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Impedometric phenol sensing using graphenated electrochip

Suman Singh^{a,*}, Nishant Kumar^a, Vijay Kumar Meena^a, Christine Kranz^b, Sunita Mishra^a^a Central Scientific Instruments Organisation (CSIR-CSIO), Chandigarh 160030, India^b Institute of Analytical and Bioanalytical Chemistry, Ulm University, Albert-Einstein-Allee 11, 89081 Ulm, Germany

A B S T R A C T

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 -1.76×10^{-9} A/ μ M and intercept of -4.69×10^{-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 μ M to 40 μ 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 μ M to 40 μ M) of phenol. The amperometry results obeyed the linear equation with slope of -0.06 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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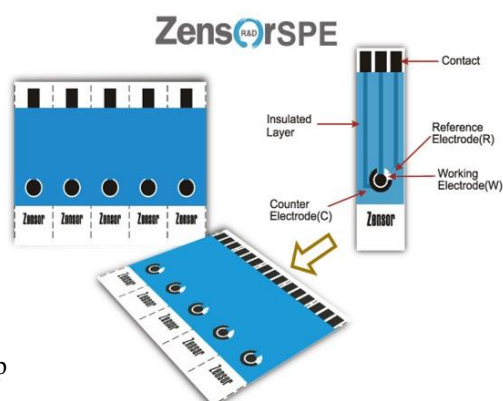
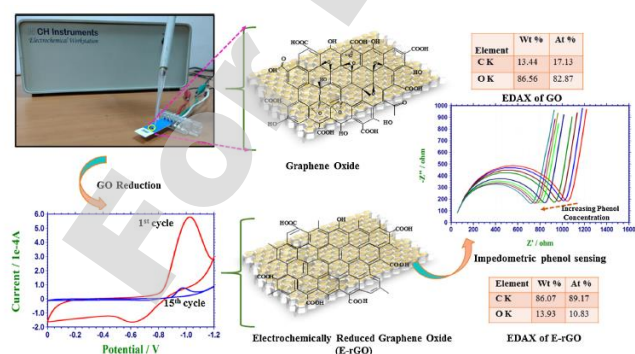


Fig 1. Pictorial representation of phenol sensing using graphenated electrochip



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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.

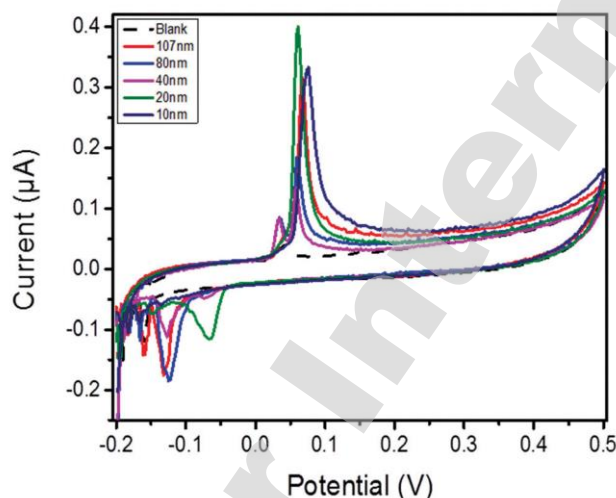
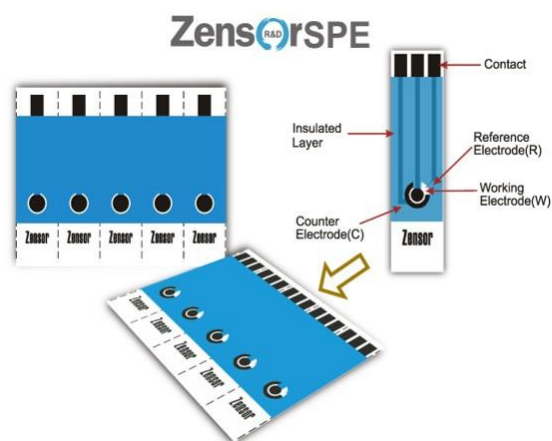
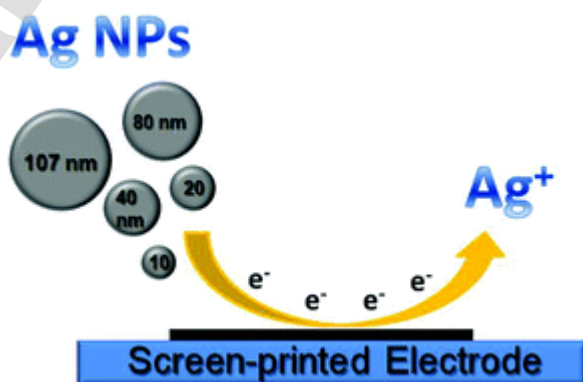


Fig. 2 Cyclic voltammograms (CVs) of silver nanoparticles of sizes 107, 80, 40, 20, and 10 nm for a glassy carbon electrode in 10 mM citrate + 90 mM KCl supporting buffer with a scan rate of 100 mV s^{-1} (vs. Ag/AgCl).



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

S. Singh,^{*a} V. K. Meena,^a B. Mizaikoff,^{*b} S. P. Singh^c and C. R. Suri^d

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 1×10^{-10} to 0.1 M for TNT, and 1×10^{-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.

