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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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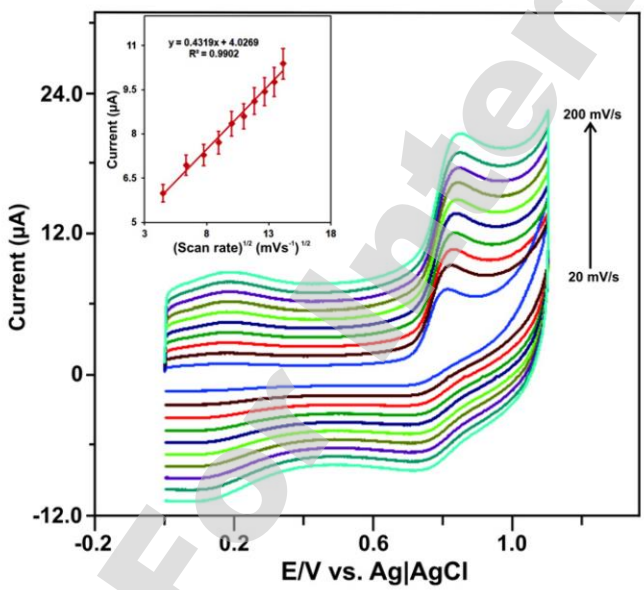
ABSTRACT

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 ± 0.01 μM. 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.



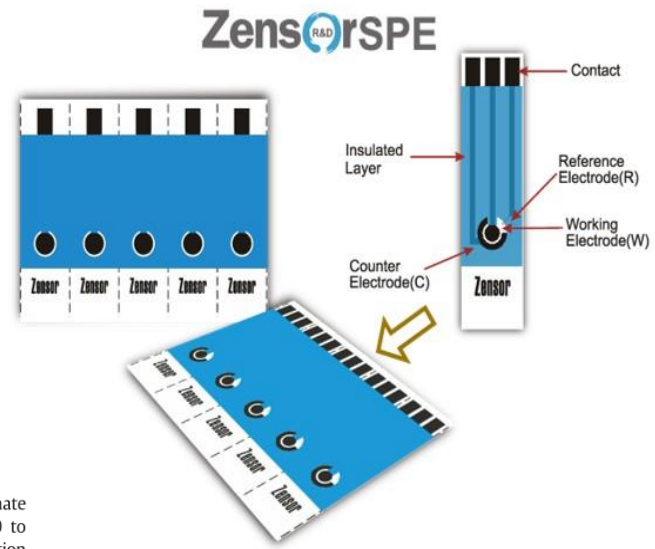


Fig. 5. A) CV response of GR/CD composite modified SPCE in 0.05 M sodium phosphate buffer pH 5 solution containing 100 μM nitrite at different scan rates from 20 to 200 mV s^{-1}. B) The corresponding calibration plot for square root of scan rate vs. oxidation peak current response of nitrite. The error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

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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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hair waving products
screen-printed carbon electrode

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 to 1.99×10^6 nmol L^{-1}) was observed, and a detection limit of 3.5 μg L^{-1} (23.19 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.

