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## Journal of Colloid and Interface Science

journal homepage: [www.elsevier.com/locate/jcis](http://www.elsevier.com/locate/jcis)



# Determination of 4-nitrophenol in water by use of a screen-printed carbon electrode modified with chitosan-crafted ZnO nanoneedles

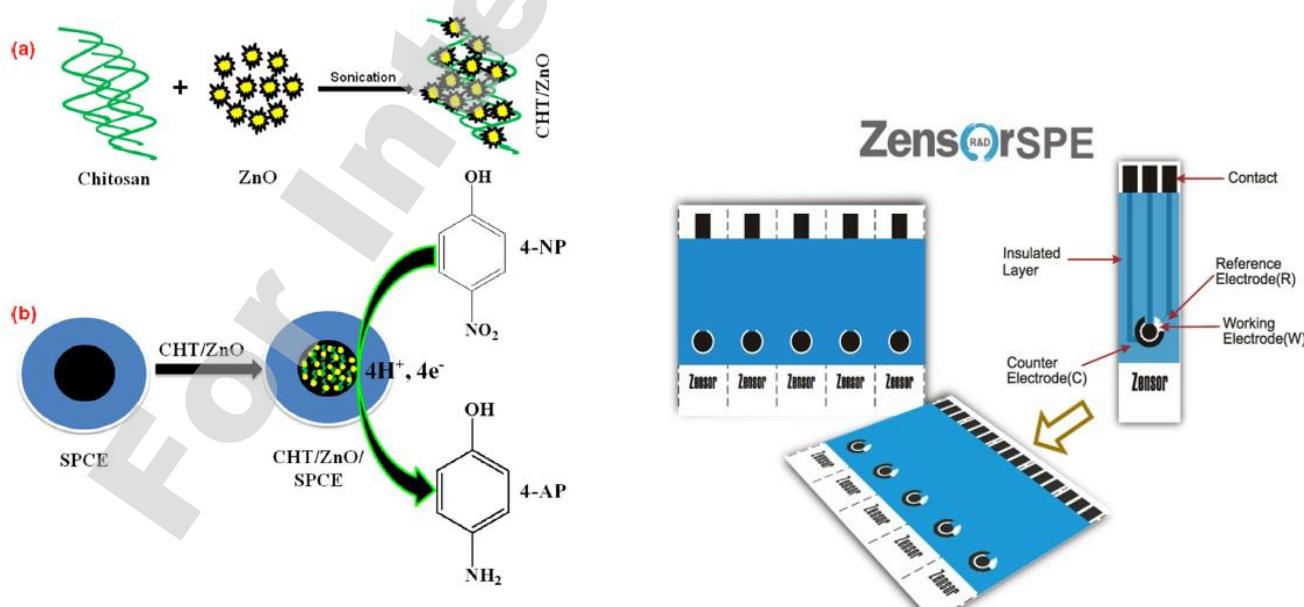
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### ABSTRACT

The toxicity and environmental pollution by nitro aromatic compounds in water samples is the most recognized problem in worldwide. Hence, we have developed a simple and highly sensitive electrochemical method for the determination of 4-nitrophenol (4-NP) in water samples based on a chitosan (CHT) crafted zinc oxide nanoneedles (ZnO NDs) modified screen printed carbon electrode. The CHT/ZnO NDs were characterized by Field emission scanning electron microscope, Fourier transform infrared spectroscopy and X-ray diffraction technique. The CHT/ZnO NDs modified electrode showed an enhanced electrocatalytic activity and lower potential detection towards 4-NP, compared with other modified electrodes. Under optimum conditions, the differential pulse voltammetry (DPV) response of CHT/ZnO NDs modified electrode displayed a wide linear response range from 0.5 to 400.6  $\mu$ M towards the detection of 4-NP with a detection limit (LOD) of 0.23  $\mu$ M. The CHT/ZnO NDs modified electrode was used for specific and sensitive detection of 4-NP in presence of possible interfering species and common metal ions with long-term stability. In addition, the excellent analytical performance of the proposed sensor was successfully applied for determination of 4-NP in water samples.

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Scheme 1. (a) Schematic representation for the preparation of CHT/ZnO NDs and (b) electrocatalytic activity of 4-NP at CHT/ZnO NDs modified SPCE.



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## Journal of Colloid and Interface Science

journal homepage: [www.elsevier.com/locate/jcis](http://www.elsevier.com/locate/jcis)



### Development of electrochemical sensor for the determination of palladium ions ( $Pd^{2+}$ ) using flexible screen printed un-modified carbon electrode



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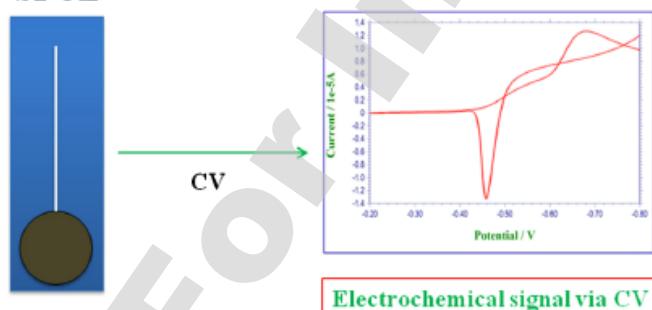
<sup>b</sup> Department of Botany and Microbiology, College of Science, King Saud University, Riyadh 11451, Saudi Arabia

#### ABSTRACT

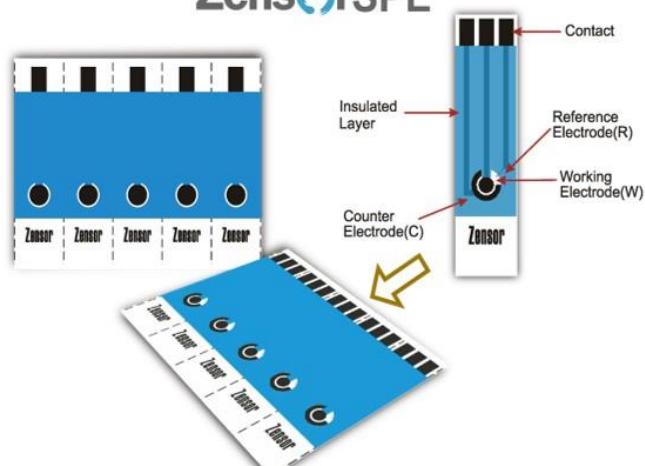
To date, the development of different modified electrodes have received much attention in electrochemistry. The modified electrodes have some drawbacks such as high cost, difficult to handle and not eco friendly. Hence, we report an electrochemical sensor for the determination of palladium ions ( $Pd^{2+}$ ) using an un-modified screen printed carbon electrode has been developed for the first time, which are characterized and studied via scanning electron microscope and cyclic voltammetry. Prior to determination of  $Pd^{2+}$  ions, the operational conditions of un-modified SPCE was optimized using cyclic voltammetry and showed excellent electro-analytical behavior towards the determination of  $Pd^{2+}$  ions. Electrochemical determination of  $Pd^{2+}$  ions reveal that the un-modified electrode showed lower detection limit of  $1.32 \mu M$  with a linear ranging from 3 to  $133.35 \mu M$  towards the  $Pd^{2+}$  ions concentration via differential pulse voltammetry. The developed sensor also applied to the successfully determination of trace level  $Pd^{2+}$  ions in spiked water samples. In addition, the advantage of this type of electrode is simple, disposable and cost effective in electrochemical sensors.

