to advantages and disadvantages of using graphene in biosensing tools, based on screen-printed sensors.

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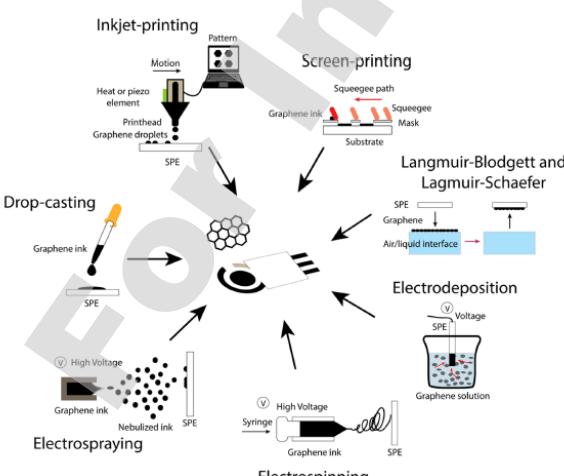
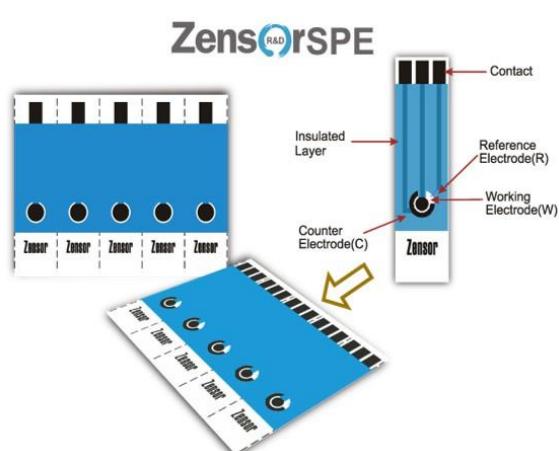


Fig. 1. Scheme of the several procedures utilized for fabrication of SPEs modified with graphene.





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Synthesis and characterizations of biscuit-like copper oxide for the non-enzymatic glucose sensor applications

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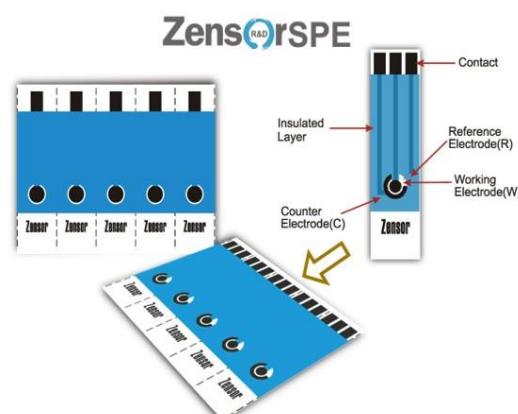
ABSTRACT

We described the synthesis of biscuit-like copper oxide (CuO) by the precipitation cum thermal annealing process. The biscuit-like CuO microstructures were successfully obtained by template free synthesis process. Thereby, the oxalic acid was used as the shape forming agent. Herein, the role of the sonic wave was quite important to controlling the shape. The CuO microstructures were characterized by the X-ray diffraction pattern, scanning electron microscope and energy dispersive X-ray analysis. The as-prepared CuO was used to fabricate the disposable sensor electrode using screen printed carbon electrode (SPCE). The CuO modified SPCE was successfully determined the glucose with the linear concentration ranging from 0.0005 to 4.03 mM and the lowest detection limit of 0.1 µM. The biscuit-like CuO microstructures based glucose sensor displayed appreciable analytical performance than the other CuO nanostructures. Moreover, the disposable CuO/SPCE was applied to determine the glucose in human blood serum, saliva and urine samples. The developed glucose sensor attained good recoveries in real sample analysis, hence, it is applicable for the commercial applications.

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Synthesis route for the preparation of biscuit-like copper oxide by precipitation cum thermal annealing process.





A dually functional 4-aminophenylboronic acid dimer for voltammetric detection of hypochlorite, glucose and fructose

Murugan Thiruppathi¹ · Natarajan Thiagarajan¹ · Manavalan Gopinathan¹ ·

Jen-Lin Chang¹ · Jyh-Myng Zen¹

Abstract The authors report on the electrochemical process for the modification of a screen printed carbon electrode (SPCE) with an azo-functionalized dimer of 4-amino phenylboronic acid. The dimer is prepared on the surface of the SPCE through the formation of azo bond, and the presence of the dimer is confirmed by cyclic voltammetry, X-ray photoelectron spectroscopy and functional group specific sensing studies. Specifically, this unique dimer-modified electrode possesses dual functionalities ($R-N=N-R'$ and $-B(OH)_2$) which makes its suitable for selective detection of hypochlorite (i.e., free chlorine) and sugar molecules (demonstrated for glucose and fructose), respectively. The heterogeneous electron transfer rate constant is 7.89 s^{-1} which indicates a fast electron transfer process at the dimer-modified SPCE. The sensor, operated at a voltage of typically 0.05 V (vs. Ag/AgCl), gives a linear response in the $1\text{ }\mu\text{M}$ to 10 mM hypochlorite concentration range and has a sensitivity of $408.16\text{ }\mu\text{A mM}^{-1}\text{ cm}^{-2}$ at neutral pH values. The catalytic rate constant is $49,872\text{ M s}^{-1}$ for free chlorine. By using hexacyanoferrate as an electrochemical probe and at a typical working voltage of 0.18 V (vs. Ag/AgCl), the sensor displays a linear response in the 1 to $500\text{ }\mu\text{M}$ fructose and glucose concentration range, with detection limits (for $S/N = 3$) of $0.24\text{ }\mu\text{M}$ for fructose and $0.36\text{ }\mu\text{M}$ for glucose.

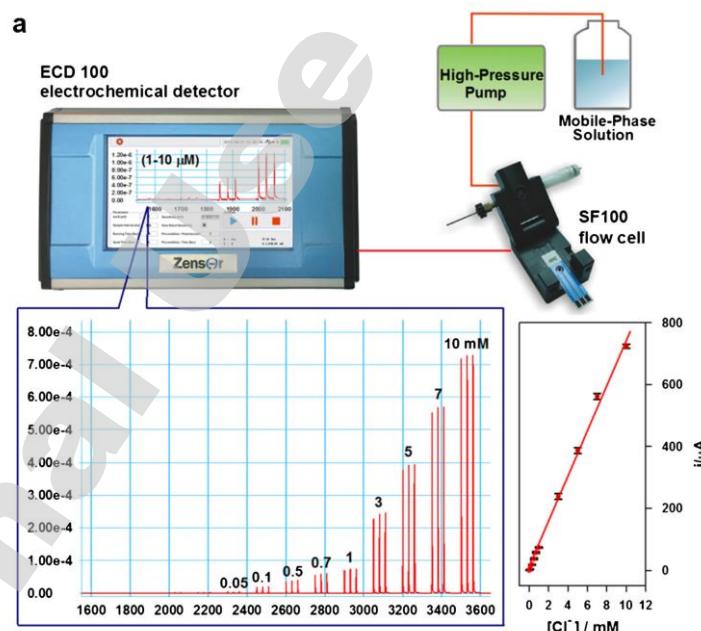
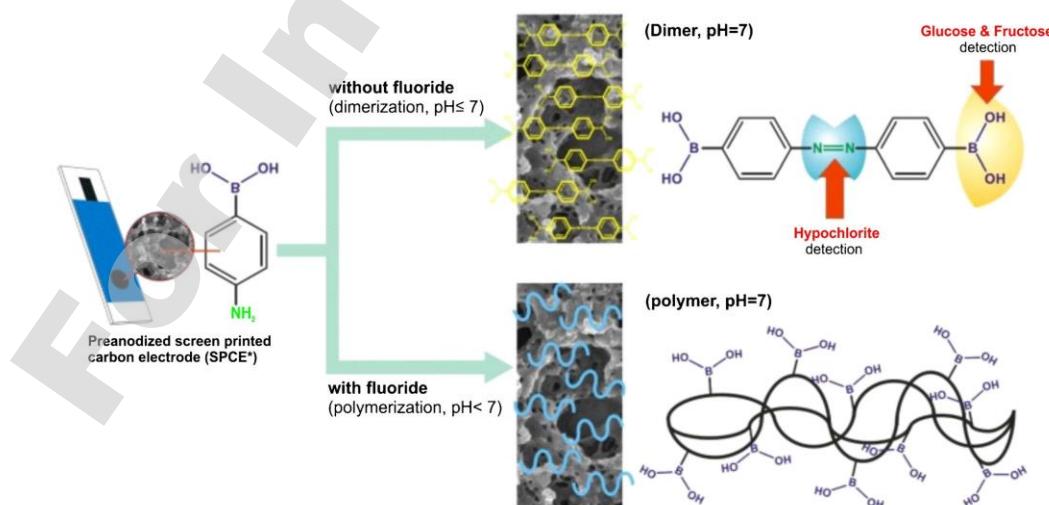


Fig. 3 a FIA responses of hypochlorite at dimer-modified electrode obtained with Zensor ECD 100 electrochemical detector/SF 100 flow cell and its corresponding calibration plot.



Scheme 1 Schematic representation of dimer/polymer preparation



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Boron-doped carbon nanotubes with uniform boron doping and tunable dopant functionalities as an efficient electrocatalyst for dopamine oxidation reaction

Ta-Jen Li^{a,1}, Min-Hsin Yeh^{a,b,1}, Wei-Hung Chiang^{b,**}, Yan-Sheng Li^b, Guan-Lin Chen^b, Yow-An Leu^{a,c}, Ta-Chang Tien^d, Shen-Chuan Lo^d, Lu-Yin Lin^e, Jiang-Jen Lin^c, Kuo-Chuan Ho^{a,c,*}

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ABSTRACT

An atmospheric pressure, solution-assisted substitution process has been developed to produce boron-doped carbon nanotubes (BCNTs) with tunable boron dopant concentrations precisely from atomic percent of 0.4–3.9% by controlling the reaction conditions. The systematic material characterizations and detailed electrochemical sensor applications were studied. The electrochemical detection of dopamine (DA) can be improved by the enhanced electrocatalytic activity and reduced electron transfer resistance of BCNTs due to the boron doping. The effects of boron dopant concentrations on the electrocatalytic activity and electron transfer resistance of the BCNTs were investigated thoroughly in this study. It was found experimentally that the anodic peak current density (i_{pa}) of DA is the highest ($169.6 \pm 8.9 \mu\text{A cm}^{-2}$) on the BCNTs (B 2.1 at.%) modified screen printed carbon electrode (SPCE). In this study, we have successfully developed a highly efficient and tunable synthesis of BCNTs in bulk quantities as the potential electrocatalysts for DA oxidation reaction. Also, it is noteworthy from a practical point of view that the developed atmospheric-pressure BCNTs synthesis method is amenable to industrial-scale production since it avoids the need for a vacuum system.

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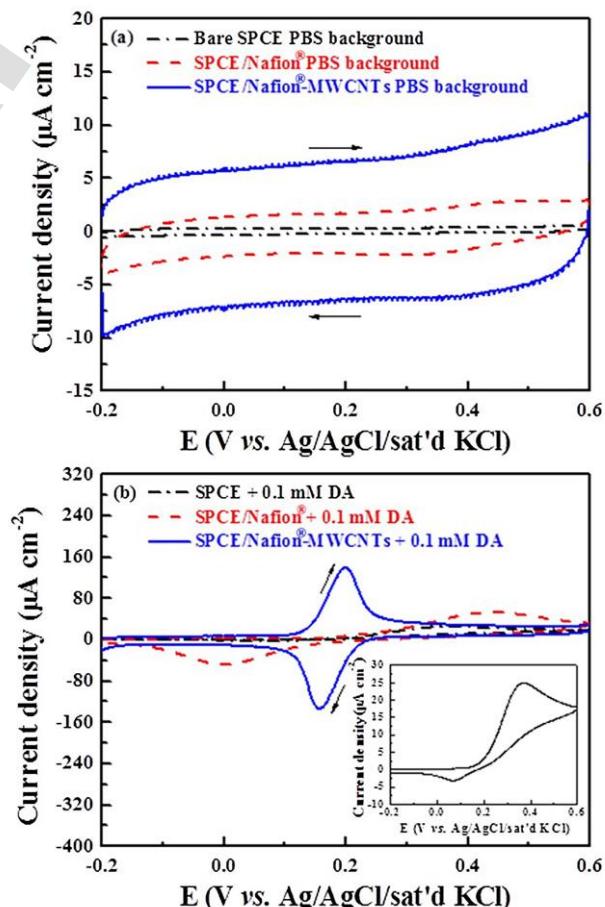
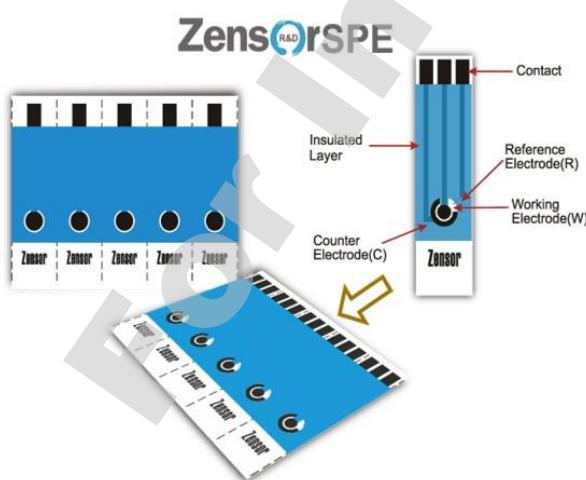


Fig. 5. Cyclic voltammograms of the bare SPCE, SPCE/Nafion®, and SPCE/Nafion®-MWCNTs recorded in (a) PBS (pH 7.0) and (b) 0.1 mM DA solution. Scan rate is 50 mV s⁻¹.