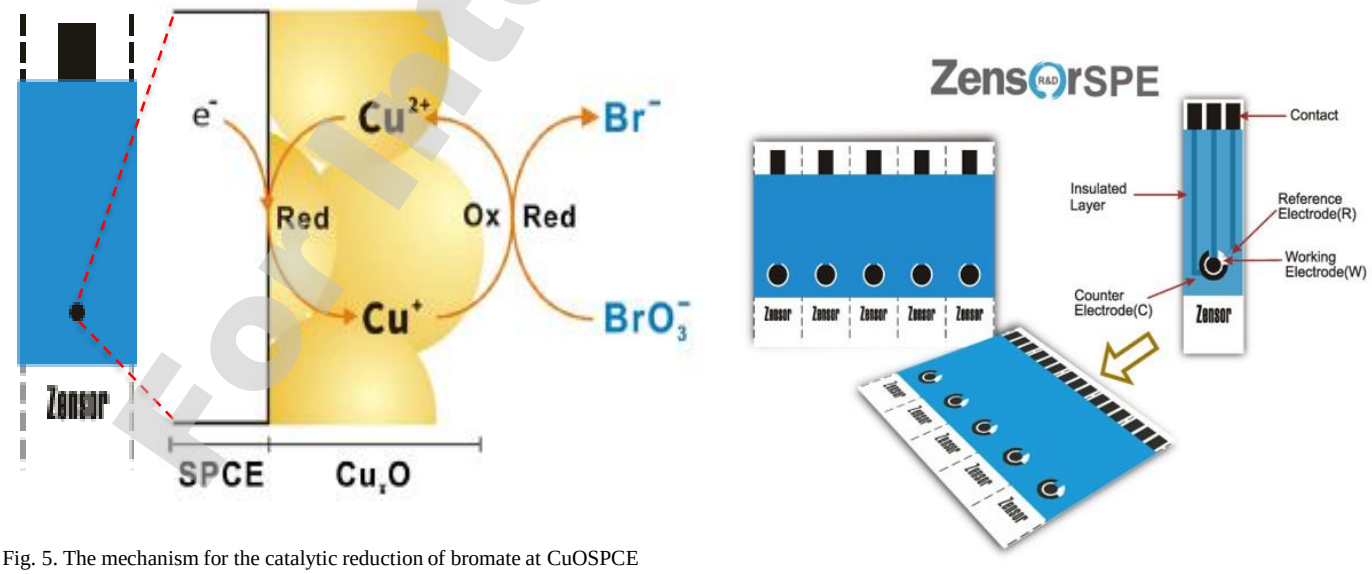

Fig. 5. The mechanism for the catalytic reduction of bromate at CuOSPCE

Electrochimica Acta 161 (2015) 100–107

Acetylcholinesterase Biosensor for Chlorpyrifos Detection Based on Multi-Walled Carbon Nanotubes-SnO_2-chitosan Nanocomposite Modified Screen-Printed Electrode

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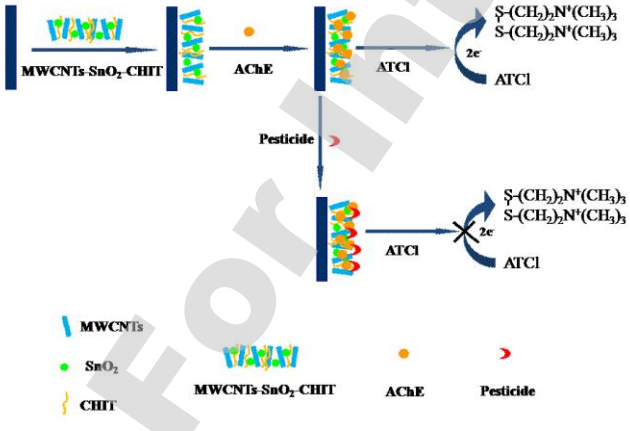
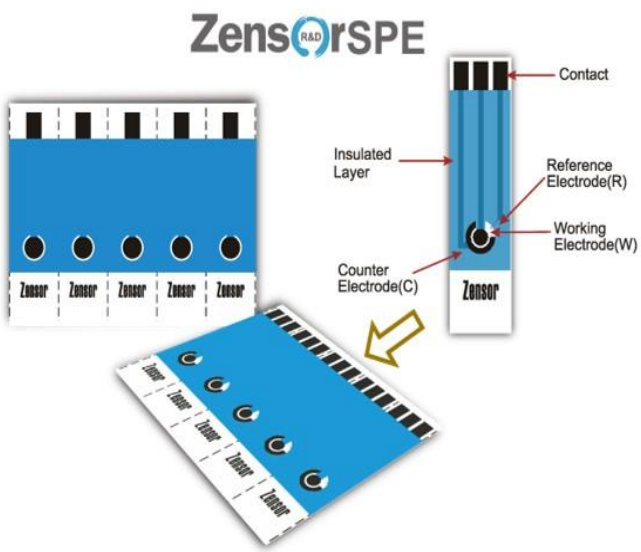
An acetylcholinesterase biosensor for organophosphate detection was developed immobilizing the AChE enzyme via MWCNTs-SnO_2-CHIT nanocomposite on screen-printed electrode. MWCNTs provide a flexible conductive film and a much larger pathway due to their high electrical conductivity and large porosity ratio, thus increasing detection sensitivity. SnO_2 decreased the peak voltage, revealed that the SnO_2 nano materials can promote the redox process. Based on the inherent conductive properties of the MWCNTs-SnO_2-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.



Int. J. Electrochem. Sci., 10 **(2015)** 10491 - 10501

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 µM with detection limit 2.5 µM and the sensitivity is 255 $\mu AmM^{-1} cm^{-2}$. The reported sensor exhibits a super selectivity and satisfactory reproducibility with good stability.

