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Chemical sensor development based on poly(o-anisidine)silverized-MWCNT nanocomposites deposited glassy carbon electrodes for environmental remediation

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Abstract:

Poly(o-anisidine)/silverized multiwall carbon nanotubes (POAS–Ag/MWCNTs) nanocomposite was synthesized by adsorption between POAS and MWCNTs using solution technique. In this approached, an extended study on the potential development of chemical sensor was done with the nanocomposites, which was prepared by a simplistic and facile-route of POAS–Ag/MWCNTs composites. Here, a thin-layer of POAS–Ag/MWCNTs nanocomposites onto glassy carbon electrode (GCE) is deposited with conducting coating agents to fabricate a selective and selective 3-methoxy phenol sensor in short response time in phosphate buffer phase. The fabricated chemi-sensor is also exhibited higher sensitivity, large-dynamic concentration ranges, long-term stability, and improved electrochemical performances towards 3-methoxy phenol. The calibration plot is linear ($r^2 = 0.9938$) over the large 3-methoxy phenol concentration ranges (0.4nM to 40.0 mM). The sensitivity and detection limit is ~3.829 $\mu Acm^{-2}mM^{-1}$ and ~0.36 ±0.05 nM (signal-to-noise ratio, at a SNR of 3) respectively. This novel effort is initiated a well-organize way of efficient sensor improvement with nanocomposites for toxic pollutants in environmental and health-care fields in large scales.

Key words: POAS-Ag/MWCNTs nanocomposites; 3-methoxy phenol; I-V method, Glassy carbon electrode; Sensitivity

Introduction:

Conducting polymer coupled carbon nanotubes based nanocomposites filled with Ag-nanosized stiff particles have evolved and attracted great interests from both in industry and academia during the last decade. Performance of polymer-CNT nanocomposites strongly depends on the degree of dispersion and aspect ratio of layered materials in the CNT matrices. In particular, exfoliation of layered materials in polymer with CNT matrices has been exposed to improve the flame retardancy, optical, sensors, thermal, ion detection, rheological and mechanical properties of base conducting polymer [1,2]. Conducting polymeric CNT nanocomposite is possessed a high stability, high permeability and density, large surface area, great light scattering, and tunable particle diameter and shell thickness in comparison with the organic vesicles formed from the self-aggregation of silverized particles. Due to these characteristics, conducting polymeric nanocomposite materials can serve as micro-reaction vessels, sensitive sensors, drug delivery vehicles, biological stiff recognitions, protective shells, immunoassays, and synthetic pigments in huge industrial and academic scales [3]. The rapid development in the field of conducting organic materials has shown its potential application in sensors and electronics [4]. Two kinds of conducting materials are promising, such as conducting polymers (polypyrrole, polyaniline, polythiophene, anisidine etc.) and fullerenes (carbon nanotubes). Functional carbon nanotubes have attracted increasing attention from various research laboratories around the world because of their exceptional electronic and mechanical properties [5]. Carbon nanotubes conjugated with conducting polymers have been utilized to fabricate transistors, sensors, hydrogen storage, conductive materials, electrodes, biosensors, and field emission, which exhibit potential as the building blocks for new nanotechnologies [6-8]. Recently, conducting polymer conjugated novel metal nanocomposites offer an exciting system to examine the opportunity of designing novel device functionality [9] and also display enhanced sensing, selective [10] and catalytic capabilities, compared with those of the pure conducting polymers [11,12]. It was reported that conducting polymer novel-metal nanocomposite can be synthesized by a one step chemical oxidative polymerization using metal salt as an oxidant [13]. It was confirmed that chemical oxidative polymerization using various metal salts such as hydrogen tetrachloroaurate(III), silver nitrate ($AgNO_3$), palladium(II) chloride and hydrogen hexachloroplatinate(IV) (H_2PtCl_6), which act as both an oxidant and as a source of metal atoms, yielded well-dispersed metal nanoparticles in bulk conducting polymers. Based on the properties of nanocomposite material, it was concluded in single-step preparation route of POAS-Ag nanocomposite by chemical oxidative polymerization in aqueous media, where the composite material employed by using MWCNTs and poly(o-anisidine) followed by mixing with $AgNO_3$ resulting POAS-Ag/MWCNTs nanocomposites.

The improvement of reliable and sensitive methods was used for the detection of phenolic compounds for environmental safety, protection, food quality control, and health [14]. There are several phenolic compounds have been classified as “priority pollutants” by both the United States Environmental Protection Agency (USEPA) and the European Commission. Phenolic compounds are comparatively general in waste streams of diverse large-scale processing and manufacturing where they serve as precursor materials in various industries such as coal mining, crude oil refining, paper bleaching, and production of dyes, resins, plastics, explosives, detergents, pharmaceuticals, pesticides, and herbicides [15,16]. In difference, few phenols of plant origin have been originated to display a broad range of attractive physiological characteristics as antioxidants, anti-inflammatories, and cardiovascular prophylactics, promoting their use as additives in some alcoholic beverages and food products [17,18]. Recent determination methods such as spectro-photometry, fluorimetry, gas or liquid chromatography, mass spectrometry and capillary electrophoresis are usually perceptive and consistent but possess limitations, such as being expensive, time-consuming and requiring preconcentration and extraction steps that increase the risk of sample loss and generation of other hazardous byproducts [19]. Electrochemical sensing of phenolic compounds represents a promising approach that can be utilized to complement already existing methods owing to collective characteristics such as high sensitivity and selectivity, low cost, simple instrumentation and potential for miniaturization [20,21].