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#### SPCE



#### Zensor<sup>R&D</sup>SPE



**Scheme 1.** Electrochemical pathway for the determination of  $Pd^{2+}$  ions via CV.





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## Journal of Colloid and Interface Science

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Regular Article

### Studies on the influence of $\beta$ -cyclodextrin on graphene oxide and its synergistic activity to the electrochemical detection of nitrobenzene

Murugan Velmurugan, Natarajan Karikalan, Shen-Ming Chen\*, Zi-Chi Dai

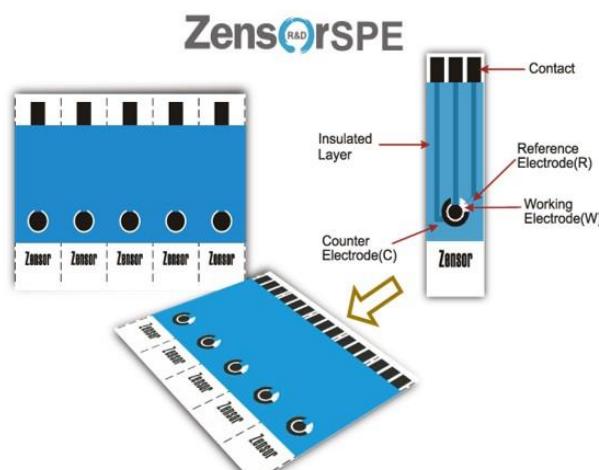
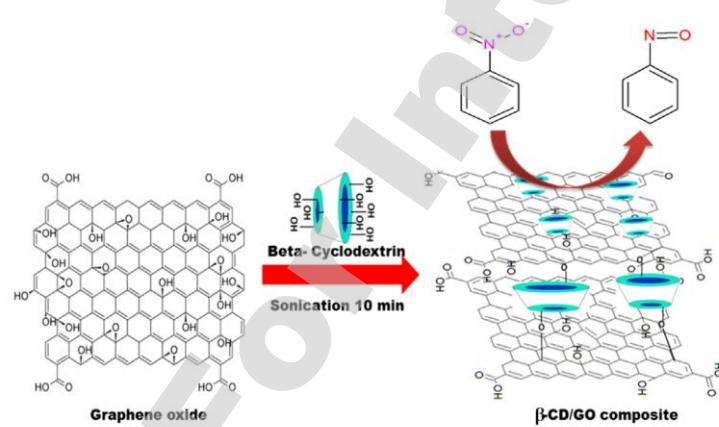
Department of Chemical Engineering and Biotechnology, National Taipei University of Technology, Taipei 106, Taiwan, ROC



#### ABSTRACT

The impact of the  $\beta$ -cyclodextrin ( $\beta$ -CD) on the graphene oxide (GO) was considerably altered the activity of electrochemical sensors. Hence, the present study, we scrutinized the electrocatalytic determination of nitrobenzene (NB) by changing the different loading level of  $\beta$ -CD on GO modified electrodes. The composites were prepared by the simple ultrasonication method and characterized by UV-Visible spectroscopy, infrared spectroscopy and scanning electron microscope. Interestingly, the synergistic electrocatalytic activity was appeared for the 1.2 mg  $\beta$ -CD loaded GO ( $\beta$ -CD<sub>1.2mg</sub>/GO) to the determination of NB whereas bare SPCE, GO and other  $\beta$ -CD loaded GO/SPCE exhibited the lower electrocatalytic activity. The  $\beta$ -CD<sub>1.2mg</sub>/GO composite modified SPCE was furnished the linear concentration range from 0.5–1000  $\mu$ M and showed the lowest detection limit of 0.184  $\mu$ M. Moreover, it exhibited high sensitivity, acceptable reproducibility and good stability. Besides, the proposed sensor was demonstrated its practicability in real water samples.

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## Sensors and Actuators B: Chemical

journal homepage: [www.elsevier.com/locate/snb](http://www.elsevier.com/locate/snb)



# Synthesis and characterization of polypyrrole decorated graphene/β-cyclodextrin composite for low level electrochemical detection of mercury (II) in water

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### ABSTRACT

Mercury (Hg(II)) is considered as one of the most toxic element that directly affects the human health and the environment. Therefore, in this study, we propose a sensitive and disposable electrochemical sensor for the detection of Hg(II) in various water samples using polypyrrole (PPy) decorated graphene/β-cyclodextrin (GR-CD) composite modified screen-printed carbon electrode (SPCE). The GR-CD/PPy composite was synthesized by chemical oxidation of PPy monomer in GR-CD solution using FeCl<sub>3</sub>. Differential pulse voltammetry (DPV) is used for the detection of Hg(II) and the DPV results reveal that GR-CD/PPy composite modified SPCE has high sensitivity towards Hg(II) than bare, GR, GR-CD and PPy modified SPCEs. The optimization studies such as effect of pH, accumulating time and effect of scanning potential towards the detection of Hg(II) were investigated. The GR-CD/PPy composite modified SPCE could detect the Hg(II) up to 51.56 μM L<sup>-1</sup> with the limit of detection (LOD) of 0.47 nM L<sup>-1</sup>. The obtained LOD was well below the guideline level of Hg(II) set by the World's Health Organization (WHO) and U.S. Environmental Protection Agency (EPA). In addition, the fabricated GR-CD/PPy composite modified SPCE selectively detected the Hg(II) in the presence of potentially interfering metal cations.

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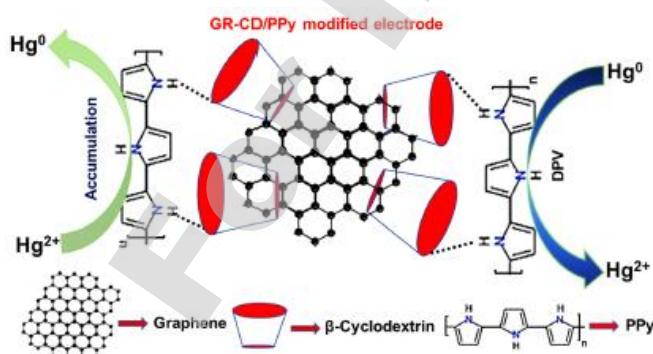
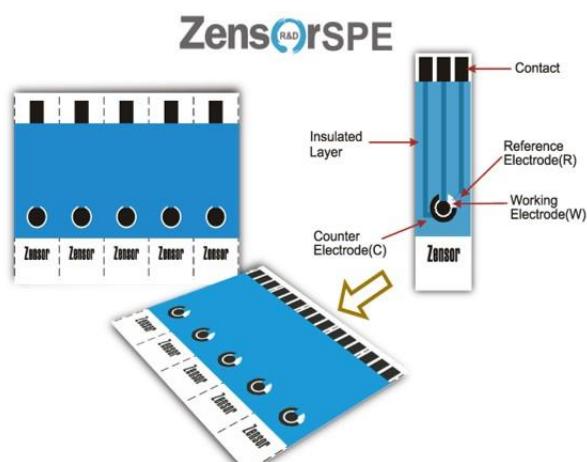


Fig. 4. The possible electrochemical mechanism for detection of mercury at GR-CD/PPy composite.