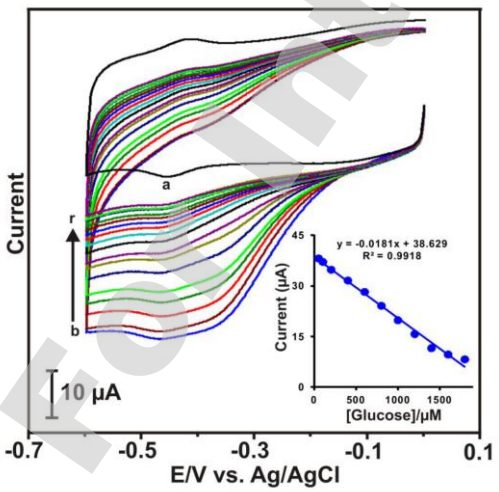
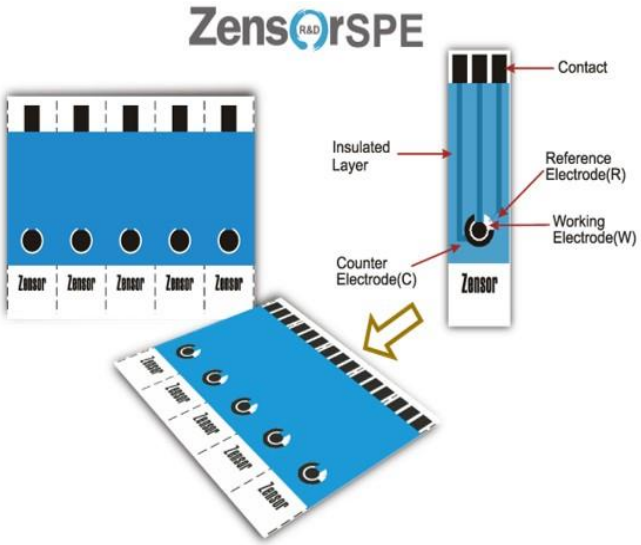


Figure 5. CVs of GOx/AuNPs-EGr/SPCE in N_2 saturated (a) and O_2 saturated PBS (pH 7) solution in various concentrations of glucose from 50 to 1800 µM at the scan rate of 50 mV s^{-1}, (b–r). The inset shows the calibration curve of I_p vs. glucose concentration.



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Electrochimica Acta

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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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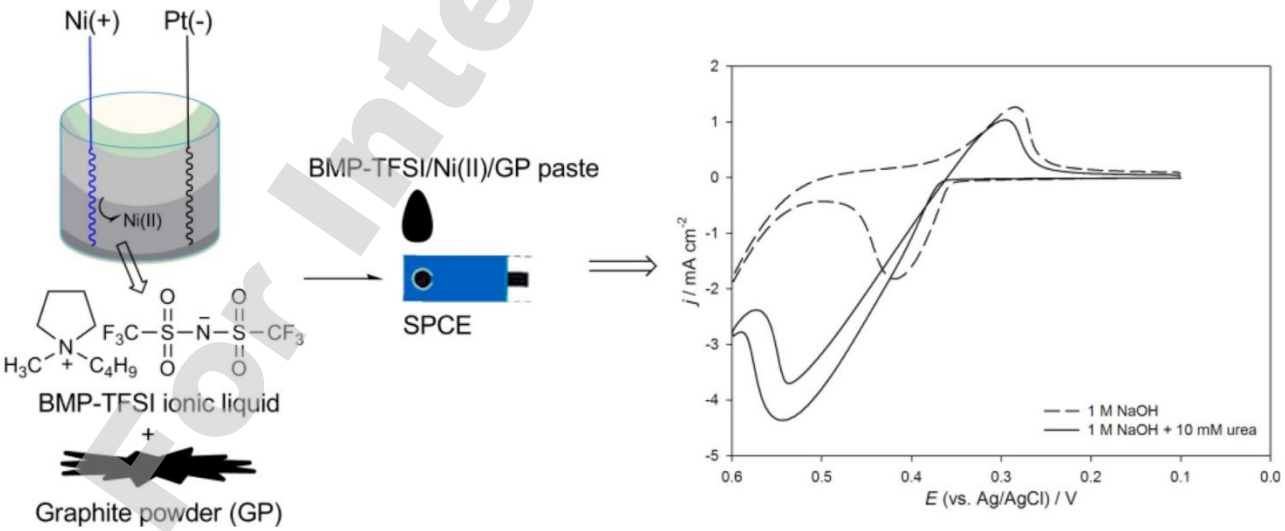
ABSTRACT

Ni(II) was introduced into four room-temperature ionic liquids (RTILs), namely 1-butyl-3-methyl-imidazolium salicylate (BMI-SAL), BMI hexafluorophosphate (BMI-PF_6), 1-butyl-1-methylpyrrolidinium dicyanamide (BMP-DCA), and BMP bis((trifluoromethyl)sulfonyl) imide (BMP-TFSI), via the addition of $NiCl_2$ 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 $\mu A \cdot mM^{-1} \cdot cm^{-2}$ 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.