Full Length Article

Electrical polymerization of a tetrazole polymer-modified electrode and its catalytic reaction toward dopamine



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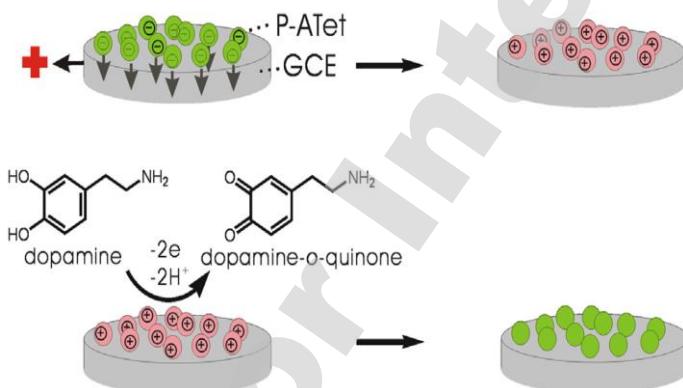
Available online 30 November 2016

ABSTRACT

A conducting polymer-modified electrode was proposed in this article, which was fabricated by electropolymerization of 5-amino-1H-tetrazole (ATet) on a glassy carbon electrode. Electrochemical studies such as differential pulse voltammetry and chronoamperometry were performed for the evaluation of the rate constant of the catalytic reaction, the diffusion coefficient of the analyte dopamine, and the linear dynamic range of the analyte determination. The film modified electrode has superior resolving power in quantitative determination from the mixture of analytes and it was found to be an efficient functionalized electrode for its sensitivity and selectivity toward the analyte of interest.

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Keywords:
5-amino-1H-tetrazole
Dopamine
Electropolymerization
Cyclic voltammetry
Differential pulse voltammetry



Scheme 2. Illustration of the catalytic oxidation of dopamine by p-ATet.

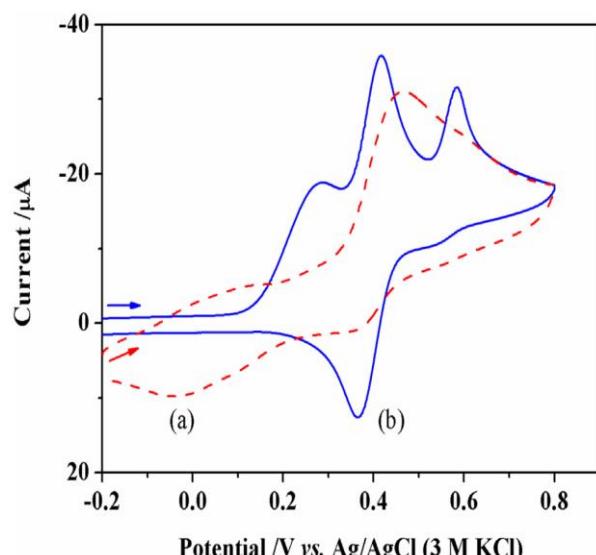


Fig. 8. Merged cyclic voltammograms of the aqueous solution containing 0.1 M KCl, ascorbic acid, dopamine, and uric acid on a bare GC electrode (a; red dashed curve) and the p-ATet modified GC electrode (b; blue solid curve) at a scan rate of 50 mV s⁻¹. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)



Fe NPs and MWCNTs based electrode as FIA detector for determination of amino acids in hypothalamus microdialysis fluids

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ABSTRACT

An amperometric electrode based on multiwall carbon nanotubes (MWCNTs) and Fe nanoparticles (NPs) has been successfully fabricated. The electrode combined with Flow Injection Analysis (FIA) exhibits linear response in the concentration range of 0.1–12 μM and the sensitivity of $30.0 \text{ nA } \mu\text{M}^{-1}$ for most of amino acids, confirming good complexation of amino acids (AAs) with Fe NPs on the modified electrode. The determination of 17 amino acids in the hypothalamus microdialysis fluids of guinea pigs, illustrates that it is a powerful tool to investigate physiology and pathology mechanisms.

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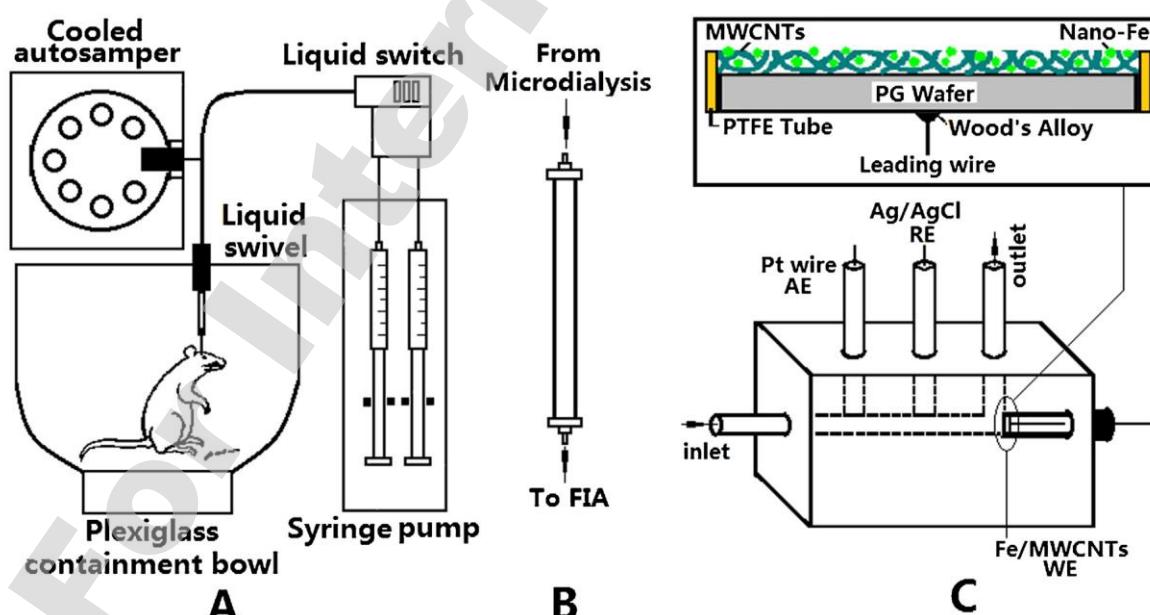


Fig. 1. Schematic diagram of the electrochemical measurement system with Fe NPs/MWCNTs electrode for determining amino acids in the hypothalamus microdialysis fluids of guinea pigs. It included A) microdialysis, B) AAs separation column, and C) Flow Injection Analysis (FIA) with Fe NPs/MWCNTs electrode as a detector (a larger view is above).



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3D graphene oxide-cobalt oxide polyhedrons for highly sensitive non-enzymatic electrochemical determination of hydrogen peroxide

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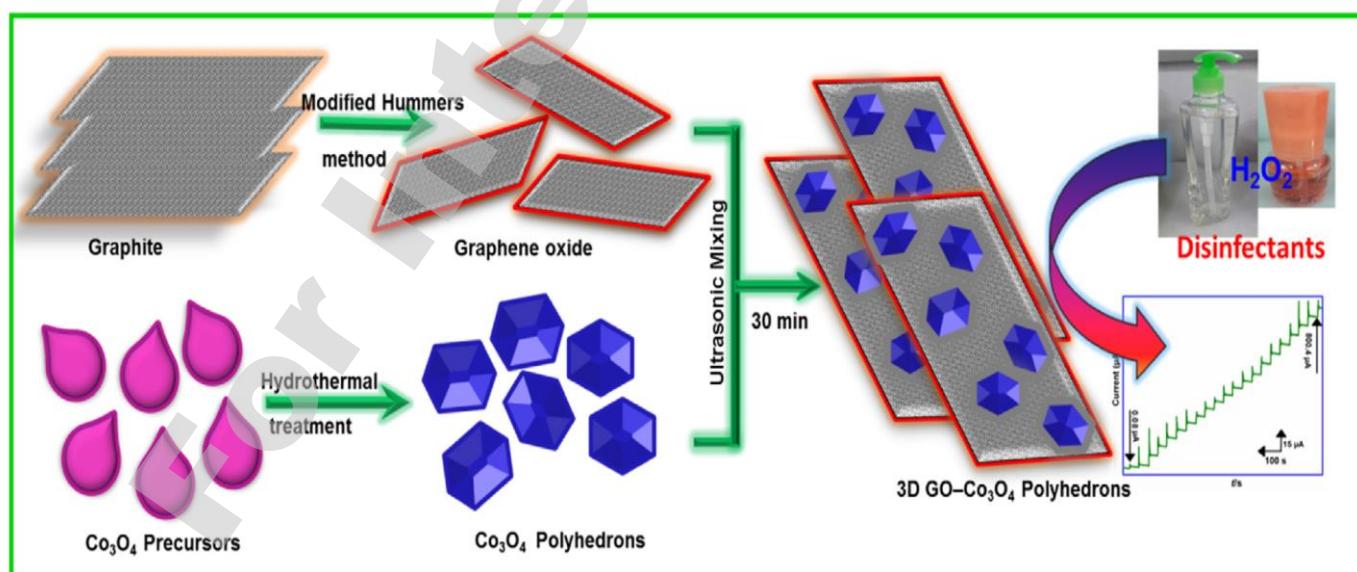
Keywords:

Graphene/metal oxide
Non-enzymatic sensing
Hydrogen peroxide
Cell signaling molecule
Chemical sensor
Analytical chemistry

ABSTRACT

Polyhedrons structured cobalt oxide (Co_3O_4 PHs) and three-dimensional graphene oxide encapsulated cobalt oxide polyhedrons (3D GO- Co_3O_4 PHs) were synthesized via facile hydrothermal synthetical route for the highly sensitive determination of hydrogen peroxide (H_2O_2). The morphological study clearly revealed the polyhedron shaped Co_3O_4 and additionally elemental, diffraction, and electrochemical studies were performed to verify the structure and shape. Owing to excellent synergy between Co_3O_4 PHs and GO, the composite possesses good porosity, large electrochemical area, roughened surface, and excellent electrocatalytic ability. The development of highly sensitive sensor is essential for H_2O_2 due to its great significance in physiological, biochemical, pharmaceutical and medicinal applications. A rapid, sensitive, selective, reproducible, and durable non-enzymatic H_2O_2 assay, by employing 3D GO- Co_3O_4 PHs modified electrode was described. The sensor offered excellent sensitivity with detection limit of 15 nM, which is superior to those of previously reported sensors. A real-time analysis was demonstrated in commercially acquired contact lens and disinfectant cleaning solutions without pre-treatment.

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Scheme 1. Schematic representation for synthesis of 3D GO- Co_3O_4 PHs.



Electrochemical acetylcholinesterase biosensor based on multi-walled carbon nanotubes/dicyclohexyl phthalate modified screen-printed electrode for detection of chlorpyrifos



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Acetylcholinesterase

ABSTRACT

A biosensor based on dicyclohexyl phthalate (DCHP) and multi-walled carbon nanotubes (MWCNTs) modified a screen-printed electrode (SPE) has been developed for detection of chlorpyrifos. Compared with a common electrode, a SPE exhibited advantageous material properties which can be applied to the in situ detection. Herein, the fabricated biosensor was developed based on the nanocomposites of DCHP and MWCNTs modified a screen-printed electrode. This strategy enhanced electron transfer rate at a lower potential and catalyzed electrochemical oxidation of acetylthiocholine effectively. Acetylcholinesterase (AChE) was immobilized onto the nanocomposites film to prepare an AChE biosensor for pesticide residues detection. Moreover, the biosensor had also been successfully employed for the determination of pesticide with low concentrations in real vegetable samples. Based on the inhibition of pesticide on the AChE activity, chlorpyrifos used as model compounds, this biosensor showed a wide range, low detection limit, good reproducibility and high stability. The inhibition of chlorpyrifos was proportional to its concentration ranging from 0.05 to $1.0 \times 10^5 \mu\text{g/L}$ with a detection limit of $0.05 \mu\text{g/L}$. The developed biosensor exhibited a good reproducibility and acceptable stability.

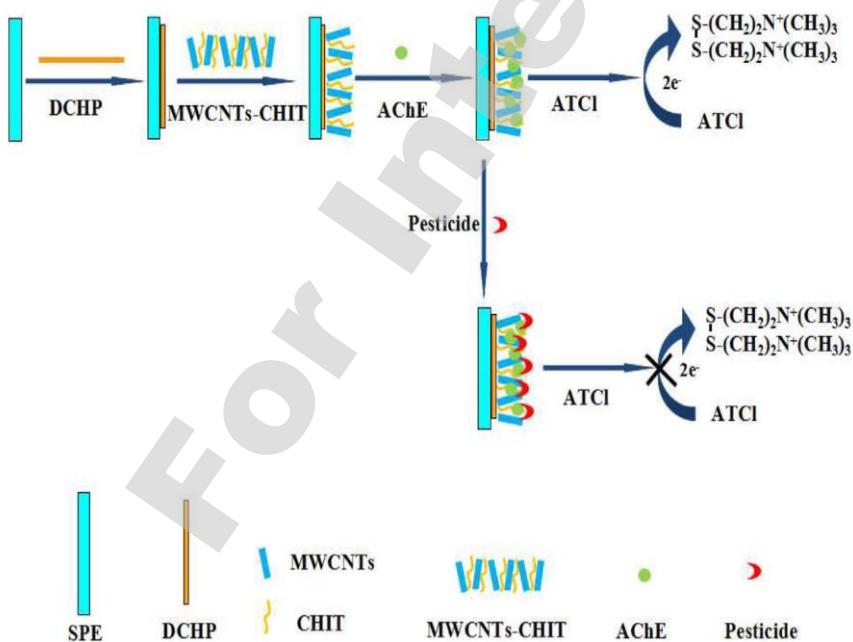
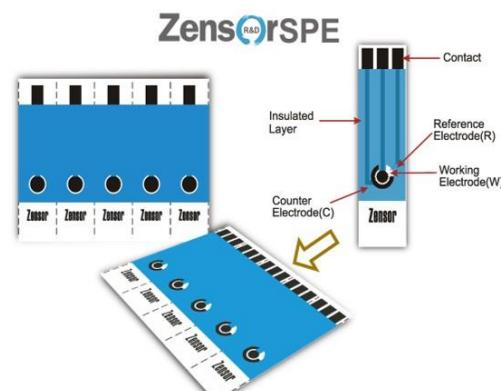


Fig. 3. Schematic illustration of the stepwise AChE biosensor fabrication process and immobilized AChE inhibition in pesticide solution.