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## Journal of Catalysis

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# Electrocatalytic reduction of nitroaromatic compounds by activated graphite sheets in the presence of atmospheric oxygen molecules



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### ARTICLE INFO

#### Article history:

Received 3 July 2017

Revised 5 September 2017

Accepted 15 September 2017

Available online 6 November 2017

#### Keywords:

Pencil graphite

Graphite exfoliation

Cerium nitrate activation

Hammett constant

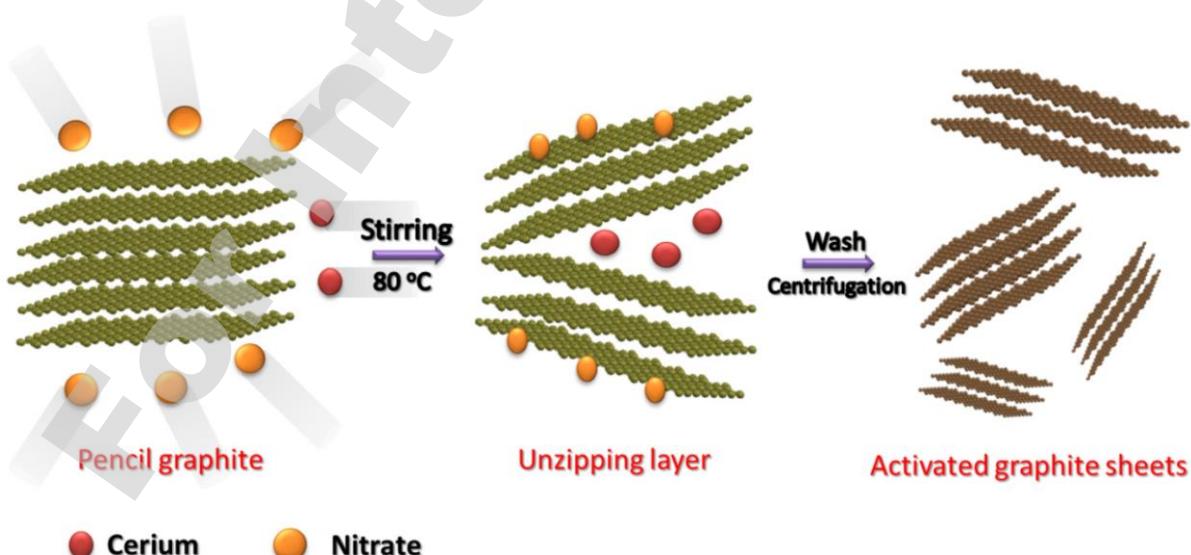
Selectivity

HOMO-LUMO interaction

### ABSTRACT

The anthropogenic climate and environmental issues incite the remediation of nitroaromatic compounds (NACs). Therefore, most of the researches have been devoted to the electrocatalytic reduction of NACs. Mainly, the carbonaceous materials have been employed as an electrode material for the determination of NACs. However, the effect of oxygen reduction is necessary to address with the electrocatalytic reduction of NACs. Hence, this work mainly focuses the reduction of NACs with the saturated oxygen and atmospheric oxygen conditions. The graphite and nitrobenzene (NB) were chosen as a model electrode and analyte for assess the effect of oxygen reduction. Though, the graphite is no longer express high electrocatalytic activity thus the activated graphite sheets were employed in the determination of NACs. Interestingly, the activated graphite sheets exhibited an excellent performance to the reduction of nitrobenzene and revealed an acceptable linear range around 0.05–1100 μM, 0.05–147 μM and 0.05–145 μM, in the N<sub>2</sub>, O<sub>2</sub> and aerated atmospheres, respectively. Moreover, the lowest detection limits were obtained around 0.026 μM, 0.031 μM and 0.032 μM, for the N<sub>2</sub>, O<sub>2</sub> and aerated atmospheres respectively. In order to investigate the electrochemical reactivity of activated graphite, four different NACs were selected such as flutamide (anti-cancer drug), methyl parathion (pesticide), 4-nitro aniline and 4-nitro phenol.

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**Fig. 1.** Schematic diagram for the activated graphite preparation.



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## Sensors and Actuators B: Chemical

journal homepage: [www.elsevier.com/locate/snb](http://www.elsevier.com/locate/snb)



### Impedometric phenol sensing using graphenated electrochip

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#### ABSTRACT

The manuscript reports impedance based sensing of phenol using electrochemically reduced graphene oxide (E-rGO) modified screen printed electrode (SPE). The chemically synthesized graphene oxide (GO) was reduced electrochemically directly on the electrode surface. The E-rGO was characterized using various analytical techniques like UV-vis spectroscopy, Transmission electron microscopy (TEM), Atomic force microscopy (AFM), Raman spectroscopy, Fourier transform infrared spectroscopy (FTIR) and contact angle measurement, to get insight to its properties. The SPE/E-rGO was then used for the detection of phenol using impedance spectroscopy. Prior to impedance based phenol sensing, the mechanism of phenol oxidation was examined using differential pulse voltammetry (DPV), which showed presence of three well defined peaks at 0.62 V, 0.24 V & 0.004 V, corresponding to the oxidation of phenol, and its oxidation products. As a function of phenol concentration, the increase in oxidation current followed the linear equation having slope of  $-1.76 \times 10^{-9} \text{ A}/\mu\text{M}$  and intercept of  $-4.69 \times 10^{-7}$ , with regression coefficient of 0.996. For impedometric sensing, change in polarization resistance with change in phenol concentration was used as a signal and the dynamic linearity range was obtained from 1  $\mu\text{M}$  to 40  $\mu\text{M}$ . The linearity curve exhibited slope of  $-7.6 \Omega\text{cm}^{-2} \mu\text{M}^{-1}$ , intercept of 986.67 and regression coefficient ( $R^2$ ) of 0.989 respectively. The effect of solution pH on impedometric response of graphenated electrochip was also evaluated. The impedometric results of phenol sensing were further validated using amperometry using same concentration range (1  $\mu\text{M}$  to 40  $\mu\text{M}$ ) of phenol. The amperometry results obeyed the linear equation with slope of  $-0.06 \text{ A/M}$  (ampere/molar), intercept of -13.98, and regression coefficient ( $R^2$ ) of 0.99. The graphenated electrochip exhibited good reproducibility and selectivity towards the analyte and offers greater ease of use.