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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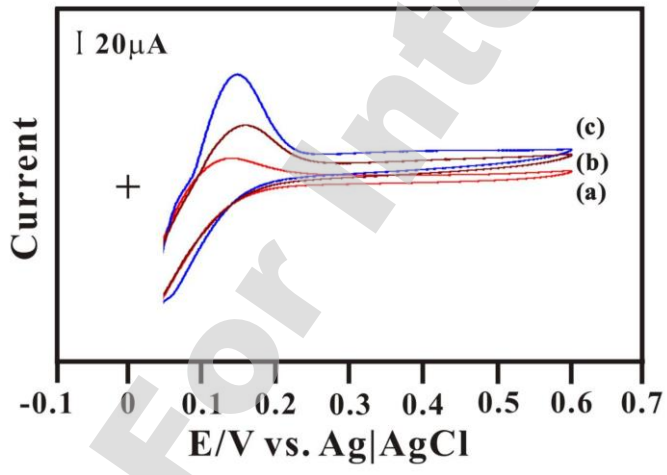
In the present work, a glucose sensor was developed based on the glucose oxidase immobilized on Pd (Pd-GOx) and nafion modified electrode. The modified electrode was characterized by atomic force microscopy and field emission scanning electron microcopy. The electrochemical analysis for electrochemical 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.



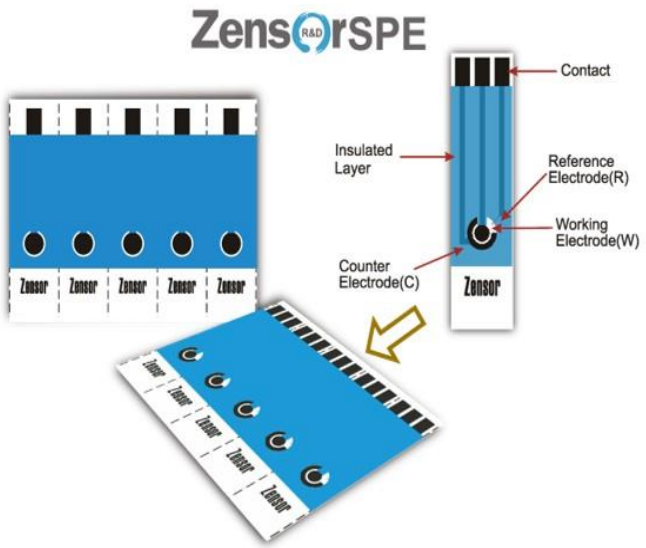


Figure 4. The cyclic voltammetry response of Nafion/Pd-GOx modified electrodes in pH 7.0 in the absence (a) and presence of 0.005 M (b) and 0.01M (c) glucose at a scan rate of 0.1 V/s.

Contents lists available at ScienceDirect

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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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ABSTRACT

In this study, a new non-heme iron complex was prepared by mixing $FeCl_3 \cdot 6H_2O$ and 2,4,6-tris(2-pyridylmethylamino)-1,3,5-triazine (TPMATA) in ionic liquid 1-butyl-1-methylpyrrolidinium bis((trifluoromethyl)sulfonyl)amide (IL [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, •OH, was produced, and the radical was detected by using a fluorescence probe. This electrode showed a sensitivity of 22.1 $\mu A \cdot mM^{-1}$ and a dynamic range of 0.025~4.69 mM with a regression coefficient R^2 of 0.993 (or 0.025~0.765 mM, $R^2 = 0.997$, sensitivity = 27.6 $\mu A \cdot mM^{-1}$). 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.