3-methoxy phenol is extremely toxic and usually serious to health and environment, it is immediately required the detection by using a reliable chemi-sensor method with POAS-Ag/MWCNTs nanocomposites using GCE. The 3-methoxy phenol by thin nanocomposite films on GCE is prepared and studied in details of the chemical sensors. The easy-coating method for the construction of POAS-Ag/MWCNTs nanocomposites thin-film within binding-agents is executed for preparation of films onto GCE. In this approach, POAS-Ag/MWCNTs nanocomposites fabricated films with conducting binders is utilized towards the target carcinogenic analytes using reliable Current-vs-Voltage method. It is confirmed that the fabricated chemi-sensor is unique and noble research work for ultra-sensitive recognition of toxic 3-methoxy phenol with POAS-Ag/MWCNTs nanocomposites onto GCE in short response-time.

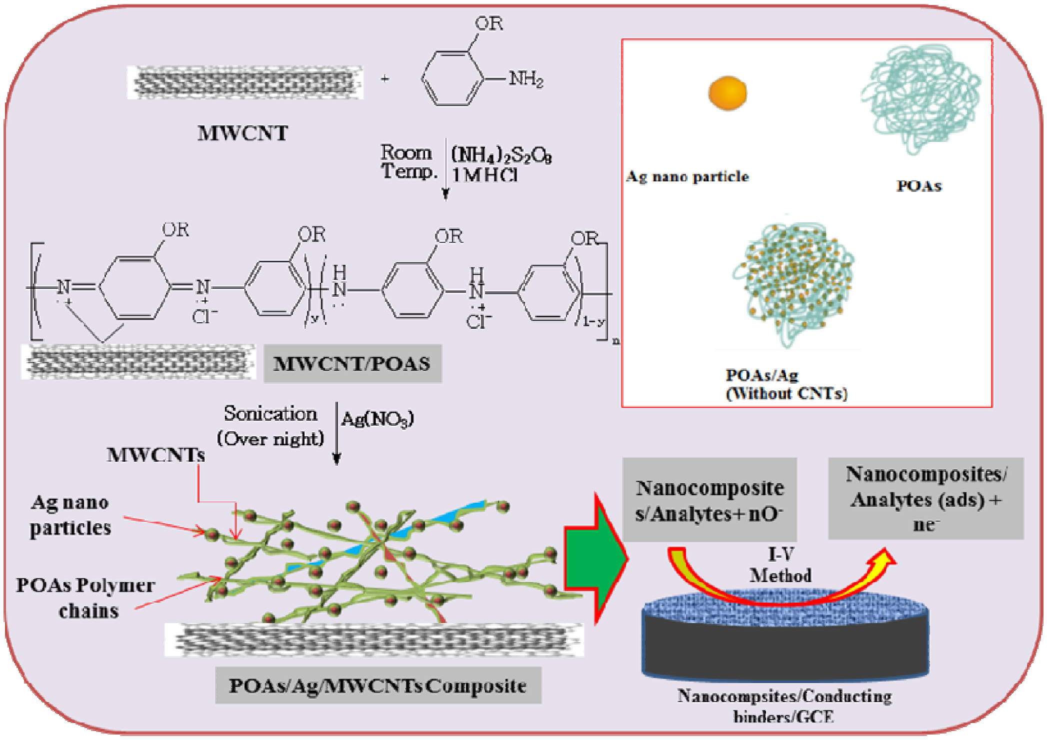
Experimental details:

Materials and Methods:

Analytical grade of 3-methoxy phenol, ethyl acetate, disodium phosphate (Na_2HPO_4), butyl carbitol acetate, and monosodium phosphate (NaH_2PO_4) was used and purchased from Sigma-Aldrich Company, USA. They were used without further purification. Stock solution of 3-methoxy phenol (0.1M) was prepared from the purchased chemical. I-V technique was executed by using Electrometer (Kethley, 6517A, Electrometer, USA) for measuring the current responses in two electrode systems for target 3-methoxy phenol chemical sensor based on POAS-Ag/MWCNTs nanocomposites in buffer phase at room conditions, where flat-GCE and Pd-wire was used as working and counter electrode respectively. The XPS measurements of Cu-GO composite materials were measured by a Thermo Scientific K-Alpha KA1066 spectrometer (Germany). Monochromatic AlKα X-ray radiation sources were used as an excitation source, where beam-spot size was kept in ~400.0 μm. The spectra were recorded with the fixed transmission mode, where pass-energy fixed at ~200.0 eV. Current-vs-voltage (I-V) method (two electrodes composed onto fabricated micro-chip) was measured for toxic 3-methoxy phenol ions for POAS-Ag/MWCNTs nanocomposites/GCE by using Keithley-Electrometer from USA.