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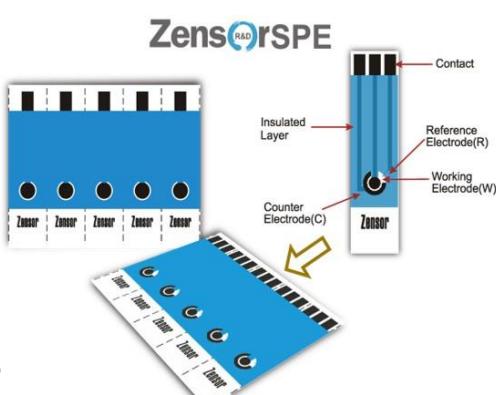
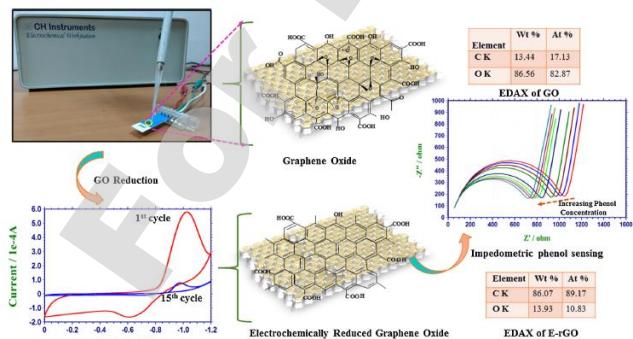


Fig 1. Pictorial representation of phenol sensing using graphenated electrochip





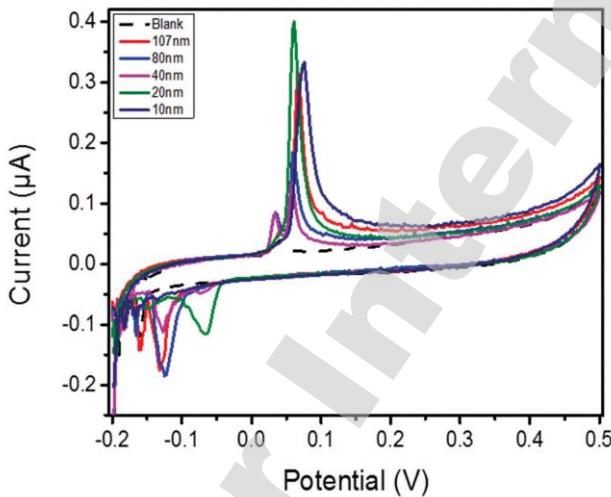
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Cite this: *Phys. Chem. Chem. Phys.*,  
2016, 18, 28183

## Impact electrochemistry on screen-printed electrodes for the detection of monodispersed silver nanoparticles of sizes 10–107 nm

Muhammad Zafir Mohamad Nasir and Martin Pumera\*

Impact electrochemistry provides a useful alternative technique for the detection of silver nanoparticles in solutions. The combined use of impact electrochemistry on screen-printed electrodes (SPEs) for the successful detection of silver nanoparticles provides an avenue for future on-site, point-of-care detection devices to be made for environmental, medicinal and biological uses. Here we discuss the use of screen-printed electrodes for the detection of well-defined monodispersed silver nanoparticles of sizes 10, 20, 40, 80, and 107 nm.



Received 6th August 2016,  
Accepted 20th September 2016

DOI: 10.1039/c6cp05463c

[www.rsc.org/pccp](http://www.rsc.org/pccp)

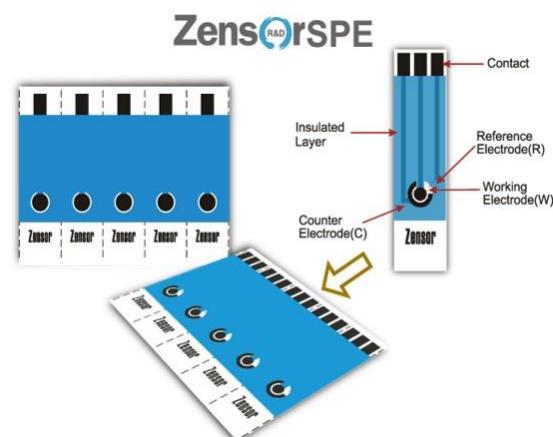
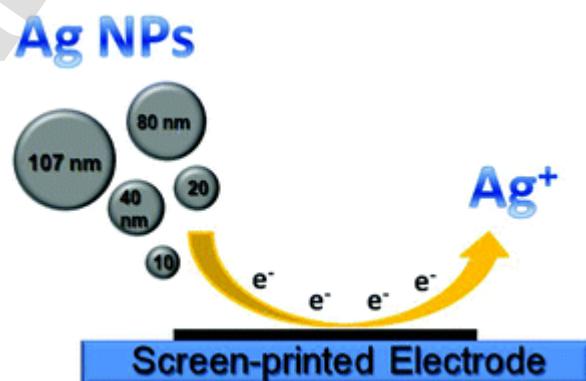


Fig. 2 Cyclic voltammograms (CVs) of silver nanoparticles of sizes 107, 80, 40, 20, and 10 nm for a glassy carbon electrode in 10 mM citrate + 90 mM KCl supporting buffer with a scan rate of 100 mV  $\text{s}^{-1}$  (vs. Ag/AgCl).



Cite this: *Anal. Methods*, 2016, **8**, 7158

## Electrochemical sensing of nitro-aromatic explosive compounds using silver nanoparticles modified electrochips

S. Singh,<sup>\*a</sup> V. K. Meena,<sup>a</sup> B. Mizaikoff,<sup>\*b</sup> S. P. Singh<sup>c</sup> and C. R. Suri<sup>d</sup>

In the present study an electrochemical deposition method for glycine-stabilized silver nanoparticles (Glyc-AgNPs) at screen printed electrodes is shown in a single step with minimal sample preparation. The advantage of this method is the direct assembly of Glyc-AgNPs at the electrode surface without external modification. The Glyc-AgNPs were characterized for their size, crystallinity and redox activity. The nanoparticles were further used for electrochemical sensing of 2,4,6-tri-nitro toluene (TNT) and di-nitro benzene (DNB), i.e. nitro-aromatic explosive compounds using differential pulse voltammetry (DPV). The Glyc-AgNP modified electrochip revealed significantly more sensitivity towards TNT as compared to DNB, as evident from the current intensity obtained due to the electrochemical reduction process. Earlier studies have suggested that tri-nitro compounds are more easily reduced as compared to mono- and di-nitro compounds, which is hypothesized as the main reason for the observed sensitivity for TNT. A linear response was observed in the range from  $1 \times 10^{-10}$  to 0.1 M for TNT, and  $1 \times 10^{-7}$  to 0.1 M for DNB. The results obtained with spiked samples provided solid grounds for future field trials with the developed sensing device.