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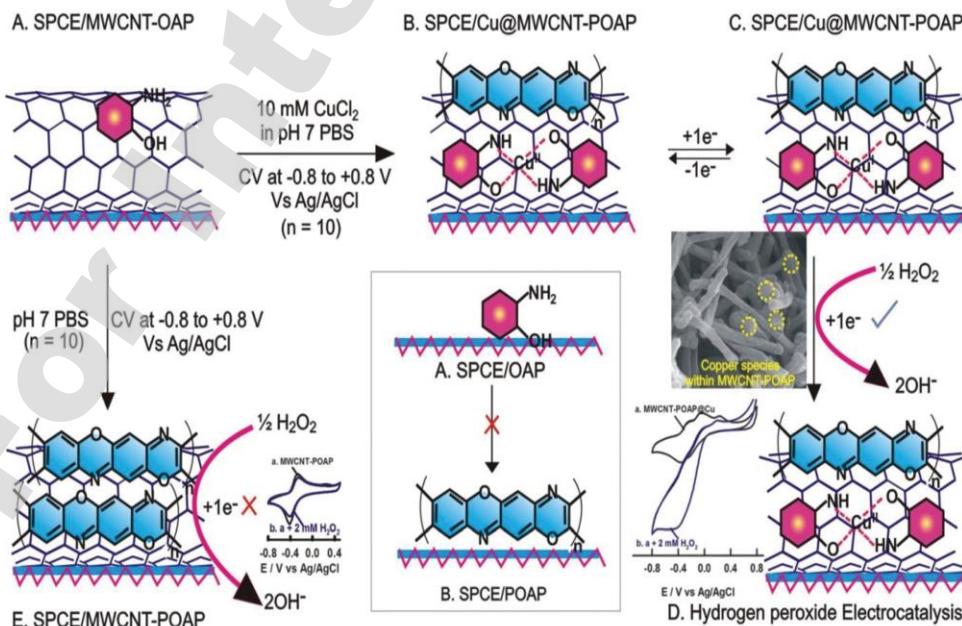
One-pot electrochemical preparation of copper species immobilized poly(o-aminophenol)/MWCNT composite with excellent electrocatalytic activity for use as an H₂O₂ sensor†

Palani Barathi,^a Balamurugan Thirumalraj,^b Shen-Ming Chen  *^b and A. Subramania  *^a

Redox activity of copper species immobilized poly(o-aminophenol)/multi-walled carbon nanotube (Cu@MWCNT-POAP) composite is reported for direct electrocatalysis towards detection of H₂O₂. The Cu@MWCNT-POAP composite was prepared by a single step *in situ* electrochemical method. The as-prepared Cu@MWCNT-POAP composites were characterized by field emission scanning electron microscopy, Fourier transform infrared spectroscopy, Raman spectroscopy, X-ray diffraction, and electrochemical impedance spectroscopy. Cyclic voltammetry (CV) studies highlighted the good redox behavior of the Cu@MWCNT-POAP composite resulting from direct electron transfer behavior of the copper redox couple (Cu²⁺/Cu⁺). The Cu@MWCNT-POAP composite displayed superior electrocatalytic activity and high performance towards detection of H₂O₂ because of its large surface area and homogenous immobilization of Cu species on the MWCNT-POAP composite. The analytical sensitivity and detection limit of the sensor were 831 μA mM⁻¹ cm⁻² and 30 nM, respectively. In addition, bio-catalytic activity of the sensor was evaluated using the Michaelis–Menten constant. The Cu@MWCNT-POAP composite showed excellent stability and reproducibility, and good recoveries for determination of H₂O₂ in milk, bleach cream, and contact lens solutions.

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Scheme 1 Schematic illustration of *in situ* preparation of Cu@MWCNT-POAP on SPCE and its electrocatalytic activity of H₂O₂.



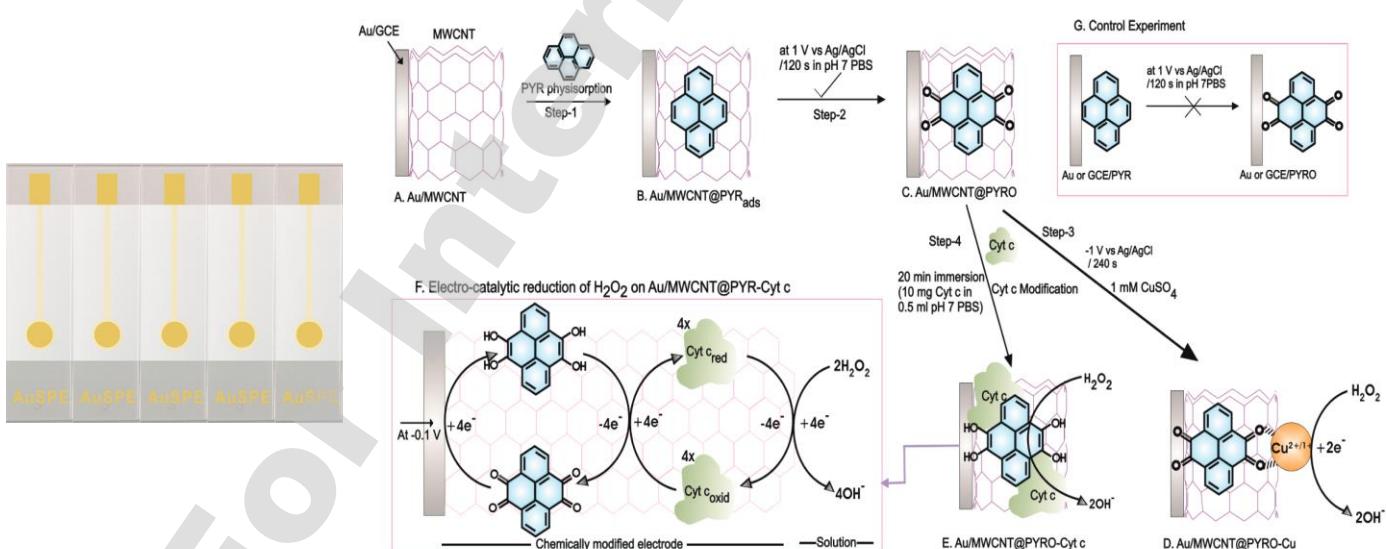
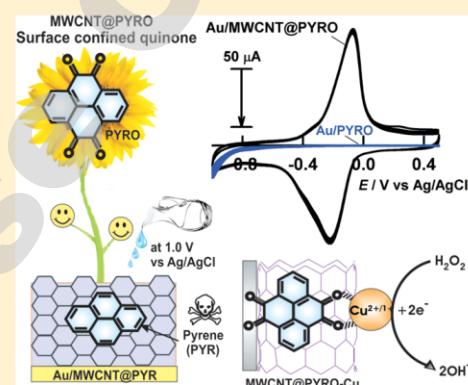
Electrochemical Conversion of Unreactive Pyrene to Highly Redox-Active 1,2-Quinone Derivatives on a Carbon Nanotube-Modified Gold Electrode Surface and Its Selective Hydrogen Peroxide Sensing

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Supporting Information

ABSTRACT: Pyrene (PYR) is a rigid, carcinogenic, unreactive, and non-electrooxidizable compound. A multiwalled carbon nanotube (MWCNT)-modified gold electrode surface-bound electrochemical oxidation of PYR to a highly redox-active surface-confined quinone derivative (PYRO) at an applied potential of 1 V versus Ag/AgCl in pH 7 phosphate buffer solution has been demonstrated in this work. Among various carbon nanomaterials examined, the pristine MWCNT-modified gold electrode showed effective electrochemical oxidation of the PYR. The MWCNT's graphite impurity promotes the electrochemical oxidation reaction. Physicochemical and electrochemical characterizations of MWCNT@PYRO by Raman spectroscopy, FT-IR, X-ray photoelectron spectroscopy, and GC-MS reveal the presence of PYRO as pyrene-tetronine within the modified electrode. The quinone position of PYRO was identified as ortho-directing by an elegantly designed ortho-isomer-selective complexation reaction with copper ion as an MWCNT@PYRO-Cu^{2+/1+}-modified electrode. Finally, a cytochrome c enzyme-modified Au/MWCNT@PYRO (i.e., Au/MWCNT@PYRO-Cyt c) was also developed and further demonstrated for the selective biosensing of hydrogen peroxide.



Scheme 1. Schematic Representation of the Electrochemical Conversion of Au/MWCNT@PYR to Au/MWCNT@PYRO (A-C) and the Electrocatalytic Reduction of H₂O₂ on Au/MWCNT@PYRO-Cu^{2+/1+} (D) and Au/MWCNT@PYRO-Cyt c (E, F), along with a Control Experiment Relating to the Electrochemical Conversion of Au/PYR to Au/PYRO (G)

Electrochemically Activated Screen Printed Carbon Electrode Decorated with Nickel Nano Particles for the Detection of Glucose in Human Serum and Human Urine Sample

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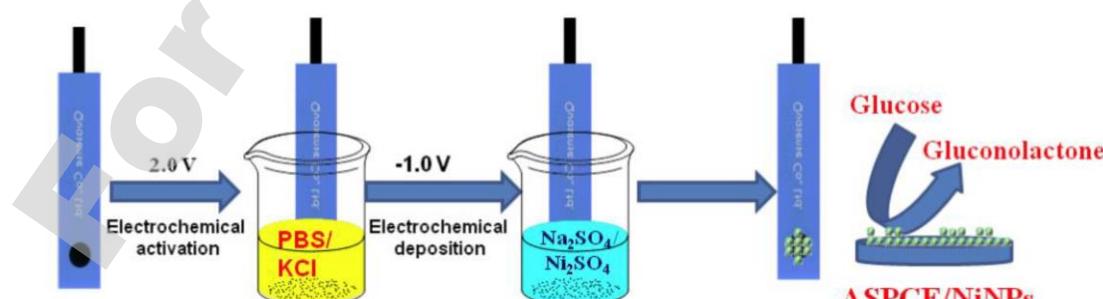
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A simple and sensitive amperometric enzyme-free glucose sensor was developed at the electrochemically activated screen printed carbon electrode (ASPCE) decorated with the nickel nanoparticles (NiNPs). We have applied simple electrochemical methods for the activation of SPCE, and the deposition of NiNPs on the ASPCE surface. The modified electrodes were characterized by the scanning electron microscope (SEM), energy dispersive X-ray spectroscopy (EDX) and electrochemical impedance spectroscopic methods (EIS). The electrocatalytic behavior of the modified electrode was studied by the cyclic voltammetry (CV), and amperometric method. The modified electrode exhibited good electrocatalytic behavior towards the oxidation of glucose with high oxidized peak current. In addition, the fabricated sensor exhibits the wide range of linearity between 5 μM to 1.5 mM with the high sensitivity of 1.9134 $\mu\text{A } \mu\text{M}^{-1}\text{ CM}^{-1}$ and the limit of detection (LOD) is 0.28 μM . The prepared ASPCE/NiNPs electrode shows the good selectivity in the presence of common interfering molecules. The practical feasibility of the sensor exhibited acceptable recoveries in determination of glucose in human blood serum and human urine. Moreover, the fabricated sensor shows good selectivity, reproducibility, and repeatability.



Scheme 1. Schematic presentation of fabrication of ASPCE/NiNPs electrode.





Contents lists available at ScienceDirect

Journal of Electroanalytical Chemistry

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A novel amperometric nitrite sensor based on screen printed carbon electrode modified with graphite/β-cyclodextrin composite

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Amperometry

ABSTRACT

A simple and disposable amperometric nitrite sensor was developed based on screen printed carbon electrode (SPCE) modified with graphite (GR) and β-cyclodextrin (CD) composite. The GR/CD composite was prepared by a simple sonication of pristine GR powder in CD aqueous solution. The GR/CD composite modified SPCE showed a higher electrocatalytic activity towards nitrite with lower overpotential (0.81 V) compared with bare, GR and CD modified SPCEs. The edge planes of GR were highly activated in presence of CD and resulting to the high catalytic activity and lower oxidation overpotential for the detection of nitrite. Under optimum conditions, the fabricated GR/CD composite modified SPCE detects the nitrite in the linear concentration range from 0.7 μM to 2.15 mM with a limit of detection of $0.26 \pm 0.01 \mu\text{M}$. The GR/CD composite modified SPCE also showed a high sensitivity, selectivity, acceptable repeatability and reproducibility along with appropriate operational stability for the detection of nitrite. In addition, the GR/CD composite modified SPCE showed a satisfactory recovery for the detection of nitrite in different water samples, authenticating an excellent practicality of the sensor.