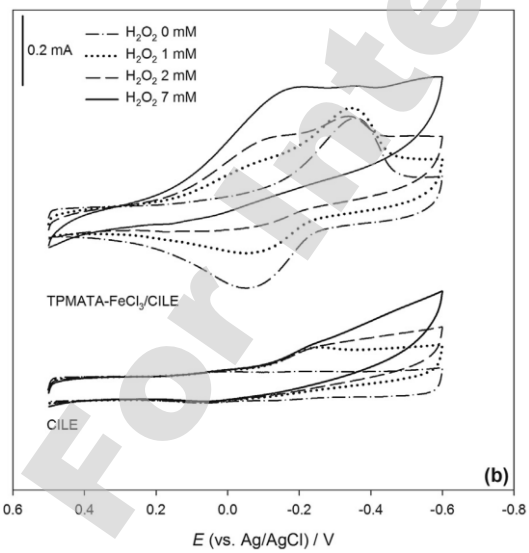
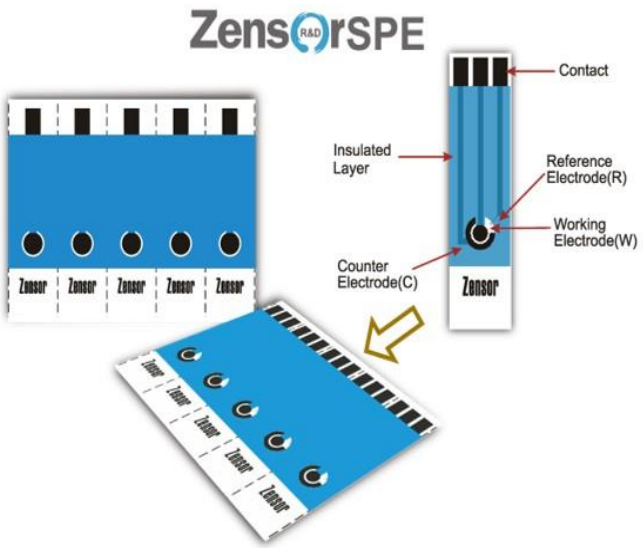


Fig. 3. CVs recorded at (a) various electrodes without H_2O_2 and at (b) TPMATA-$FeCl_3$/CILE (TPMATA/$FeCl_3$ = 20/60 (mM/mM)) or CILE with and without H_2O_2 in 0.1 M pH 7.0 PBS. Scan rate: 50 $mV \cdot s^{-1}$.



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Sensors and Actuators B: Chemical

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

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$Cu_3(PO_4)_2$-deposited electrode
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Nanostructure
Amino acid
Complexation

ABSTRACT

$Cu_3(PO_4)_2$-deposited electrodes capable of detecting nonelectroactive α-amino acids (AAs) are developed by the dissolution-precipitation method. The $Cu_3(PO_4)_2$-dominated compounds of flake-shaped nanostructures are quickly and uniformly deposited on the surface of acicula-nanostructured $Cu(OH)_2$-electrodeposited electrodes in a 100 mM Na_2HPO_4 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 $H_2PO_4^-$ on the electrode surface and produces the $Cu^{II}(H_2PO_4)_2$ 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 μM for electroactive and nonelectroactive α-AAs. The $Cu_3(PO_4)_2$-deposited electrodes are integrated into a chromatographic separation systems as an AA sensor to have promise for the detection of biological and food samples.

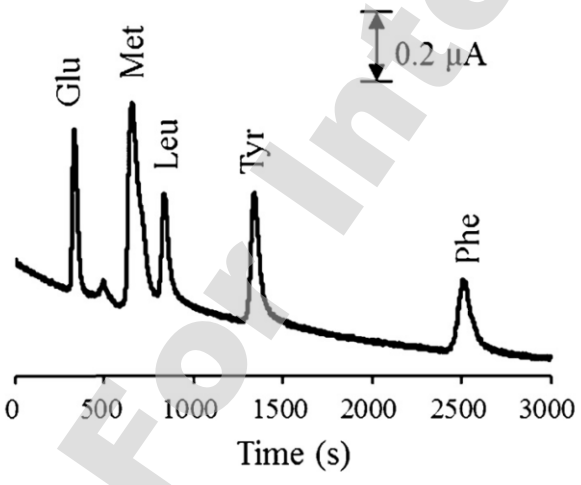
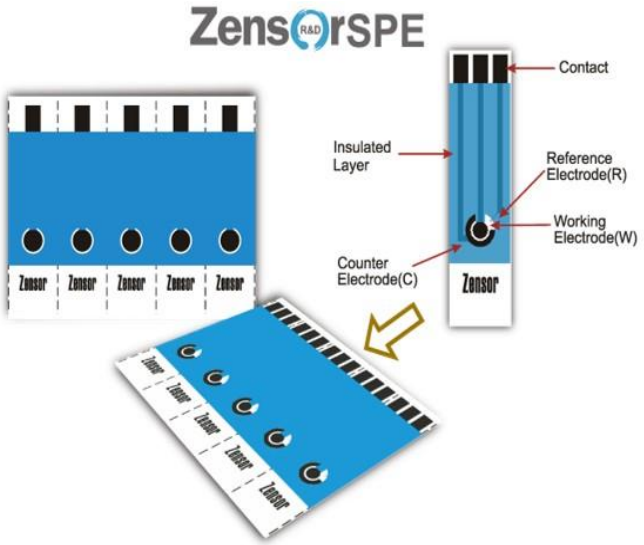


Fig. 6. Chromatogram of a mixture of five representative amino acids (0.5 mM) using a silica-based HPLC column measured by a $Cu_3(PO_4)_2$-deposited electrode with a flow rate of 300 μL/min.