Received 8th July 2016  
Accepted 17th August 2016

DOI: 10.1039/c6ay01945e

[www.rsc.org/methods](http://www.rsc.org/methods)

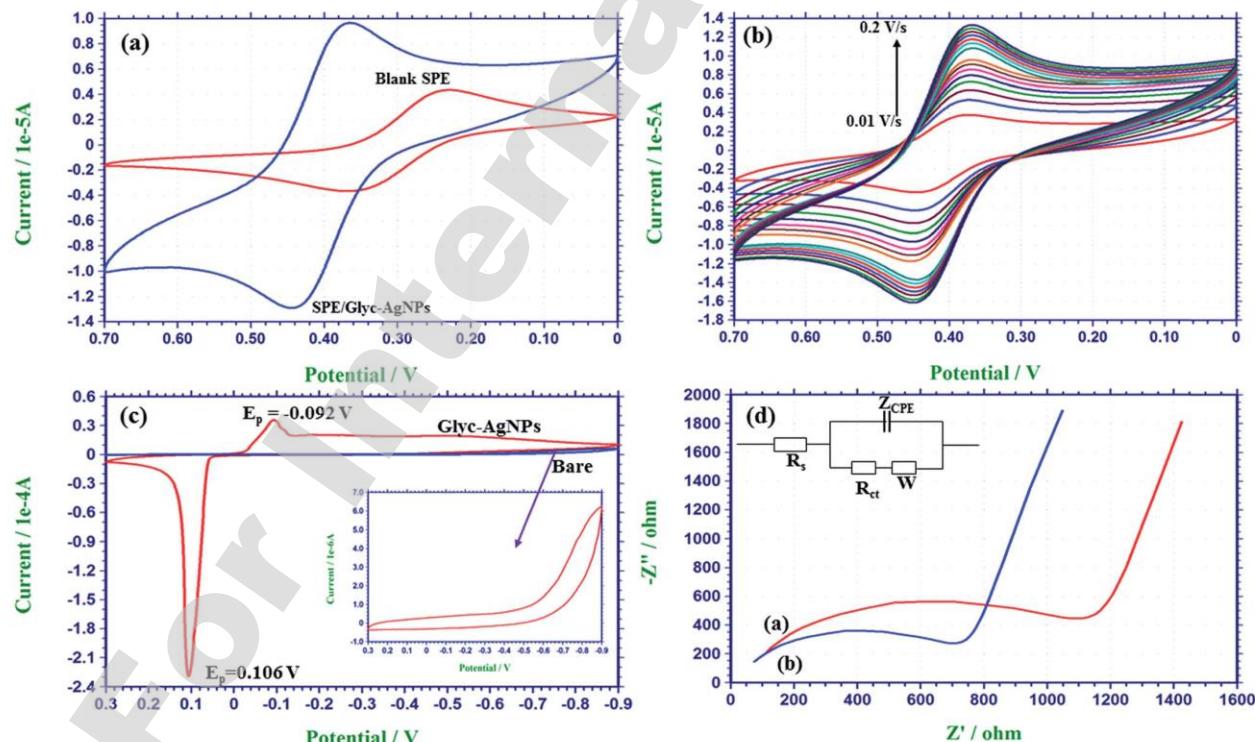


Fig. 4 (a) CV of bare and SPE/Glyc-AgNPs electrochips in 0.1 M KCl containing 5 mM of  $\text{Fe}^{3+}/\text{Fe}^{2+}$ . (b) Effect of scan rate on CV of the SPE/Glyc-AgNPs electrochip. (c) CV of bare and SPE/Glyc-AgNPs electrochips in phosphate buffer. (d) Nyquist plot of bare and SPE/Glyc-AgNPs electrochips in 0.1 M KCl containing 5 mM of  $\text{Fe}^{3+}/\text{Fe}^{2+}$ .

# A novel Laccase Biosensor based on Laccase immobilized Graphene-Cellulose Microfiber Composite modified Screen-Printed Carbon Electrode for Sensitive Determination of Catechol

Received: 29 November 2016

Accepted: 15 December 2016

Published: 24 January 2017 Selvakumar Palanisamy<sup>1</sup>, Sayee Kannan Ramaraj<sup>2</sup>, Shen-Ming Chen<sup>1</sup>, Thomas C. K. Yang<sup>3</sup>, Pan Yi-Fan<sup>1</sup>, Tse-Wei Chen<sup>1</sup>, Vijayalakshmi Velusamy<sup>3,4</sup> & Sonadevi Selvam<sup>2</sup>

In the present work, we demonstrate the fabrication of laccase biosensor to detect the catechol (CC) using laccase immobilized on graphene-cellulose microfibers (GR-CMF) composite modified screen printed carbon electrode (SPCE). The direct electrochemical behavior of laccase was investigated using laccase immobilized different modified SPCEs, such as GR/SPCE, CMF/SPCE and GR-CMF/SPCE. Compared with laccase immobilized GR and CMF modified SPCEs, a well-defined redox couple of Cu<sup>I</sup>/Cu<sup>II</sup> for laccase was observed at laccase immobilized GR-CMF composite modified SPCE. Cyclic voltammetry results show that the as-prepared biosensor has 7 folds higher catalytic activity with lower oxidation potential towards CC than SPCE modified with GR-CMF composite. Under optimized conditions, amperometric *i-t* method was used for the quantification of CC, and the amperometric response of the biosensor was linear over the concentration of CC ranging from 0.2 to 209.7 μM. The sensitivity, response time and the detection limit of the biosensor for CC is 0.932 μM A<sup>-1</sup> cm<sup>-2</sup>, 2 s and 0.085 μM, respectively. The biosensor has high selectivity towards CC in the presence of potentially active biomolecules and phenolic compounds. The biosensor also accessed for the detection of CC in different water samples and shows good practicality with an appropriate repea.

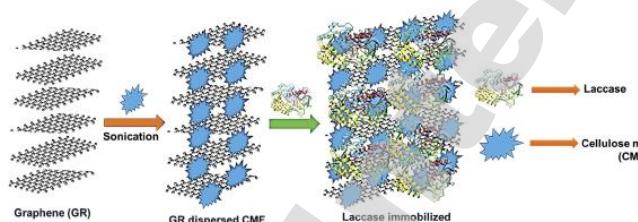


Figure 1. Schematic representation for the fabrication of laccase biosensor.

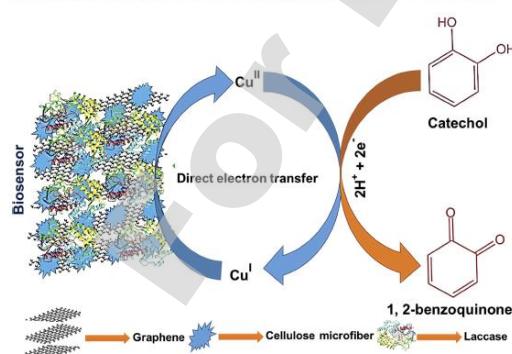
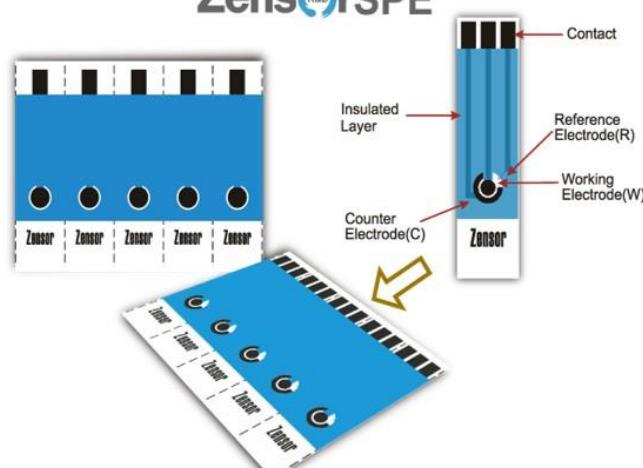


Figure 8. Schematic representation for the electrochemical redox behavior of laccase and electro-oxidation mechanism of CC by the as-prepared laccase biosensor.