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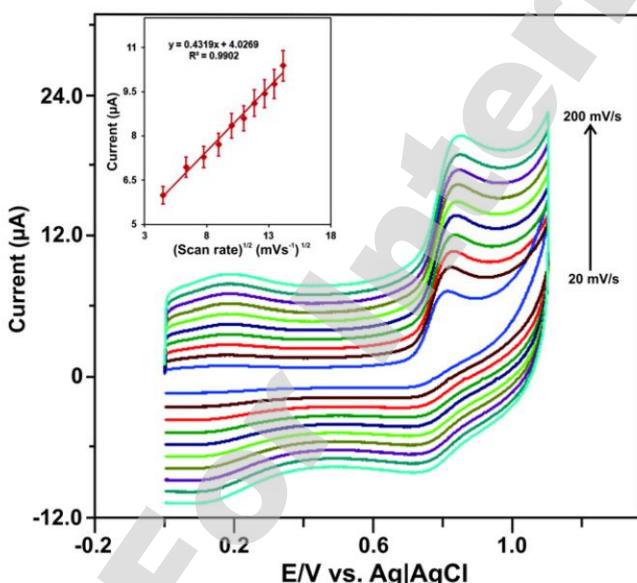
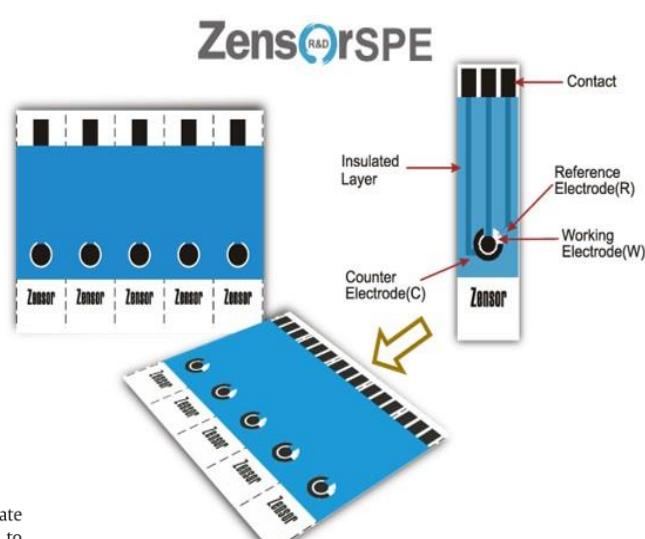


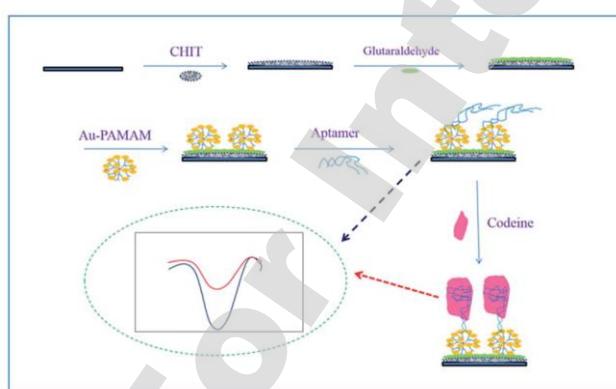
Fig. 5. A) CV response of GR/CD composite modified SPCE in 0.05 M sodium phosphate buffer pH 5 solution containing 100 μM nitrite at different scan rates from 20 to 200 mV s⁻¹. B) The corresponding calibration plot for square root of scan rate vs. oxidation peak current response of nitrite. The error bars relative to the standard deviation of 3 measurements.



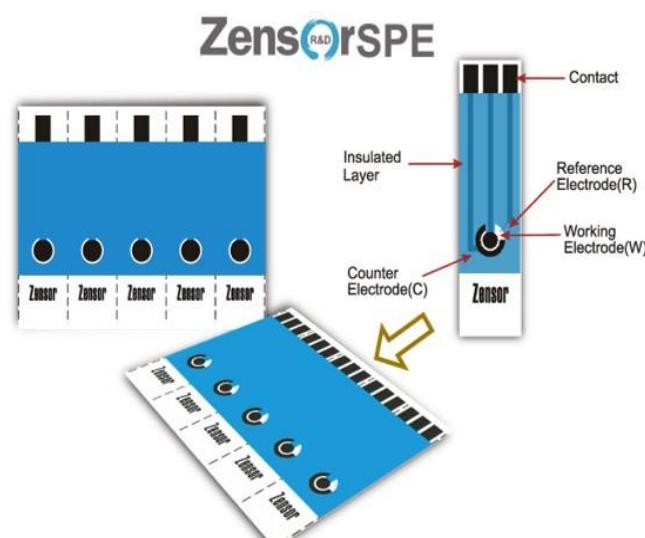
An ultrasensitive aptamer biosensor for the detection of codeine based on a Au nanoparticle/polyamidoamine dendrimer-modified screen-printed carbon electrode

Xiaofang Niu,^{ab} Liangliang Huang,^a Jinhang Zhao,^a Mengdi Yin,^a Dan Luo^b and Yunhui Yang^{*a}

This paper reports a novel aptamer biosensor for the ultrasensitive detection of codeine in aqueous solutions by the special interactions between codeine-binding aptamers. Polyamidoamine dendrimers (PAMAM) were used to absorb gold nanoparticles (AuNPs) and modify the surface of screen-printed carbon electrodes (SPCEs). The codeine aptamer was immobilized on the PAMAM/glutaraldehyde (GA)/chitosan (CHIT)-modified electrode through Au–SH affinity. The specific combination between the aptamer and codeine can obstruct the electron transfer of electrochemical probe $K_3Fe(CN)_6/K_4Fe(CN)_6$, which can be used to detect codeine. The linear range covered from 1×10^{-12} mol L⁻¹ to 1×10^{-7} mol L⁻¹, and the detection limit was 3×10^{-13} mol L⁻¹. The new aptamer biosensor is sensitive and selective enough to detect codeine directly in blood serum and other aqueous solutions. Compared with other conventional methods, it has several advantages, such as a lower detection limit, a broader detection range and a fast detection process.



Scheme 1 Stepwise procedure of the aptamer sensor for the detection of codeine.



Short Communication

Fabrication of Aptasensors Modified by MWCNTs-CS / Fe₃O₄-CS Based on SPEs

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In this paper, A new electrochemical aptamer biosensor for detecting tetracycline (TET) has been developed based on the signal amplification of MWCNTs-CS and Fe₃O₄-CS. The multiwalled carbon nanotube (MWCNTs) and ferroferric oxide (Fe₃O₄) were dispersed in chitosan evenly. Then the MWCNTs-CS , Fe₃O₄-CS and the aptamer of anti-TET were modified on the surface of screen printing electrode respectively for preparation of the aptasensor. The electrochemistry properties of the surface modification were investigated by using cyclic voltammetry (CV). The proposed aptasensor showed a high sensitivity and a good stability. The proposed aptasensor exhibited a wide linear range from 10⁻² to 10⁻⁹ M and with the correlation coefficients of 0.9651. The detection limit for tetracycline was 10⁻⁹ M. The application of this method for samples of TET-spiked raw milk suggested satisfactory recoveries between 92% and 98%. The proposed method was proven to be a feasible quantitative method for tetracycline analysis.

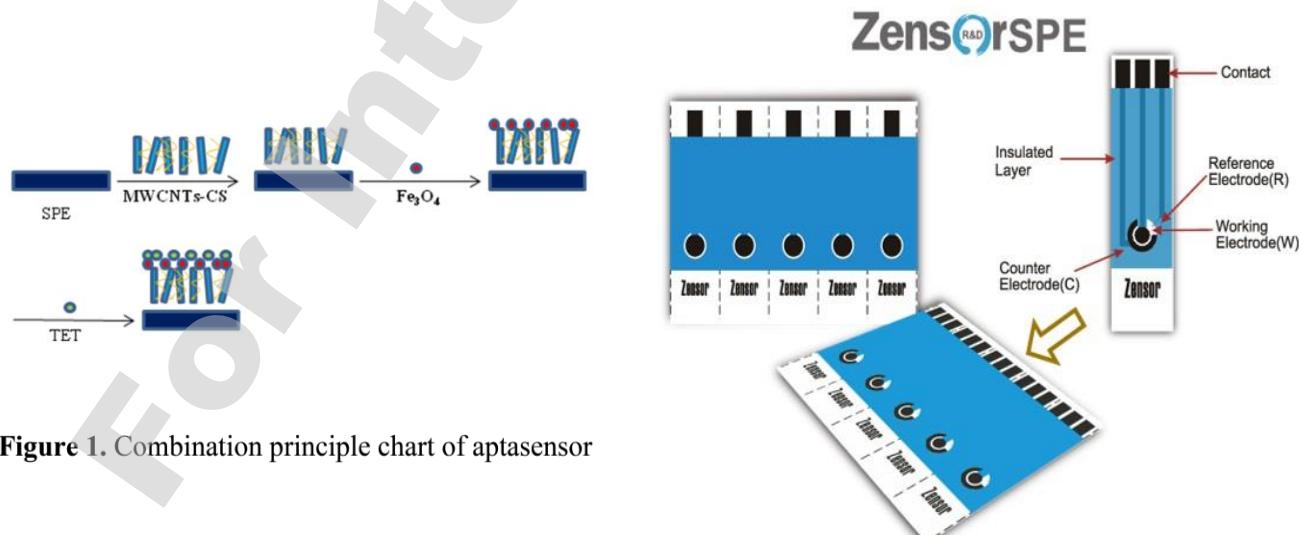


Figure 1. Combination principle chart of aptasensor



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Electrochimica Acta

journal homepage: www.elsevier.com/locate/electacta



Manipulation of defect density and nitrogen doping on few-layer graphene sheets using the plasma methodology for electrochemical applications

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ABSTRACT

In this study, we successfully manipulate the defect density and thickness (number of layers) of few-layer graphene sheets at low temperatures ($\leq 300^\circ\text{C}$) using microwave plasma torch (MPT) coupled with plasma-enhanced chemical vapor deposition (PECVD) method. The graphene defects and thickness of 2–10 layers can be controlled by variation in the argon flow rate and pressure during graphene growth step. The quality and thickness of graphene sheets are characterized using Raman spectroscopy and high-resolution transmission electron microscopy (HRTEM). The nitrogen plasma has been demonstrated to effectively dope N atoms onto graphene sheets in which the N-doping content varies monotonously from 4.7 to 13.3 at%. The distribution of the N-doping types can be tuned by control of the graphene defect density with the I_D/I_G ratio increasing gradually from 0.3 to 0.8 and the nitrogen plasma power to generate multiple functionalities of the resultant materials. For example, the medium-quality graphene doped by high-power nitrogen plasma exhibits the highest electrocatalytic activity toward the oxygen reduction reaction (ORR) with a mean electron-transfer number of 3.94 which is comparable with that of platinum. The high-quality graphene doped by low-power nitrogen plasma shows the high activity and selectivity for simultaneously detecting uric acid, ascorbic acid, and dopamine because of the high content of the pyridinic-N structure.

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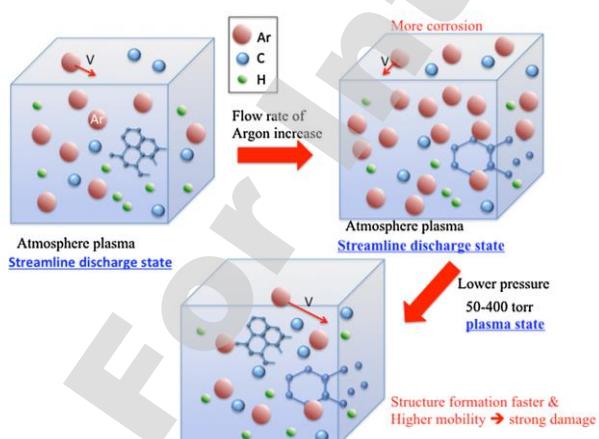
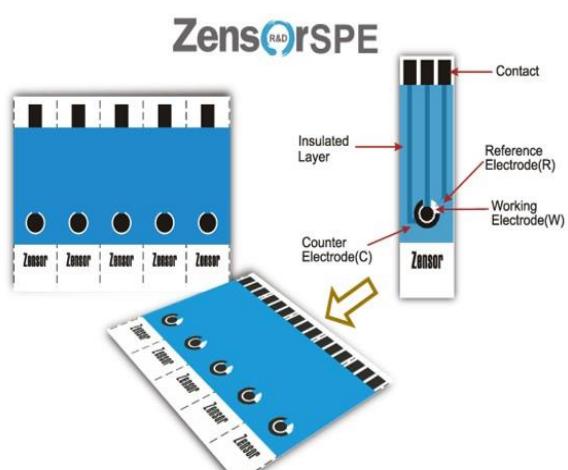


Fig. 2. Schematic representation of the process used for growing graphene sheets. The defect density of graphene is controlled by variation in the plasma density which is adjusted by the variation in total gas flow rate and chamber pressure. This effect increases the movement of the carbon atoms anchored to the graphene sheet and increases the defect density on the graphene domains. Moreover, the plasma density in the reaction chamber increases considerably when the chamber pressure is decreased. This effect markedly enhances the generation of active carbon atoms and favors the formation of graphene sheets and further increases the defect density on the graphene domains.