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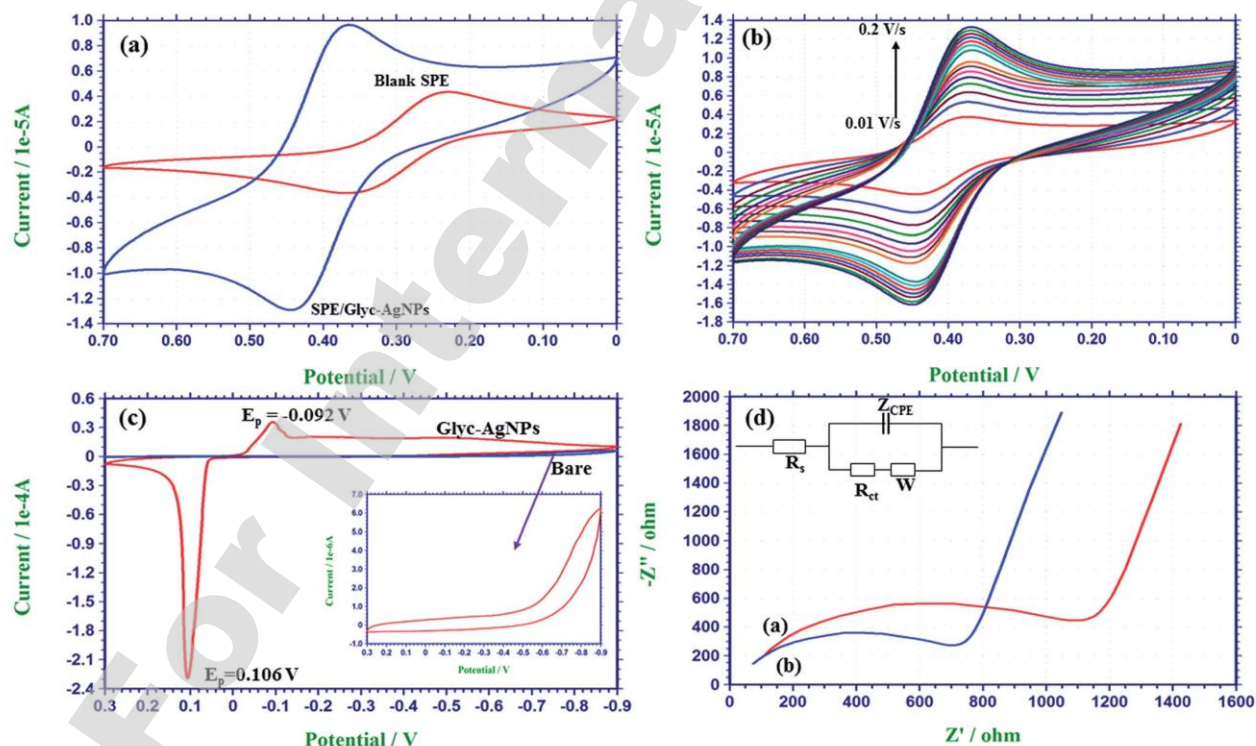


Fig. 4 (a) CV of bare and SPE/Glyc-AgNPs electrochips in 0.1 M KCl containing 5 mM of $\text{Fe}^{3+}/\text{Fe}^{2+}$. (b) Effect of scan rate on CV of the SPE/Glyc-AgNPs electrochip. (c) CV of bare and SPE/Glyc-AgNPs electrochips in phosphate buffer. (d) Nyquist plot of bare and SPE/Glyc-AgNPs electrochips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

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Selvakumar Palanisamy¹, Sayee Kannan Ramaraj², Shen-Ming Chen¹, Thomas C. K. Yang³, Pan Yi-Fan¹, Tse-Wei Chen¹, Vijayalakshmi Velusamy^{3,4} & Sonadevi Selvam²

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 $\text{Cu}^{\text{I}}/\text{Cu}^{\text{II}}$ 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 $0.932 \mu\text{M}\mu\text{A}^{-1}\text{cm}^{-2}$, 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.

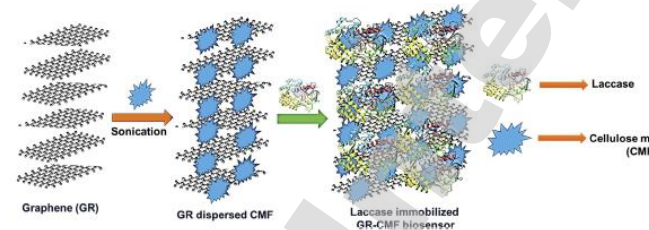


Figure 1. Schematic representation for the fabrication of laccase biosensor.

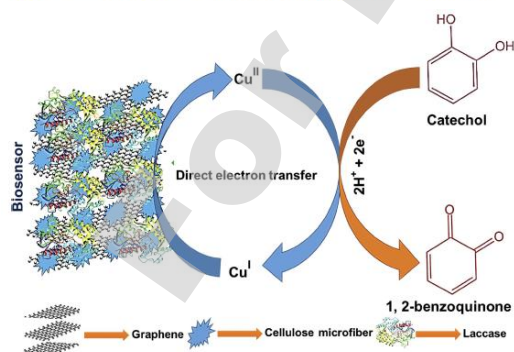


Figure 8. Schematic representation for the electrochemical redox behavior of laccase and electro-oxidation mechanism of CC by the as-prepared laccase biosensor.

Zensar SPE