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## Chemical Engineering Journal

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### Amphiphilic compounds enhance the dechlorination of pentachlorophenol with Ni/Fe bimetallic nanoparticles

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#### ABSTRACT

Pentachlorophenol (PCP), a general ionized chlorinated aromatic contaminant, was treated with Ni/Fe nanoparticles (NPs). An increase in the Ni/Fe dosage enhanced the removal of PCP. The most effective nickel percentage was 0.5%. Among the selected surfactants including carboxymethyl cellulose, Triton X-100, and cetyl trimethylammonium bromide (CTAB), CTAB markedly enhanced the removal of PCP by Ni/Fe. From removal kinetics, increased sorption of PCP onto Ni/Fe surfaces with CTAB was observed when compared to that without CTAB. This is the result of the small particle size of Ni/Fe-CTAB and the electrostatic interaction between an electronegative phenolate group of PCP and the electropositive Ni/Fe-CTAB. The increased sorption of PCP onto Ni/Fe surfaces by CTAB accelerated the reduction of PCP. In addition, with CTAB, the observed bulky and soft surface of Ni/Fe NPs allows enhanced electron transfer from the zerovalent iron core. The removal mechanism of PCP is dechlorination for Ni/Fe-CTAB but, for bare Ni/Fe, adsorption is mainly responsible for the removal. The dechlorination pathways of PCP with Ni/Fe-CTAB were investigated. The ortho position of chloride can be more easily reduced than other positions. Ni/Fe-CTAB NPs have a high potential to treat polychlorinated aromatics.

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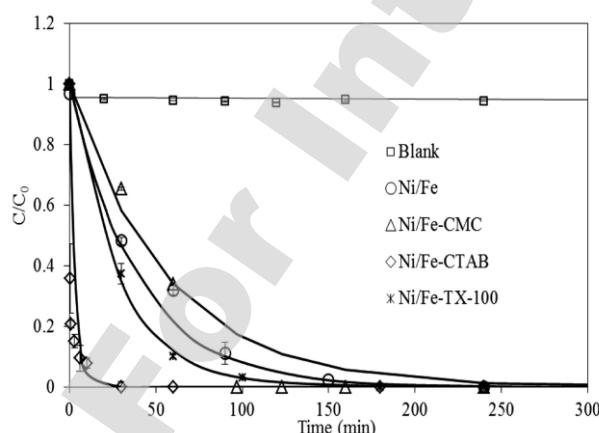
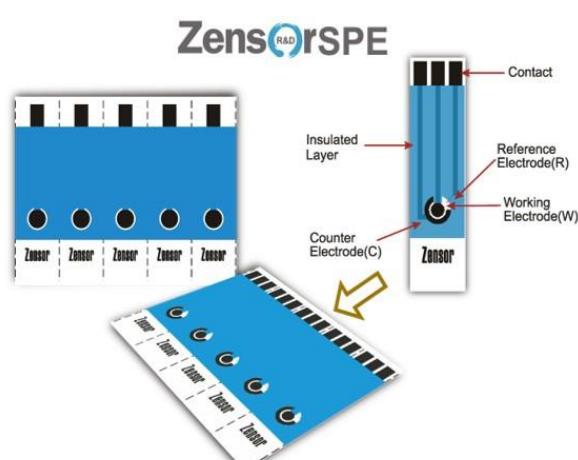


Fig. 3. Effect of different surfactants on the removal of PCP with surfactant on the Ni/Fe nanoparticles (CTAB was 0.92 mM; TX-100 was 0.20 mM; CMC was 0.067 mM).



## An Amperometric Nitrobenzene Electrochemical Sensor Based on Electrochemically Activated Graphite Modified Screen Printed Carbon Electrode

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Received: 9 February 2015 / Accepted: 11 March 2015 / Published: 23 March 2015

In the present study involves the fabrication of amperometric sensor for the detection of nitrobenzene (NB) using electrochemically activated graphite (EAG) modified screen printed carbon electrode (SPCE). The EAG modified SPCE was prepared by a simple electrochemical activation of graphite in PBS containing KCl solution at an applied potential of 2.0 V for 300 s. The EAG modified SPCE showed a good electrocatalytic reduction behavior towards NB with a lower overpotential than that of other modified SPCEs. Amperometric results reveals that the reduction peak current of NB was linear over the concentrations from 0.3 to 374.5  $\mu\text{M}$ . The response time of the sensor was calculated as 5 s. The sensitivity was found as  $1.445 \mu\text{A}\mu\text{M}^{-1} \text{cm}^{-2}$  with the detection limit of 0.06  $\mu\text{M}$  for NB. In addition, the fabricated electrode showed a good selectivity for NB in the presence of nitroaromatic and phenolic compounds with good operational stability.

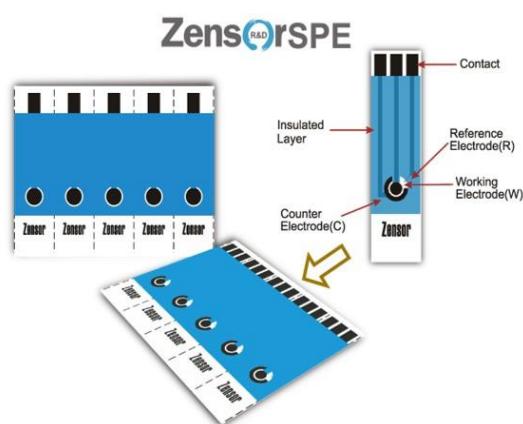
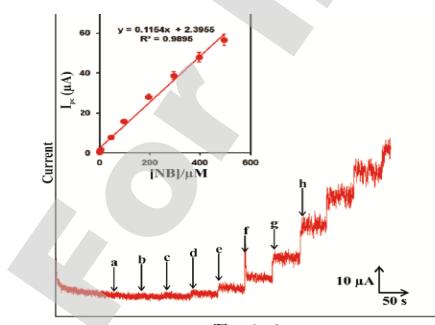


Figure 5. A) Amperometric  $i$ - $t$  response obtained at EAG/SPCE for the addition of 0.3  $\mu\text{M}$  (a), 0.5  $\mu\text{M}$  (b), 1  $\mu\text{M}$  (c), 3  $\mu\text{M}$  (d), 5  $\mu\text{M}$  (e), 10  $\mu\text{M}$  (f), 20  $\mu\text{M}$  (g) and 50  $\mu\text{M}$  NB (h) into the PBS. Applied potential: -0.624 V. B) Calibration plot for amperometric current response vs. [NB].