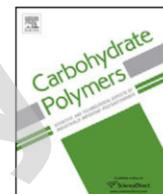


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Carbohydrate Polymers

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Preparation of β -cyclodextrin entrapped graphite composite for sensitive detection of dopamine

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Screen-printed carbon electrode

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ABSTRACT

A simple dopamine (DA) electrochemical sensor was developed based on a screen-printed carbon electrode (SPCE) modified with β -cyclodextrin entrapped graphite (GR/ β -CD) composite for the first time. The polar hydroxyl groups on the β -CD rims interact with polar groups of edges of GR sheets resulting into the high dispersion ability of GR in β -CD solution. The GR/ β -CD modified electrode exhibited a higher electrochemical response to DA with a lower oxidation potential (0.224 V) than that of bare/ β -CD (0.38 V) and GR (0.525 V) modified SPCEs, revealing an excellent electro-oxidation behavior of GR/ β -CD composite toward DA. Under optimum conditions, the fabricated sensor detects the DA in the linear concentration range from 0.1 to 58.5 μ M with a limit of detection of 0.011 μ M and the sensitivity of $1.27 \pm 0.02 \mu\text{A } \mu\text{M}^{-1} \text{ cm}^{-2}$. The fabricated sensor also exhibits the excellent repeatability, practicality, reproducibility, storage stability along with acceptable selectivity.

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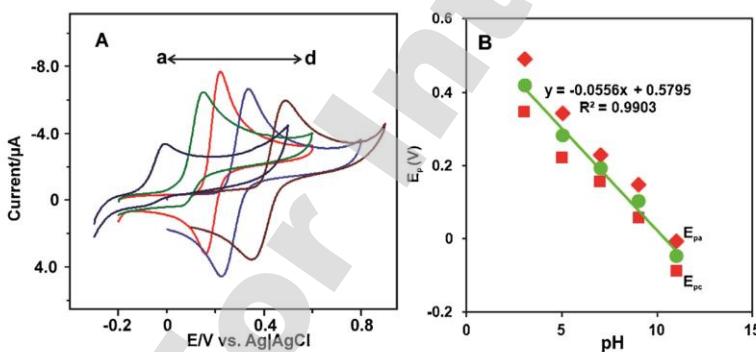
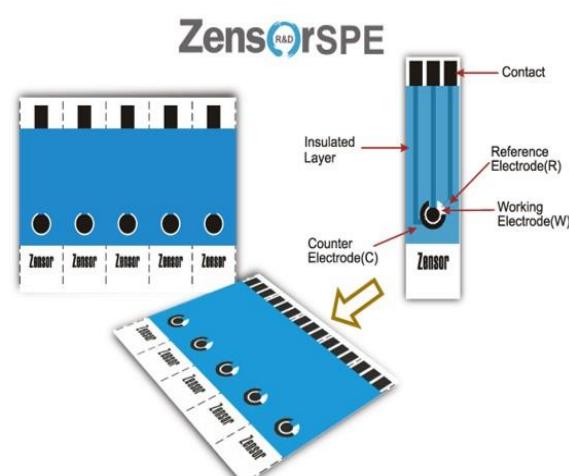


Fig. 5. (A) CV response obtained at GR/ β -CD modified SPCE for 50 μ M of DA at different pH solutions from 3 to 9 (a-d) at a scan rate of 50 mV s^{-1} . (B) Calibration plot for pH vs. E_0 .



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PVA-AWP/tyrosinase functionalized screen-printed electrodes for dopamine determination†

M. Stoytcheva,^{*a} R. Zlatev,^a F. F. Gonzalez Navarro,^a Z. Velkova,^{bc} V. Gochev,^d G. Montero,^a A. G. Ayala Bautista^a and L. Toscano-Palomar^e

The development of highly sensitive amperometric biosensors for dopamine determination using commercially available SPEs in combination with the PVA-AWP photopolymer as the enzyme immobilization matrix is described in this work. This research focuses on (i) the optimization of the conditions for SPE biofunctionalization by tyrosinase entrapment in PVA-AWP and of the working conditions for dopamine determination by mathematical model application, and (ii) the evaluation of the analytical performances of the PVA-AWP/tyrosinase functionalized SPEs. Dopamine determination under optimum conditions for electrode biofunctionalization (PVA-AWP 3%, 60 min UV light exposure) and under optimum working conditions (pH 6.5, 25 °C) was performed in the dynamic concentration range of 0.9–500 μmol L⁻¹, 0.2–400 μmol L⁻¹, and 0.03–150 μmol L⁻¹, using respectively C SPE, MWCNT-GNP/C SPE, and graphene-GNP/C SPE. The LOD was found to be 300 nmol L⁻¹, 60 nmol L⁻¹, and as low as 10 nmol L⁻¹, correspondingly. The excellent analytical performances of the graphene-GNP C SPE and MWCNT-GNP C SPE were associated with their large active area (19.72 mm² and 15.3 mm²) and enhanced electrocatalytic properties ($k^{\circ} = 8.1 \times 10^{-3}$ cm s⁻¹ and 4.4×10^{-3} cm s⁻¹) compared with the bare C SPE (12.47 mm² and $k^{\circ} = 3.0 \times 10^{-3}$ cm s⁻¹). The developed biosensors were stable, reproducible, and more sensitive than most of the known biosensors for dopamine determination. They were successfully applied for dopamine determination in injections. Taking into consideration the fact that the selected enzyme immobilization approach using a water-soluble photopolymer opens the possibility of SPE biofunctionalization by photolithography, the developed biosensors are promising for fast, simple, sensitive, selective, and cost effective analysis of dopamine.

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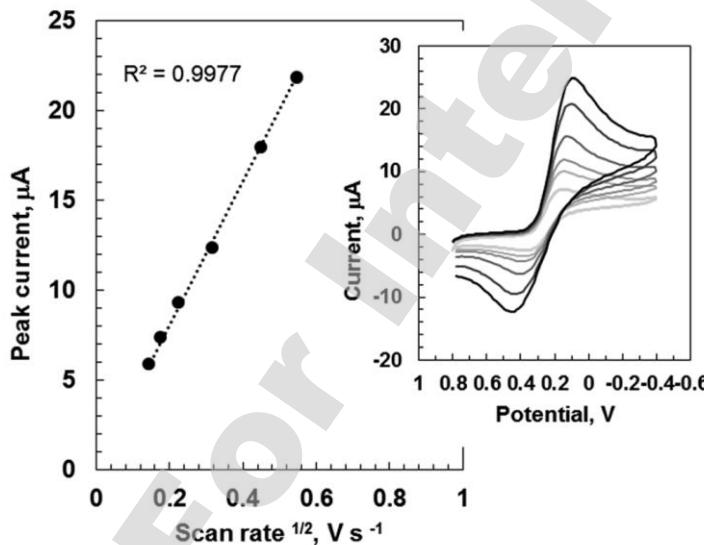
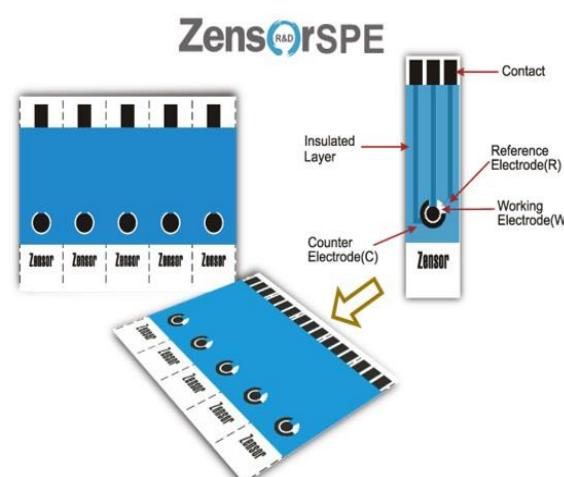


Fig. 2 Peak current vs. the square root of the scan rate. Inset: CV curves for $K_3Fe(CN)_6$ 3 mmol L⁻¹ in KNO_3 1 mol L⁻¹. PVA-AWP 3.0%; UV light exposure time 30 min. GCE, Tokay GC 20, 3 mm diameter.





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Talanta

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Reusable electrochemical sensor for bisphenol A based on ionic liquid functionalized conducting polymer platform

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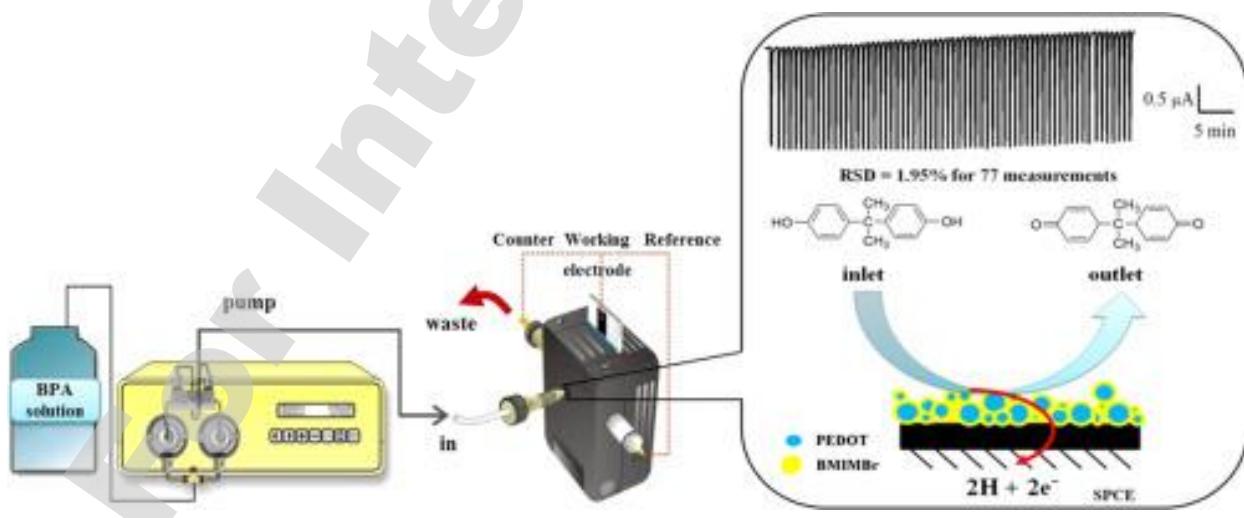
Flow-injection amperometry

Reusability

ABSTRACT

The toxicity of bisphenol A (BPA) has attracted considerable attention, and the reported electrochemical sensors for BPA need further improvement in reusability due to serious surface fouling. In this study, a composite film is designed aiming to provide both an accurate and repeatable platform for BPA determination. The conducting poly(3,4-ethylenedioxothiophene) film (PEDOT) and ionic liquid 1-butyl-3-methylimidazolium bromide (BMIMBr) were modified onto screen-printed carbon electrodes (SPCE) by electropolymerization and drop/spin methods, respectively. The surface characteristics of the composite film were characterized by field emission scanning electron microscopy (FE-SEM), X-ray photoelectron spectroscopy (XPS) and surface water contact angle experiments. The composite film-modified electrodes exhibited a linear response to BPA in the range of 0.1–500 µM in pH 7.0 phosphate buffer solution (PBS) under optimized flow-injection amperometry. The method sensitivity and detection limit ($S/N=3$) were $0.2661 \mu\text{A } \mu\text{M}^{-1}$ ($2.419 \mu\text{A } \mu\text{M}^{-1} \text{ cm}^{-2}$) and 0.02 µM, respectively. A relative standard deviation of 1.95% was obtained for 77 successive measurements of 10 µM BPA, and the repeatability outperformed previously reported work. The proposed method was applied to detect BPA released from plastic water bottles using the standard addition method, and satisfactory recoveries were obtained. The electrochemical assay was validated by comparison with the chromatographic method, and the results showed good agreement between the two methods.

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Involvement of Cu(II) in the electrocatalytic reduction of bromate on a disposable nano-copper oxide modified screen-printed carbon electrode: hair waving products as an example

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ABSTRACT

A disposable nano-copper oxide modified screen-printed carbon electrode (CuOSPCE) was developed as a quick and convenient method to identify the bromate content in hair waving products. The electrode was prepared via electrodeposition of copper ions on a bare screen-printed carbon electrode (SPCE). It was demonstrated that the nano-copper oxide on the SPCEs could significantly enhance the electrochemical reduction of bromate in weak acidic solutions. The analytical results indicate that CuOSPCE coupling with a flow injection analysis (FIA) system (CuOSPCE/FIA) is a sensitive method for the determination of the bromate. A wide linear range from 0.01 to 300 mg L⁻¹ ($66.27 \text{ to } 1.99 \times 10^6 \text{ nmol L}^{-1}$) was observed, and a detection limit of 3.5 µg L⁻¹ ($23.19 \text{ nmol L}^{-1}$) ($D_L, S/N = 3$) was calculated. The results also indicated that both the sensitivity and the response time of CuOSPCE/FIA toward bromate were not affected by several anions. Furthermore, the CuOSPCE/FIA demonstrated extremely high recovery, ranging from 98.45% to 103.89%, as well as good accuracy compared to the results obtained by a standard iodometric method.