Sensors and Actuators B 206 (2015) 584–591

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 μA μM^{-1} cm^{-2}.

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

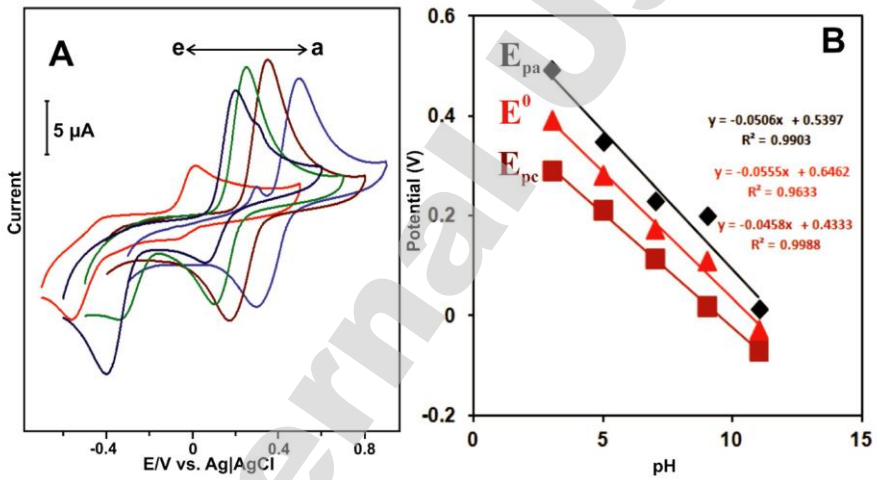
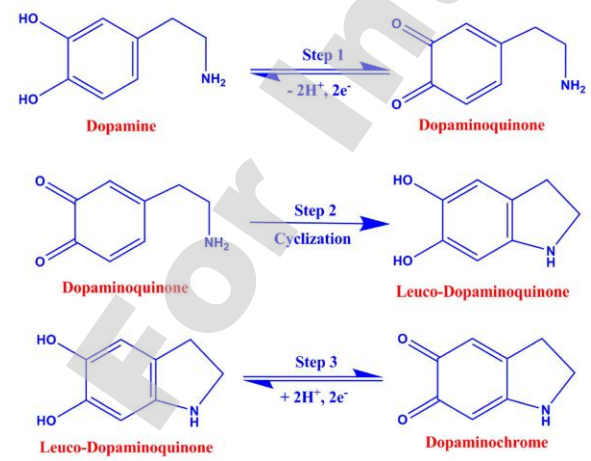


Fig. 4. A) Cyclic voltammetry obtained at ASPCE/AgNPs for the response to 100 μM of DA in different pH solutions (pH 3, 5, 7, 9 and 11, a–e) at a scan rate of 50 mV s^{-1}. B) Calibration plot for pH vs. E_{pa}, E_{pc} and E^0.



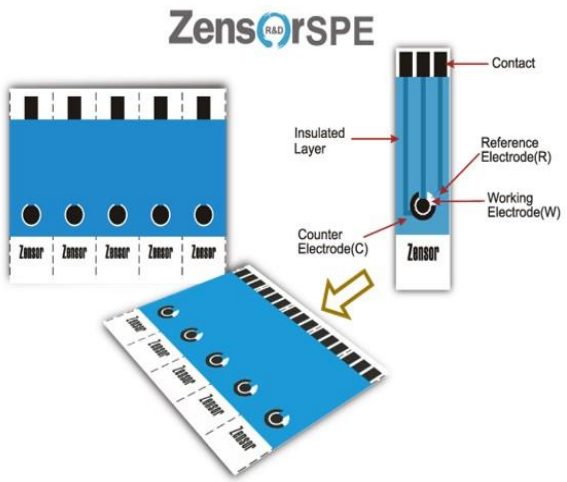


Fig. 5. Electrochemical mechanism involved in DA at AgNPs modified ASPCE.

Electroanalysis **2015**, *27*, 1998 – 2006

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Electrochemistry Communications