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ELECTROANALYSIS

DOI: 10.1002/elan.201500255

# Potentiostatic Electrochemical Preparation of Bismuth Nanoribbons and its Application in Biologically Poisoning Lead and Cadmium Heavy Metal Ions Detection

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**Abstract:** A simple and elegant electrochemical potentiostatic method has been described for the preparation of highly stable and electrocatalytically active bismuth nanoribbons (BiNRs). The average length and width of the BiNRs were of  $100 \pm 50$  nm and  $10 \pm 5$   $\mu\text{m}$ , respectively. Here, disodium ethylene diamine tetraacetate was employed as a scaffold for the growth of BiNRs. The formation of BiNRs was confirmed by surface morphological,

elemental and cyclic voltammetric analyses. The BiNRs exhibited excellent electrocatalytic ability in detecting biologically poisoning heavy metal ions such as lead and cadmium. The described BiNRs based sensor presents good linear dependence on lead and cadmium ions in the concentration range of 1–50  $\mu\text{g/L}$  for both metal ions with a detection limit of 0.104  $\mu\text{g/L}$  for lead and 0.145  $\mu\text{g/L}$  for cadmium.

**Keywords:** Bionanotechnology • Bismuth nanoribbons • Potentiostatic • Lead • Cadmium • Electrocatalysis

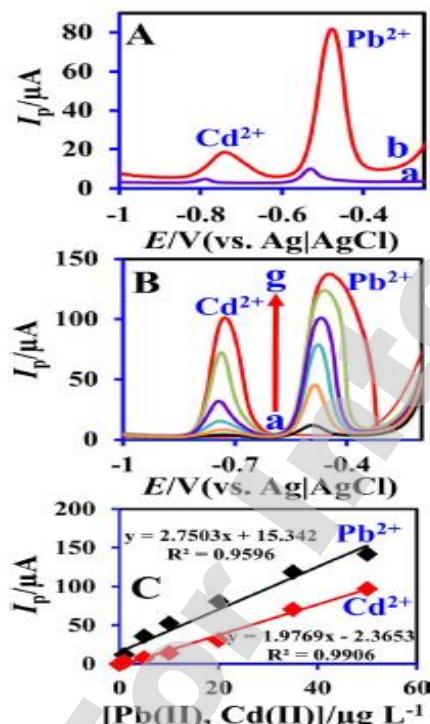
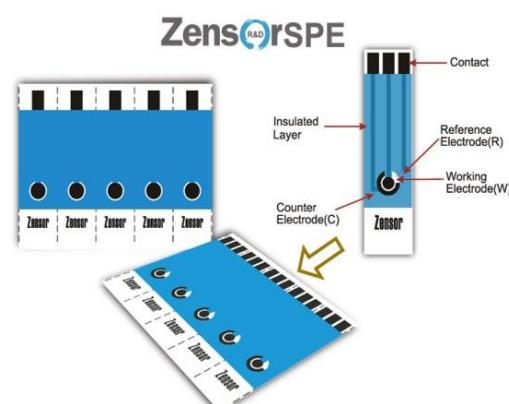


Fig. 3. (A) SWASV responses of bare (a) and BiNRs (b) modified SPCE in 0.1 M acetate buffer (pH 5) containing 20  $\mu\text{g/L}$  concentration of Pb(II) and Cd(II) at the scan rate of 50  $\text{mV s}^{-1}$ . The deposition potential was held at  $-1.20$  V, while the deposition time was 200 s. (B) SWASV response of BiNRs/SPCE for the simultaneous detection of Pb(II) and Cd(II) in 0.1 M acetate buffer (pH 5). The concentrations of metal ions (Pb(II) and Cd(II)) are curves a to g: 0, 1, 5, 10, 20, 35 and 50  $\mu\text{g/L}$ . The deposition potential was held at  $-1.20$  V, while deposition time was 200 s. (C) The corresponding linear calibration plots between peak currents and concentrations of Pb(II) and Cd(II).

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# Electrochemical Detection of Phenol in Industrial Pollutant Absorbed Molecular Sieves by Electrochemically Activated Screen Printed Carbon Electrode

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Received: 17 December 2014 / Accepted: 20 January 2015 / Published: 24 February 2015

An electrochemically activated screen printed carbon electrode (EASPCE) was used for the electrochemical detection of phenol in the industrial pollutant absorbed molecular sieves. GC-MS analysis had identified 15 organic compounds and found that phenol was the most abundant one among these indentified organic compounds in the industrial pollutant absorbed molecular sieves. In addition, the phenol was also detected at modified electrodes by using the electrochemical methods such as cyclic voltammetry and differential pulse voltammetry. The surface morphology of the bare screen printed carbon electrode (SPCE) and EASPCE was investigated by scanning electron microscopy. The result of EASPCE showed a good oxidation peak response to phenol in the presence of industrial pollutant absorbed molecular sieves, while the bare SPCE showed a very week response to phenol compared with EASPCE. The electrochemical behaviours of phenol implied that the oxidation of phenol is one electron and one proton transferred electrochemical reaction.

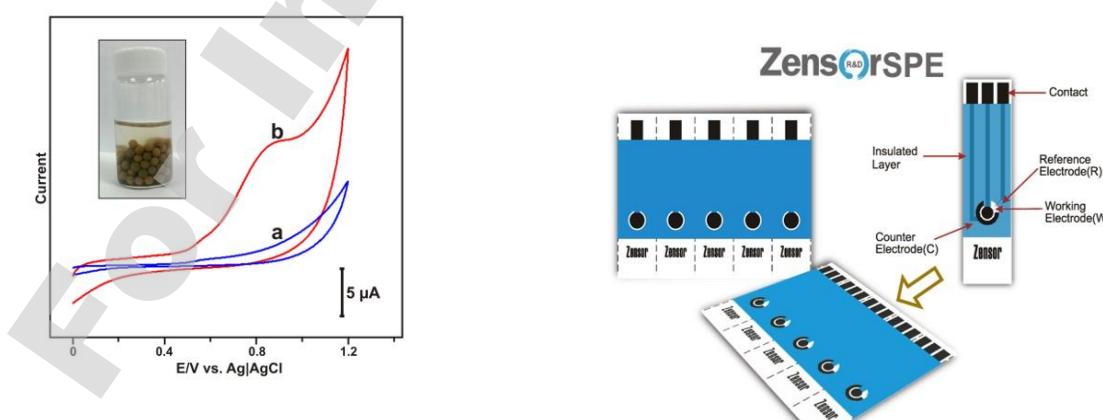


Figure 5. Cyclic voltammetry response of bare SPCE (a) and EASPCE (b) in PBS containing industrial pollutant absorbed molecular sieves at a scan rate of  $50 \text{ mVs}^{-1}$ . Inset shows the digital photographs of industrial pollutant absorbed molecular sieves in PBS.