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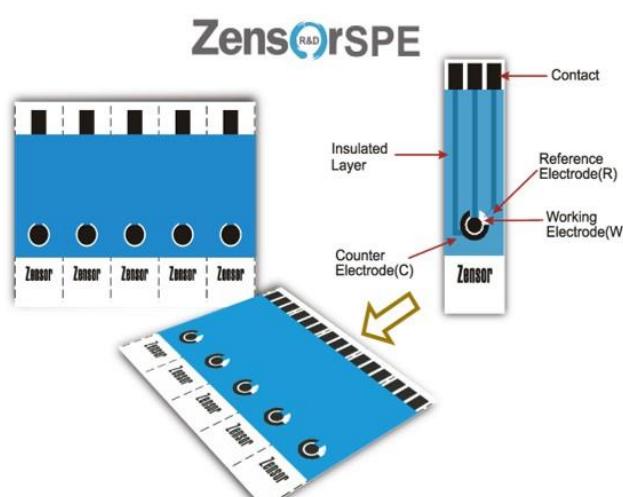
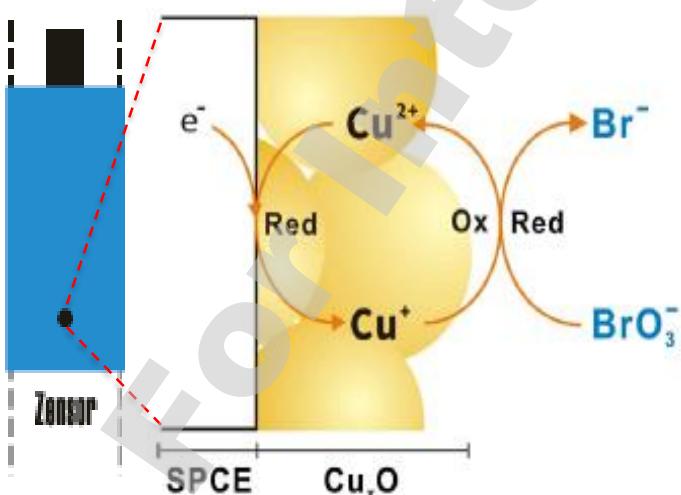


Fig. 5. The mechanism for the catalytic reduction of bromate at CuOSPCE



Electrochimica Acta 161 (2015) 100–107

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Acetylcholinesterase Biosensor for Chlorpyrifos Detection Based on Multi-Walled Carbon Nanotubes-SnO₂-chitosan Nanocomposite Modified Screen-Printed Electrode

Dongfei Chen¹, Yancui Jiao¹, Huiying Jia¹, Yemin Guo¹, Xia Sun^{1,*}, Xiangyou Wang¹, Jianguang Xu^{2,*}

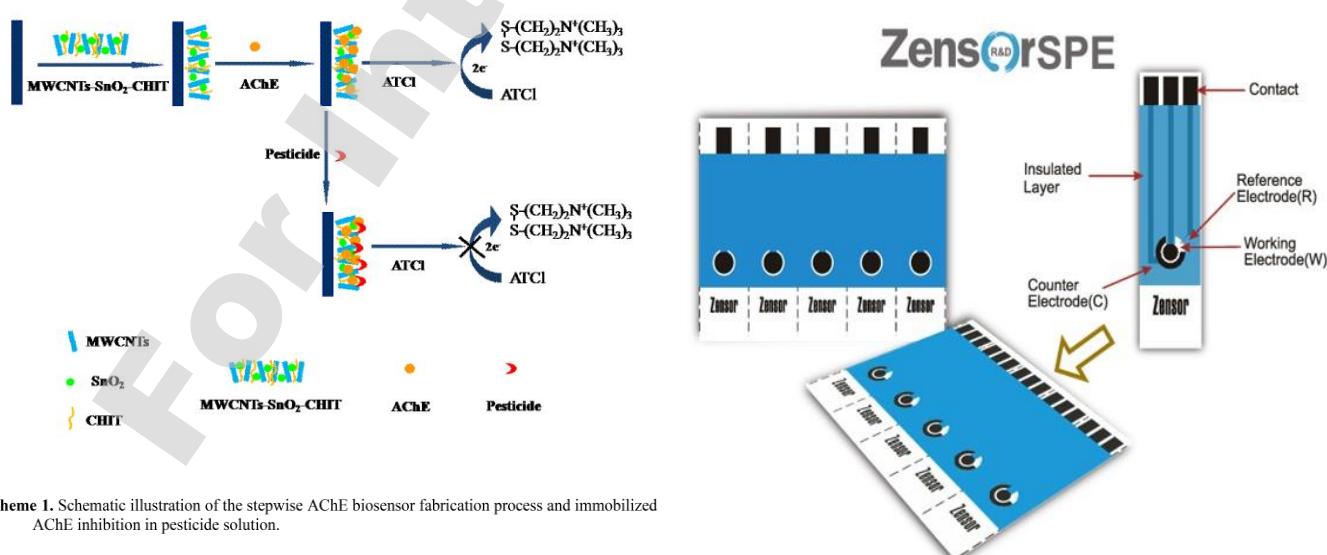
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An acetylcholinesterase biosensor for organophosphate detection was developed immobilizing the AChE enzyme via MWCNTs-SnO₂-CHIT nanocomposite on screen-printed electrode. MWCNTs provide a flexible conductive film and a much larger pathway due to their high electrical conductivity and large porosity ratio, thus increasing detection sensitivity. SnO₂ decreased the peak voltage, revealed that the SnO₂ nano materials can promote the redox process. Based on the inherent conductive properties of the MWCNTs-SnO₂-CHIT, the immobilized AChE had greater affinity for ATCl and excellent catalytic effect in the hydrolysis of ATCl. Under optimized conditions, the proposed AChE biosensor exhibited sensitive and stable response for the detection of chlorpyrifos, ranging from 0.05 to 1.0×10^3 µg/L with a limit of detection down to 0.05 µg/L. The proposed biosensor was successfully applied in the determination of chlorpyrifos pesticides in cabbage, lettuce, leek and pakchoi samples, obtained acceptable recovery of 89.3~103.3%. With excellent stability, sensitivity, and simplicity, the proposed AChE biosensor showed a feasible quantitative method in detection of chlorpyrifos residues.



Scheme 1. Schematic illustration of the stepwise AChE biosensor fabrication process and immobilized AChE inhibition in pesticide solution.

Direct Electron Transfer of Glucose Oxidase and Electrocatalysis of Glucose Based on Gold Nanoparticles/Electroactivated Graphite Nanocomposite

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In this study, we reported a direct electron transfer reaction of glucose oxidase (GOx) at gold nanoparticles-electroactivated graphite/screen printed carbon electrode (AuNPs-EGr/SPCE). The activated graphite was prepared through a simple electrochemical activation method in the electrolyte medium containing 0.1 M KCl. The characterization of as-prepared electrocatalyst AuNPs-EGr was studied by scanning electron microscopy and elemental analysis. The enzyme GOx was immobilized on the surface of AuNPs-EGr modified SPCE by the drop casting method. The redox behavior of GOx/AuNPs-EGr/SPCE was clearly observed at a formal potential of -0.404 V with a peak separation (ΔE_p) of 42 mV which reveals that the fast electron transfer process has been observed between GOx and AuNPs-EGr modified SPCE. The modified electrode displayed very good linear response to glucose oxidation from 50 to 1600 μ M with detection limit 2.5 μ M and the sensitivity is $255 \mu\text{A}\text{mM}^{-1} \text{cm}^{-2}$. The reported sensor exhibits a super selectivity and satisfactory reproducibility with good stability.

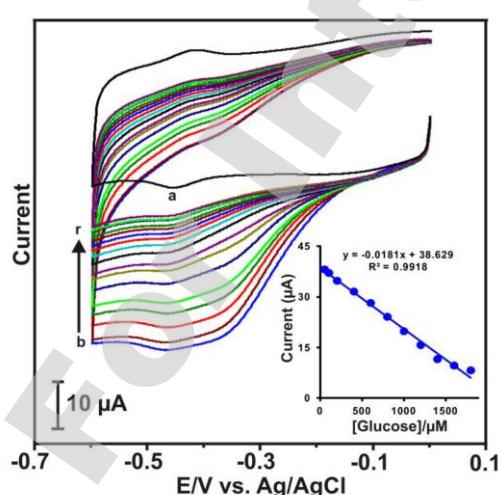
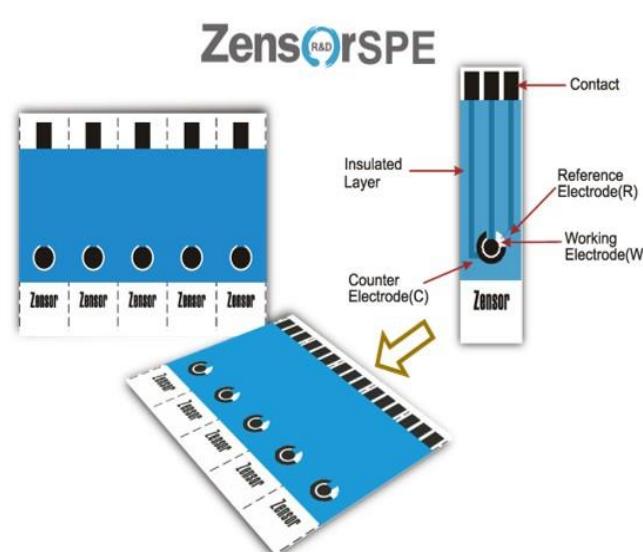


Figure 5. CVs of GOx/AuNPs-EGr/SPCE in N_2 saturated (a) and O_2 saturated PBS (pH 7) solution in various concentrations of glucose from 50 to 1800 μM at the scan rate of 50 mV s^{-1} , (b–r). The inset shows the calibration curve of I_p vs. glucose concentration.





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Easy-to-prepare electrochemical platform composed of ionic liquid-Ni(II)-graphite composites: laboratory study on electrochemical oxidation of urea, alcohols, and glucose

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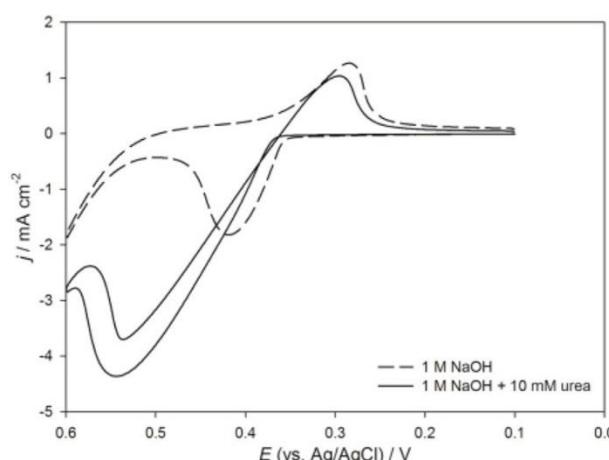
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Fuel
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Nickel

ABSTRACT

Ni(II) was introduced into four room-temperature ionic liquids (RTILs), namely 1-butyl-3-methylimidazolium salicylate (BMI-SAL), BMI hexafluorophosphate (BMI-PF₆), 1-butyl-1-methylpyrrolidinium dicyanamide (BMP-DCA), and BMP bis((trifluoromethyl)sulfonyl) imide (BMP-TFSI), via the addition of NiCl₂ or the anodic dissolution of Ni metal. The RTILs containing different Ni(II) species were mixed with pure and fine graphite (GP) powder to form RTIL/Ni(II)/GP composites, which were used to prepare composite electrodes for the electrocatalytic oxidation of urea, alcohols (methanol, ethanol, isopropanol, butanol, and glycerol), and glucose. Ni(II) produced from the anodic dissolution of Ni metal in BMP-TFSI showed the best activity. The BMP-TFSI/Ni(II)_{anodization}/GP composite thus has potential as an easy-to-prepare electrochemical platform for the electrochemical oxidation of the above-mentioned compounds. The oxidation and determination of urea using the BMP-TFSI/Ni(II)_{anodization}/GP composite electrode was thoroughly studied. A very high sensitivity of 517 $\mu\text{A}\cdot\text{mM}^{-1}\cdot\text{cm}^{-2}$ was obtained. This electrode also showed good stability during the anodic electrolysis of the aforementioned compounds, indicating that it may be appropriate as an anode for the electrolysis of urea, alcohols, and glucose.

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Electrochimica Acta 182 (2015) 113–121

Short Communication

Electrochemical Studies on the Response to Glucose in the Presence of Bilirubin, Creatinine and Uric Acid at Nafion/Pd-GOx Modified Screen Printed Carbon Electrode

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In the present work, a glucose sensor was developed based on the glucose oxidase immobilized on Pd (Pd-GOx) and nafion modified electrode. The modified electrode was characterized by atomic force microscopy and field emission scanning electron microscopy. The electrochemical analysis for electrochemical activity was accessed by cyclic voltammetry. The modified electrode displayed an excellent electrooxidation behavior to glucose and was detected by cyclic voltammetry and amperometry. In optimized conditions, the fabricated Nafion/Pd-GOx modified electrode exhibited a sharp amperometric response to Human blood and glucose. The modified electrode also holds its high selectivity in the presence of bilirubin, creatinine, and uric acid, indicating it can be an ideal electrode material for detection of glucose in diabetes.

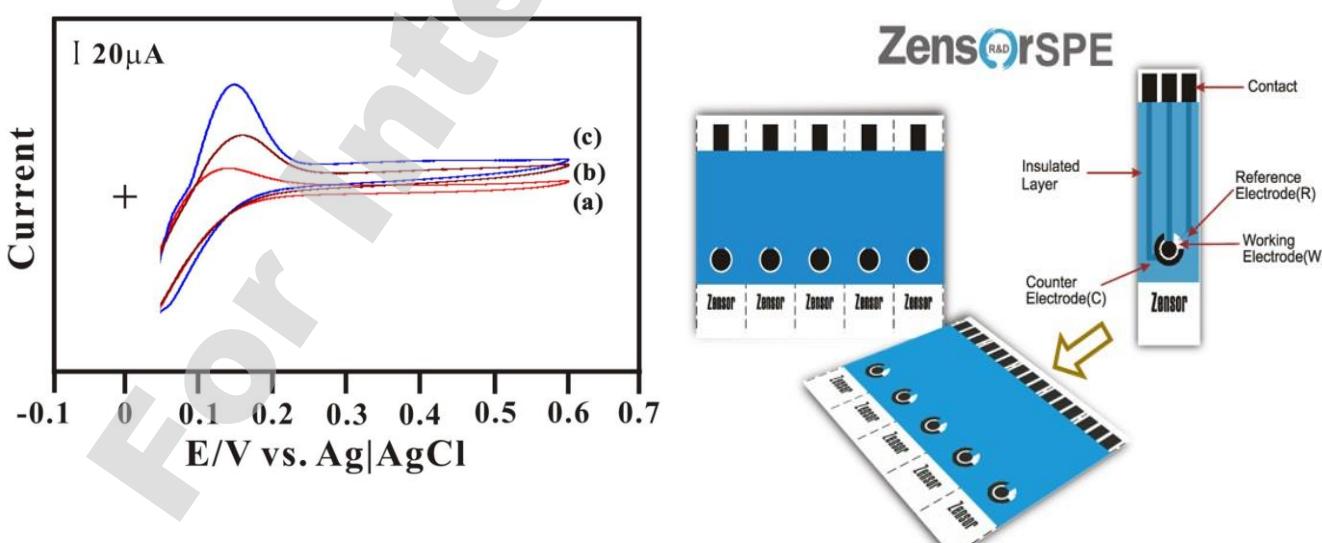


Figure 4. The cyclic voltammetry response of Nafion/Pd-GOx modified electrodes in pH 7.0 in the absence (a) and presence of 0.005 M (b) and 0.01M (c) glucose at a scan rate of 0.1 V/s.