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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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Screen printed carbon electrode
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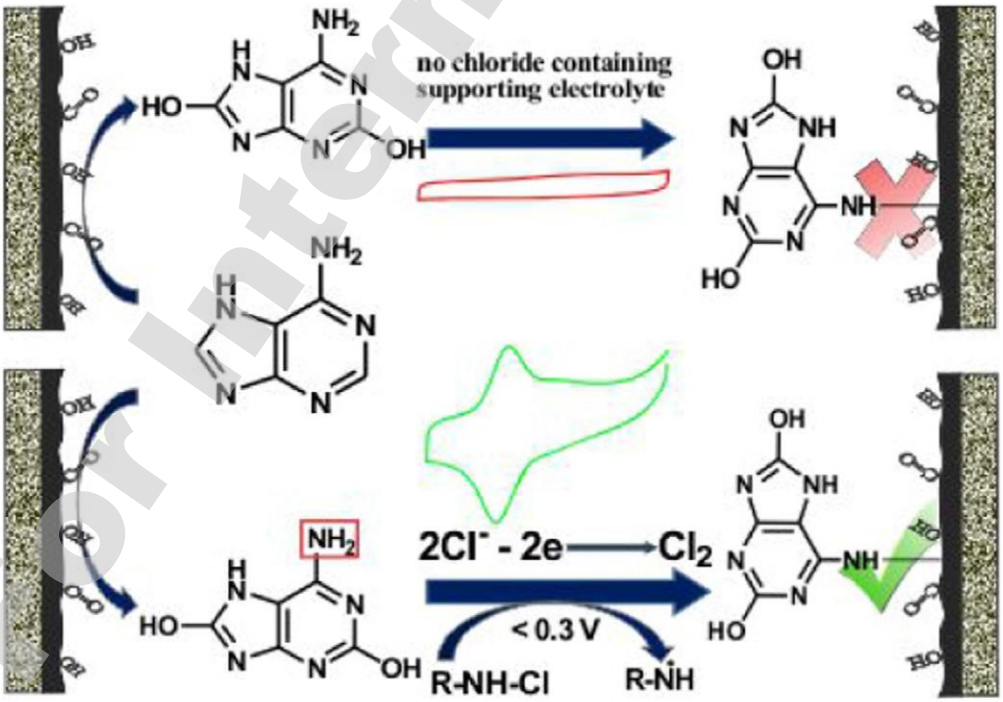
Electrogenerated chlorine

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.



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

Impact Electrochemistry of Layered Transition Metal Dichalcogenides

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[‡]Department of Inorganic Chemistry, University of Chemistry and Technology Prague, Technická 5, 166 28 Prague 6, Czech Republic

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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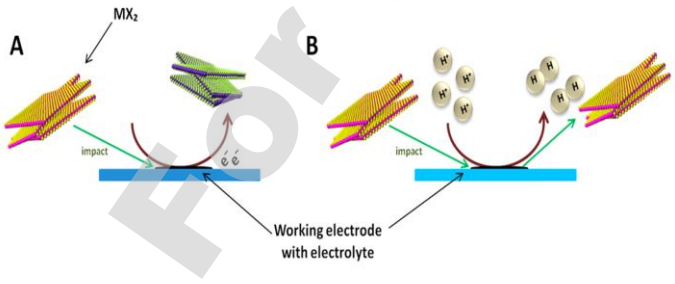

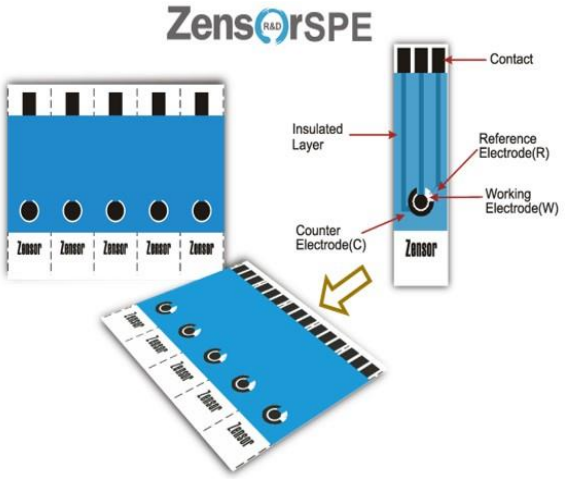

Figure 1. Schematic diagrams of (A) direct and (B) indirect voltammetry of impact nanoparticles of TMD (MX_2).

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

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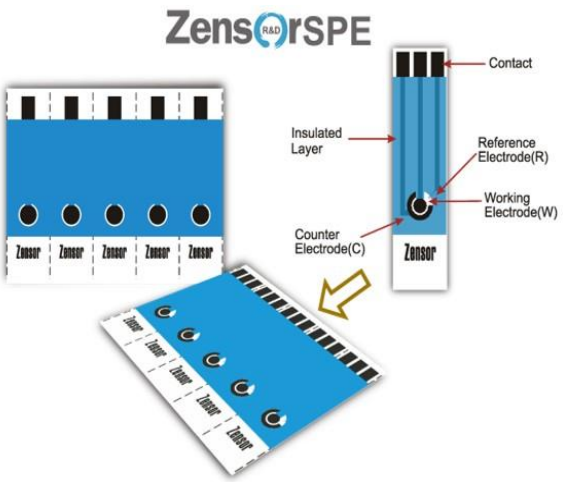
ABSTRACT