# Electrochemical fabrication of gold nanoparticles decorated on activated fullerene C60: an enhanced sensing platform for trace level detection of toxic hydrazine in water samples†

Selvakumar Palanisamy, Balamurugan Thirumalraj and Shen-Ming Chen\*

A novel and highly sensitive amperometric hydrazine sensor was fabricated using gold nanoparticles (AuNPs) decorated on activated fullerene C60 (AC60) modified screen printed carbon electrode (SPCE). An electrochemical method was used for the fabrication of the AC60–AuNPs modified SPCE which was characterized by scanning electron microscopy and elemental analysis. The fabricated AC60–AuNPs modified SPCE showed an enhanced electrocatalytic activity towards hydrazine over that of other modified SPCEs. Furthermore, the detection potential of hydrazine was notably lower (0.161 V) at the AuNPs decorated AC60 modified SPCE than AuNPs decorated bare (0.208 V) and C60 (0.186 V) modified SPCEs. Under optimum conditions, the amperometric response of the sensor was linear over the hydrazine concentrations from 0.13  $\mu$ M to 1.21 mM with a fast response time of 1.3 s. In addition, the proposed sensor showed the lowest limit of detection (LOD) of 0.039  $\mu$ M, with a high sensitivity of 0.583  $\mu$ A  $\mu$ M $^{-1}$  cm $^{-2}$ . The sensor also holds its high selectivity in the presence of common metal ions and biologically active interfering species. In addition, the practicality of the fabricated sensor in tap water samples is comparable with those detected by the HPLC method.

Received 25th August 2015

Accepted 27th October 2015

DOI: 10.1039/c5ra17197k

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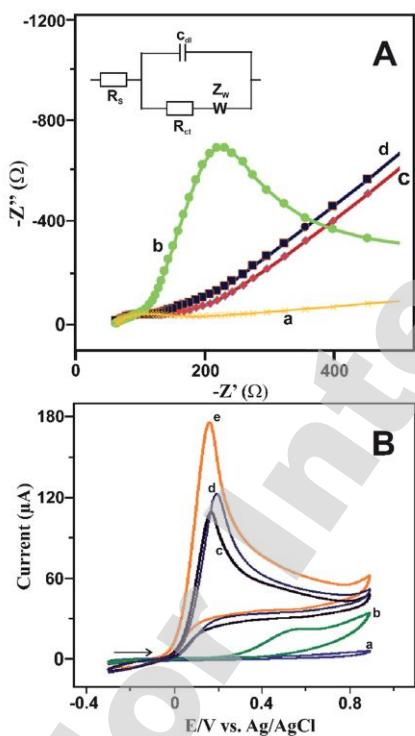
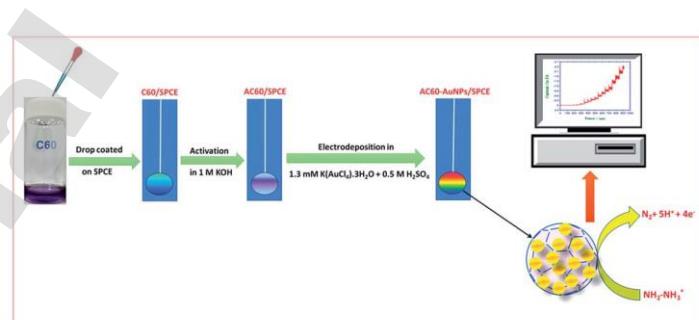
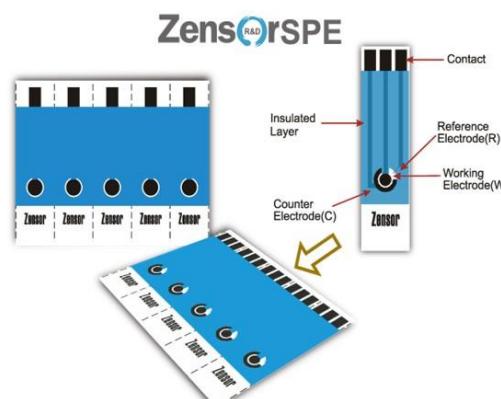


Fig. 3 (A) EIS of bare (a), C60 (b), C60–AuNPs (c) and AC60–AuNPs (d) modified SPCEs in PBS containing 5 mM  $\text{Fe}(\text{CN})_6^{3-/4-}$  with 0.1 M KCl; inset shows the Randles equivalent circuit model. (B) Cyclic voltammetric response of C60 (a), AC60 (b), C60–AuNPs (c), AuNPs (d), and AC60–AuNPs (e) modified SPCEs for 1 mM hydrazine containing PBS at a scan rate of 50 mV s $^{-1}$ .



Scheme 1 Schematic representation for the fabrication of AC60–AuNPs modified SPCE and oxidation of hydrazine.





Short Communication

## Electrochemical Sensing of SF<sub>6</sub> Decomposition Products Based on a Screen Printed Carbon Electrode

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Received: 1 December 2014 / Accepted: 22 January 2015 / Published: 24 February 2015

In the present work, a screen printed carbon electrode (SPCE) was used for the electrochemical detection of SF<sub>6</sub> decomposition products. At least 11 compounds from SF<sub>6</sub> decomposition gas sample were observed and identified by GC-MS. The SPCE was characterized by a scanning electron microscopy and electrochemical impedance spectroscopy. Cyclic voltammetry (CV) and differential pulse voltammetry (DPV) was used for the detection of SF<sub>6</sub> decomposition products. The results of GC-MS, CV and DPV reveal that SF<sub>6</sub> decomposition products mostly contain SO<sub>2</sub>. The CV result shows three main peaks in 0.1 M KOH solution; a cathodic peak at -0.556 V and anodic peaks at -0.127 and 0.252 V, respectively. This is due to the reduction and oxidation products of adsorbed SO<sub>2</sub> on the electrode surface. The DPV also reveals three distinct peaks; one reduction peak at -0.572 V and other two oxidation peaks at -0.204 and 0.18 V. In addition, this study can also be further extended for detection of similar gases in the solution phase.

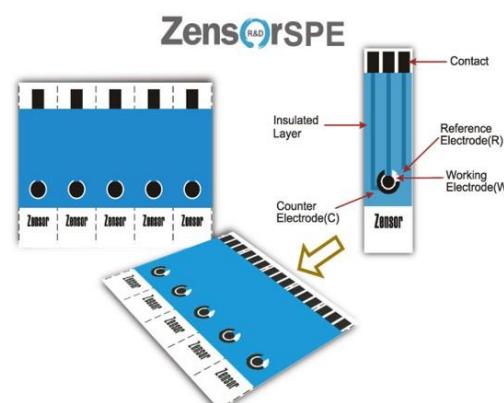
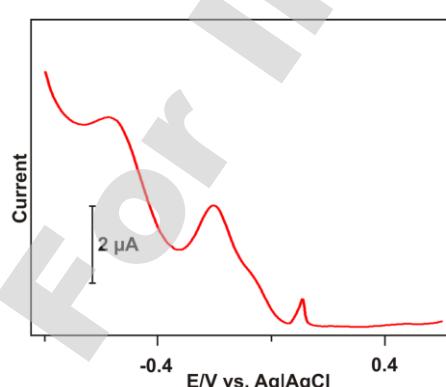


Figure 4. Differential pulse voltammetry response obtained at SF<sub>6</sub> decomposition gas adsorbed SPCE in 0.1 KOH at a scan rate of 20 mV s<sup>-1</sup>.