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Electrochemical study of a new non-heme iron complex-modified carbon ionic liquid electrode with electrocatalytic activity towards hydrogen peroxide reduction

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Carbon composite electrode

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Iron compound

ABSTRACT

In this study, a new non-heme iron complex was prepared by mixing $\text{FeCl}_3 \cdot 6\text{H}_2\text{O}$ and 2,4,6-tris(2-pyridylmethylamino)-1,3,5-triazine (TPMATA) in ionic liquid 1-butyl-1-methylpyrrolidinium bis[(tri-fluoromethyl)sulfonyl]amide ([BMP⁺][TFSA⁻]). The iron complex (TPMATA- FeCl_3) was used as a modifier for preparing the TPMATA- FeCl_3 -modified carbon ionic liquid electrode (TPMATA- FeCl_3 /CILE). H_2O_2 was electrocatalytically reduced at the TPMATA- FeCl_3 /CILE in neutral aqueous solutions via Fenton's mechanism in which hydroxyl radical, $\bullet\text{OH}$, was produced, and the radical was detected by using a fluorescence probe. This electrode showed a sensitivity of $22.1 \mu\text{A}\cdot\text{mM}^{-1}$ and a dynamic range of $0.025\sim4.69 \text{ mM}$ with a regression coefficient R^2 of 0.993 (or $0.025\sim0.765 \text{ mM}$, $R^2 = 0.997$, sensitivity = $27.6 \mu\text{A}\cdot\text{mM}^{-1}$). The detection limit was 0.0125 mM ($S/N = 3$). This electrode shows the potential to be used as an electrochemical H_2O_2 sensor or for the production of hydroxyl radicals.

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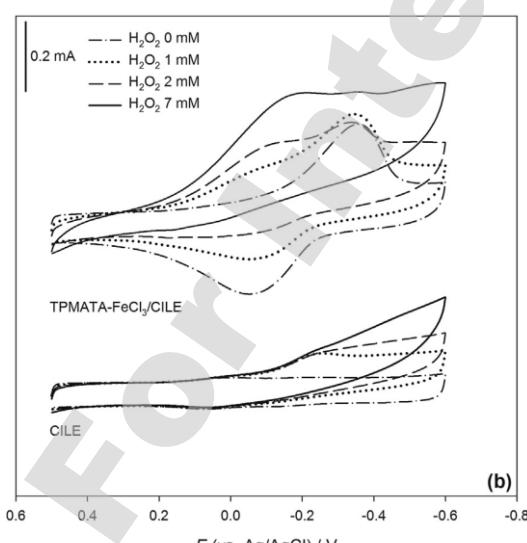
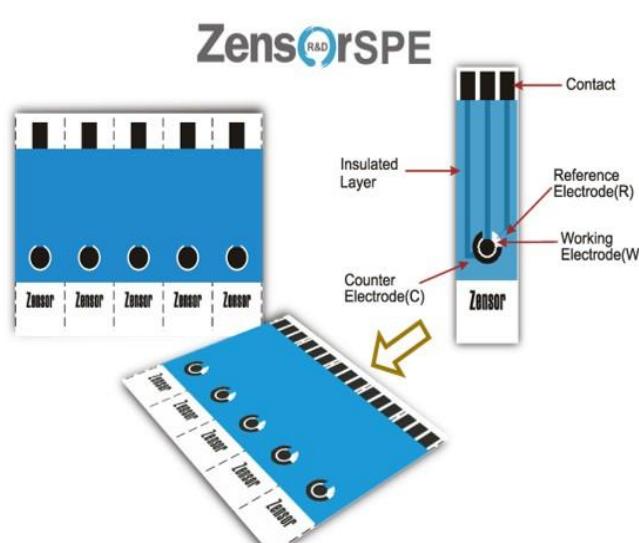


Fig. 3. CVs recorded at (a) various electrodes without H_2O_2 and at (b) TPMATA- FeCl_3 /CILE (TPMATA/ FeCl_3 = 20/60 (mM/mM)) or CILE with and without H_2O_2 in 0.1 M pH 7.0 PBS. Scan rate: $50 \text{ mV}\cdot\text{s}^{-1}$.





Contents lists available at ScienceDirect

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Fabrication of nanostructured copper phosphate electrodes for the detection of α -amino acids



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Cu₃(PO₄)₂-deposited electrode

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Nanostructure

Amino acid

Complexation

ABSTRACT

Cu₃(PO₄)₂-deposited electrodes capable of detecting nonelectroactive α -amino acids (AAs) are developed by the dissolution-precipitation method. The Cu₃(PO₄)₂-dominated compounds of flake-shaped nanostructures are quickly and uniformly deposited on the surface of acicula-nanostructured Cu(OH)₂-electrode-deposited electrodes in a 100 mM Na₂HPO₄ solution (pH 5.0) within 2 h. Analysis of X-ray photoelectron spectroscopy and electrochemical kinetics shows that an oxidative reaction at +0.11 V increases the ratio of H₂PO₄⁻ on the electrode surface and produces the Cu^{II}(H₂PO₄)₂ complex. Moreover, the Cu^{II} compounds and the AAs can form complexes to accompany the chemical oxidation of AAs and the formation of the Cu^I complex, increasing the amount of oxidative current detected via the chemical-electrochemical mechanism. The amperometric response presented good linearity and sensitivity in the range of 143–600 μ M for electroactive and nonelectroactive α -AAs. The Cu₃(PO₄)₂-deposited electrodes are integrated into a chromatographic separation systems as an AA sensor to have promise for the detection of biological and food samples.

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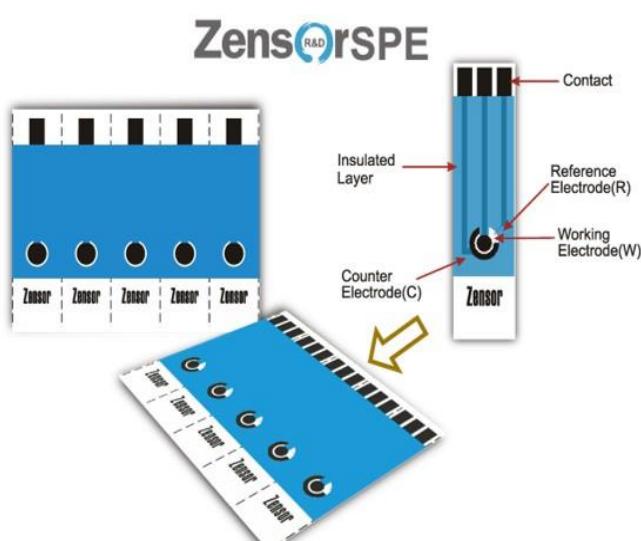
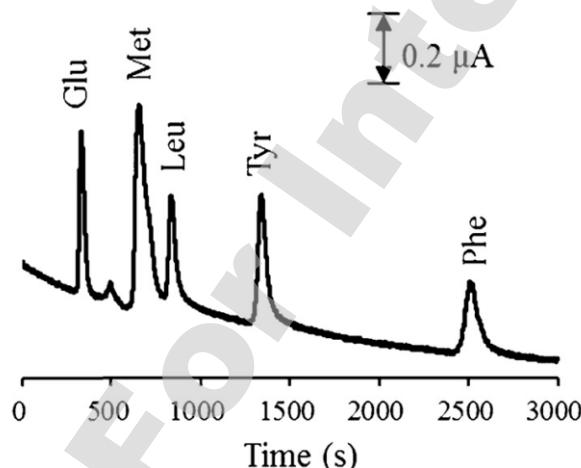


Fig. 6. Chromatogram of a mixture of five representative amino acids (0.5 mM) using a silica-based HPLC column measured by a Cu₃(PO₄)₂-deposited electrode with a flow rate of 300 μ L/min.



Sensors and Actuators B 206 (2015) 584–591

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Fabrication of Silver Nanoparticles Decorated on Activated Screen Printed Carbon Electrode and Its Application for Ultrasensitive Detection of Dopamine

Selvakumar Palanisamy,^[a] Balamurugan Thirumalraj,^[a] Shen-Ming Chen,*^[a] M. Ajmal Ali,^[b] K. Muthupandi,^[c] R. Emmanuel,^[c] P. Prakash,*^[c] and Fahad M. A. Al-Hemaid^[b]

Abstract: In the present study, we report the fabrication of silver nanoparticles (AgNPs) decorated on activated screen printed carbon electrode (ASPCE). The AgNPs were prepared by using *Justicia glauca* leaf extract as a reducing and stabilizing agent and the ASPCE was prepared by a simple electrochemical activation of screen printed carbon electrode (SPCE). The ASPCE/AgNPs

shows a reversible electrochemical behaviour with enhanced response for DA than that of other modified SPCes. Under optimum conditions, the electrochemical oxidation current response of DA is linear over the concentration range from 0.05 to 45.35 μM . The limit of detection is found as 0.017 μM with a high sensitivity of $7.85 \mu\text{A} \mu\text{M}^{-1} \text{cm}^{-2}$.

Keywords: Bionanotechnology • Activated screen printed carbon electrode • Green synthesis • Silver nanoparticles • Dopamine

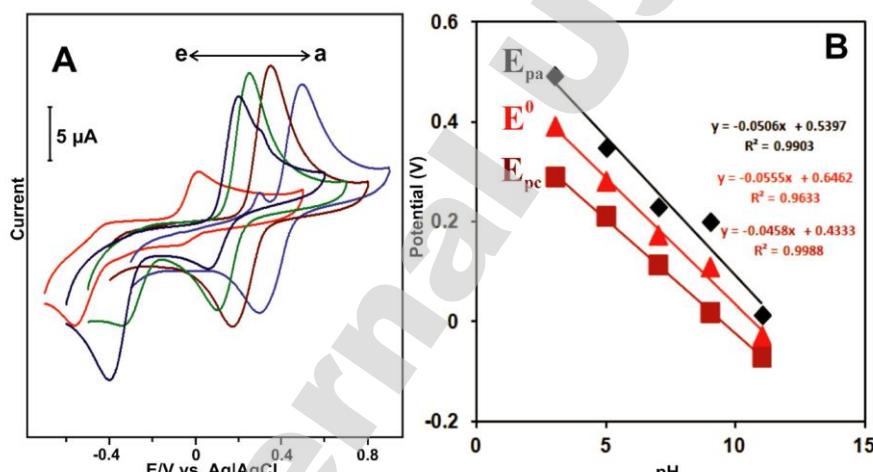


Fig. 4. A) Cyclic voltammetry obtained at ASPCE/AgNPs for the response to 100 μM of DA in different pH solutions (pH 3, 5, 7, 9 and 11, a–e) at a scan rate of 50 mV s^{-1} . B) Calibration plot for pH vs. E_{pa} , E_{pc} and E^0 .

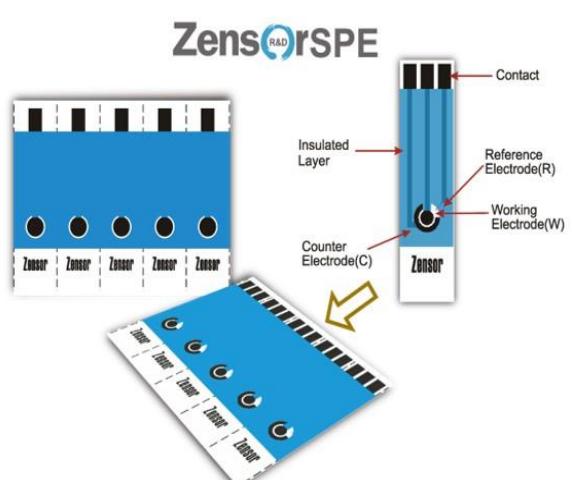
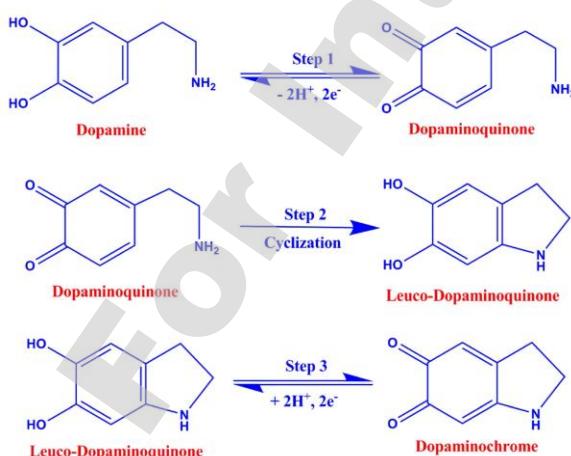


Fig. 5. Electrochemical mechanism involved in DA at AgNPs modified ASPCE.