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 μA μM^{-1} 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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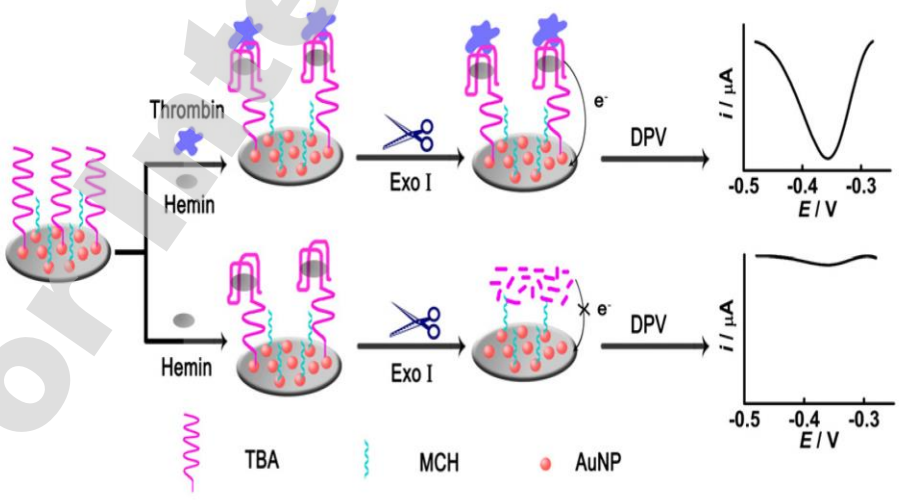
ABSTRACT

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.



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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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.

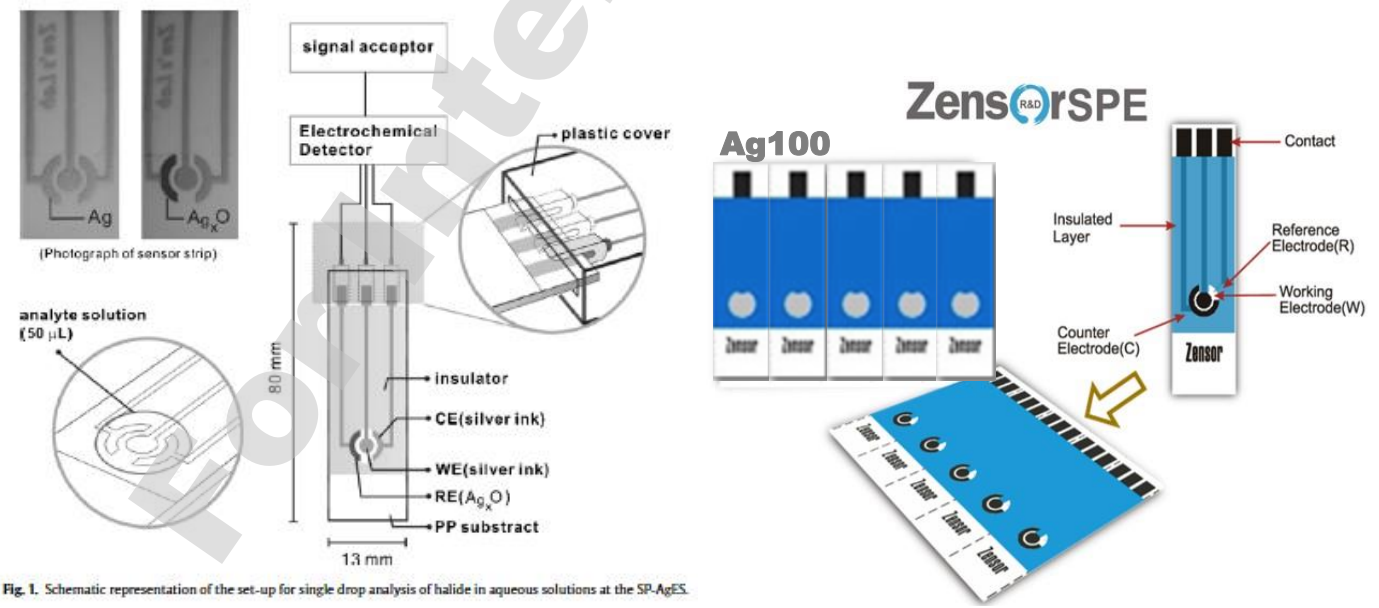

Fig. 1. Schematic representation of the set-up for single drop analysis of halide in aqueous solutions at the SP-AgES.

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