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Short communication

Facile and stable immobilization of adenine on screen printed carbon electrode assisted by electrogenerated chlorine for electrocatalytic oxidation of NADH



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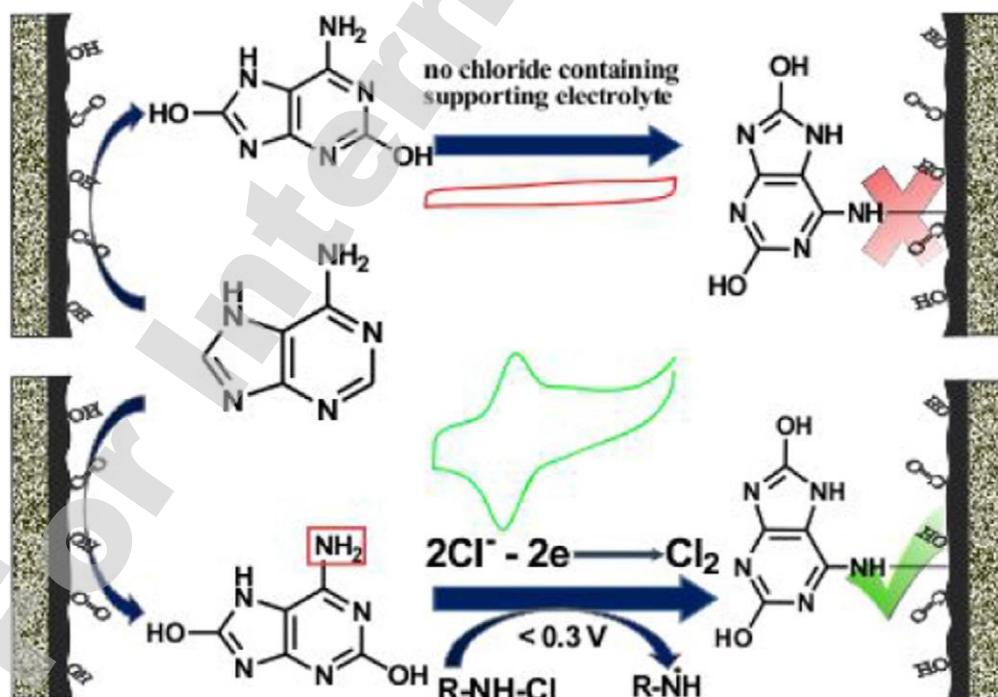
NADH oxidation

Electrogenerated chlorine

ABSTRACT

This work presents a facile method to electrochemically immobilize adenine, which represents an amine-containing model molecule, on screen printed carbon electrode. Various chloride-containing supporting electrolytes can be employed to electrogenerate chlorine for activating the amine functionality to result in a strong covalent bonding on the "preanodized" screen printed carbon electrode. As confirmed by both cyclic voltammetry and X-ray photoelectron spectroscopy, the as-immobilized 2,8-dihydroxyadenine is highly stable and cannot be removed even under ultrasonication. Good electrocatalytic activity towards β -nicotinamide adenine dinucleotide (NADH) oxidation is further demonstrated for its applicability.

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Scheme 1. Schematic representation of adenine immobilization assisted by electrogenerated chlorine.



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Impact Electrochemistry of Layered Transition Metal Dichalcogenides

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ABSTRACT Layered transition metal dichalcogenides (TMDs) exhibit paramount importance in the electrocatalysis of the hydrogen evolution reaction. It is crucial to determine the size of the electrocatalytic particles as well as to establish their electrocatalytic activity, which occurs at the edges of these particles. Here, we show that individual TMD (MoS_2 , MoSe_2 , WS_2 , or WSe_2 ; in general MX_2) nanoparticles impacting an electrode surface provide well-defined current "spikes" in both the cathodic and anodic regions. These spikes originate from direct oxidation of the nanoparticles (from M^{4+} to M^{6+}) at the anodic region and from the electrocatalytic currents generated upon hydrogen evolution in the cathodic region. The positive correlation between the frequency of the impacts and the concentration of TMD nanoparticles is also demonstrated here, enabling determination of the concentration of TMD nanoparticles in colloidal form. In addition, the size of individual TMD nanoparticles can be evaluated using the charge passed during every spike. The capability of detecting both the "indirect" catalytic effect of an impacting TMD nanoparticle as well as "direct" oxidation indicates that the frequency of impacts in both the "indirect" and "direct" scenarios are comparable. This suggests that all TMD nanoparticles, which are electrochemically oxidizable (thus capable of donating electrons to electrodes), are also capable of catalyzing the hydrogen reduction reaction.



KEYWORDS: catalysis · hydrogen evolution · particle coulometry

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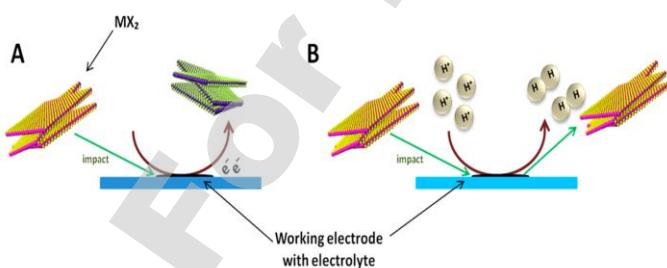
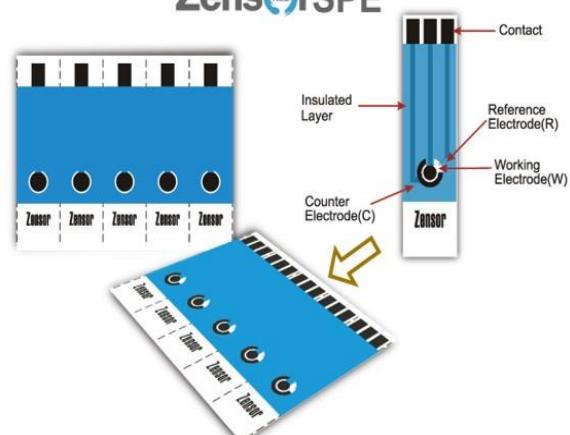


Figure 1. Schematic diagrams of (A) direct and (B) indirect voltammetry of impact nanoparticles of TMD (MX_2).

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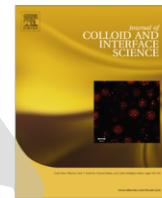




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Palladium nanoparticles decorated on activated fullerene modified screen printed carbon electrode for enhanced electrochemical sensing of dopamine

Selvakumar Palanisamy ^a, Balamurugan Thirumalraj ^a, Shen-Ming Chen ^{a,b,*}, M.Ajmal Ali ^b, Fahad M.A. Al-Hemaid ^b

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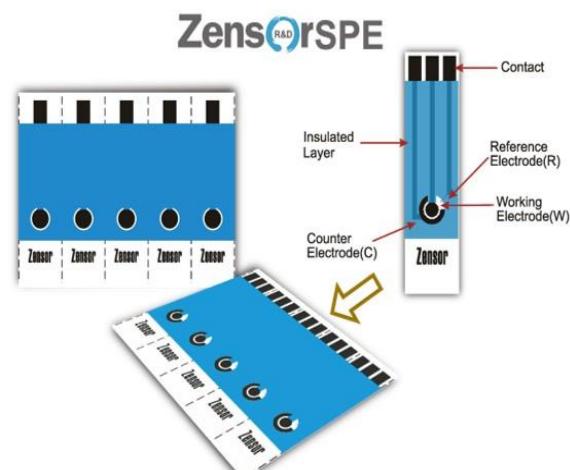
Electrooxidation

Differential pulse voltammetry

ABSTRACT

In the present work, an enhanced electrochemical sensor for dopamine (DA) was developed based on palladium nanoparticles decorated activated fullerene-C60 (AC60/PdNPs) composite modified screen printed carbon electrode (SPCE). The scanning electron microscopy and elemental analysis confirmed the formation of PdNPs on AC60. The fabricated AC60/PdNPs composite modified electrode exhibited an enhanced electrochemical response to DA with a lower oxidation potential than that of SPCE modified with PdNPs and C60, indicating the excellent electrooxidation behavior of the AC60/PdNPs composite modified electrode. The electrochemical studies confirmed that the electrooxidation of DA at the composite electrode is a diffusion controlled electrochemical process. The differential pulse voltammetry was employed for the determination of DA; under optimum conditions, the electrochemical oxidation signal of DA increased linearly at the AC60/PdNPs composite from 0.35 to 133.35 μM . The limit of detection was found as 0.056 μM with a sensitivity of $4.23 \mu\text{A} \mu\text{M}^{-1} \text{cm}^{-2}$. The good recovery of DA in the DA injection samples further revealed the good practicality of AC60/PdNPs modified electrode.

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Short communication

Label-free and amplified aptasensor for thrombin detection based on background reduction and direct electron transfer of hemin

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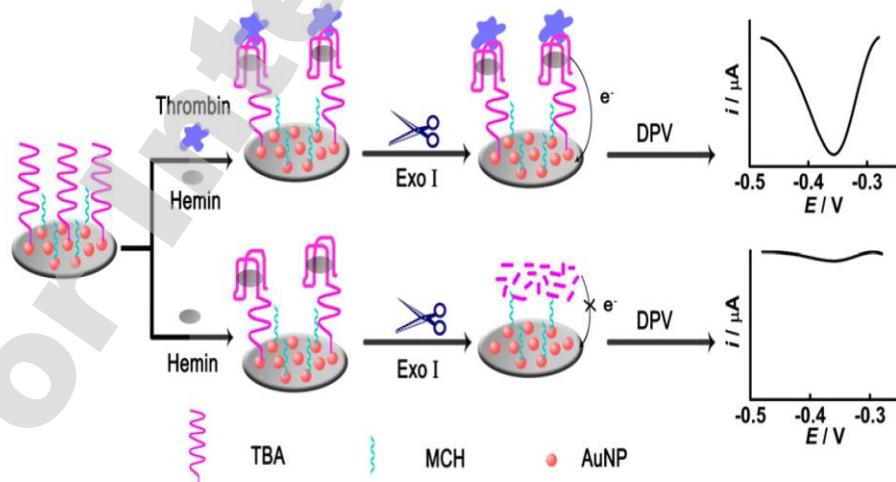
Hemin

Thrombin

ABSTRACT

In this work, we describe the development of a sensitive and label-free aptasensor for thrombin detection based on background noise reduction by exonuclease I (Exo I) and signal amplification by direct electron transfer (DET) of hemin. The thrombin binding aptamers (TBAs) are self-assembled on a sensing electrode. In the absence of the target thrombin, the TBAs are digested by Exo I, which avoids the association of hemin and significantly minimizes the background current noise. The presence of thrombin stabilizes the folded TBA G-quadruplex and prevents it from degrading by Exo I. The G-quadruplex bound hemin thus generates amplified signal output. In our sensing approach, the introduction of Exo I significantly enhances the signal to noise ratio of the sensor response and achieves sensitive detection of thrombin. Our new method is also coupled with good selectivity against other non-target proteins and thus holds great potential for the development of robust aptasensors for the detection of different types of targets.

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Scheme 1. Illustration of the assay protocol for aptamer-based, label-free and sensitive EC detection of thrombin based on background current reduction and DET of hemin.



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A disposable screen-printed silver strip sensor for single drop analysis of halide in biological samples

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Ag/Ag_xO reference electrode

ABSTRACT

A screen-printed silver strip with three-electrode configuration of Ag-working, Ag-counter and Ag/Ag_xO reference electrodes was developed for simultaneous determination of chloride, bromide and iodide in aqueous solutions. It was fabricated simply by screen-printing silver ink onto a polypropylene (PP) base. The in-situ prepared Ag/Ag_xO reference electrode can avoid the leaching interference in chloride detection while using a conventional Ag/AgCl reference electrode. A single drop of analyte (50 µL) is enough to determine iodide, bromide and chloride by measuring the well-separated oxidation peak currents of respective silver halides. The calibration graph was linear from 10 µM to 20 mM for iodide and bromide and 100 µM to 20 mM for chloride and the detection limit ($S/N = 3$) was 3.05 µM, 2.95 µM and 18.83 µM for iodide, bromide and chloride, respectively. The strip is designed to be disposable and as such manual polishing is not necessary. The proposed sensor is not only simple to manufacture and easy to operate but also fast and precise with little detection volume. It is successfully applied to the determination of halide ions in real samples.

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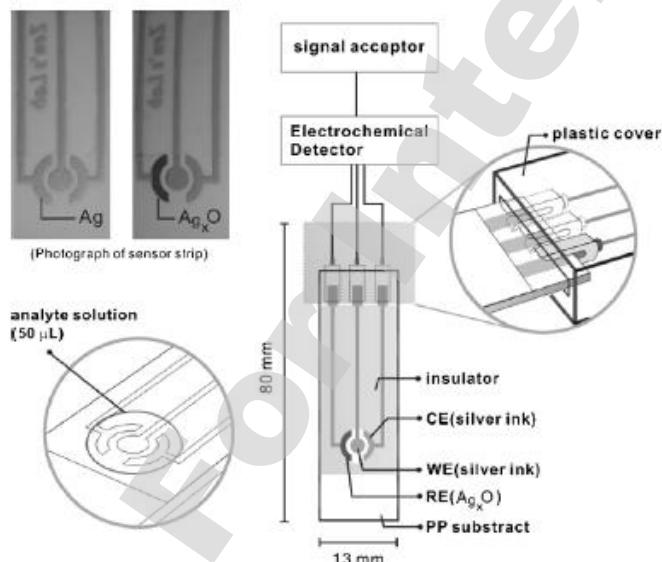


Fig. 1. Schematic representation of the set-up for single drop analysis of halide in aqueous solutions at the SP-AgES.