Preparation of POAS–Ag/MWCNTs nanocomposites:

The nanocomposite was synthesized by the solution self-oxidizing technique of o-anisidine (OAS), an organic monomer mixed into the inorganic solution of silver nitrate, which was already explained in our previous study [22]. Here, when the OAS solution was added to the inorganic silver nitrate system under rigorous stirring over 24 h concurrently functionalized MWCNTs, the resultant mixture was turned slowly into brown coloured slurries and kept for 24 h at room temperature. Now the resultant composite gels were filtered off, washed thoroughly with demineralised water to remove excess acid and any adhering trace of oxidant. The washed material was dried over P4O10 at 45.0 C in an oven. The dried products were immersed in demineralised water to obtain small granules. They were converted to the H+ form by keeping them into 1.0 M HCl solution for 24 h with occasionally shaking intermittently replacing the supernatant liquid. The excess acid was removed after several washing with demineralised water. The material was finally dried at 45.0 C for several hours. Silver-metalized nanocomposite material has been prepared by the incorporation of inorganic silver nitrate in electrically conducting monomer OAS, exhibited as self-oxidizing agent. A schematic representation of the synthetic preparation, fabrication onto GCE and sensor application is presented in Scheme 1.



Scheme 1. Schematic representation of the synthetic preparation of POAS-Ag/MWCNTs, polymer-composite fabrication onto GCE, and chemical sensor applications

Preparation and fabrication of GCE with nanocomposites:

Phosphate buffer solution (PBS, 0.1 M) at pH 7.0 is prepared by mixing of equi-molar concentration of 0.2 M Na_2HPO_4 and 0.2 M NaH_2PO_4 solution in 100.0 mL de-ionize water at room conditions. GCE is fabricated with POAS-Ag/MWCNTs nanocomposites using butyl carbitol acetate (BCA) and ethyl acetate (EA) as a conducting binder. Then it is kept in the oven at 50.0 °C for 1 hour until the film is completely dried, stable, and smooth. A cell is assembled with POAS-Ag/MWCNTs nanocomposites/GCE and Pd-wire as a working and counter electrodes respectively. As received 3-methoxy phenol is diluted to make various concentrations (0.4 nM ~ 40.0 mM) in DI water and used as a target analyte. The ratio of current versus concentration (slope of calibration curve) is used to calculate the 3-methoxy phenol sensitivity. Detection limit is evaluated from the ratio of 3N/S (ratio of Noise×3 vs. Sensitivity) from the linear dynamic range of calibration curve. Electrometer is used as a constant voltage sources for I-V measurement in simple two electrode system. Amount of 0.1M PBS was kept constant in the beaker as 10.0 mL throughout the chemical investigation. The POAS-Ag/MWCNTs nanocomposites is fabricated and employed for the detection of 3-methoxy phenol in liquid phase. I-V response is measured with POAS-Ag/MWCNTs nanocomposites/GCE film.

Results and Discussions:

Characterization of nanocomposites:

The POAS-Ag/MWCNTs nanocomposites were already characterized by using TGA, FTIR, and XRD in our previous report. Here, X-ray photoelectron spectroscopy (XPS) and field-emission scanning electron microscope (FESEM) is measured and presented. Basically, XPS is a quantitative spectroscopic method that determines the elemental-composition, empirical-formula, chemical-state and electronic-state of the elements that present within materials. XPS spectra are attained by irradiating nanomaterials with a beam of X-rays, while simultaneously determining the kinetic energy and number of electrons that get-away from the top 1 to 10.0 nm of the material being analyzed. Here, XPS measurements were measured for POAS–Ag/MWCNTs nanocomposites to investigate the chemical states of carbon, oxygen, silver, and nitrogen. XPS was used to determine the chemical state of the POAS-Ag/MWCNTs nanocomposites and their depth. The full XPS spectrum of POAS–Ag/MWCNTs nanocomposites is measured and presented in Fig. 1a. In Fig. 1b, the spectra were found by the C1s peak at approximately 284.9eV for the covalent bond equivalent to C-C chain existed in MWCNT skeleton presence in POAS–Ag/MWCNTs nanocomposites [23]. The O1s spectrum shows a distinguished peak at 531.7 eV in Fig. 1c. The peak at 531.7 eV is assigned to oxygen, which indicated the presence of oxygen (ie, O_2^-) in the POAS–Ag/MWCNTs nanocomposites [24]. In Fig. 1d, the binding energy of N1s is measured as 399.8 eV for the POAS–Ag/MWCNTs nanocomposites [25]. Figure 1e presents the XPS spectra (spin-orbit doublet peaks) of the Ag3d$_{(5/2)}$ and Ag3d$_{(3/2)}$ regions recorded with POAS–Ag/MWCNTs nanocomposites. The binding energy of the Ag3d$_{(5/2)}$ and Ag3d$_{(3/2)}$ peak at 367.1 eV and 373.1 eV denotes the presence of silvermetal in the nanocomposites [26]. Therefore, it is concluded that the POAS–Ag/MWCNTs nanocomposites have three different elements.

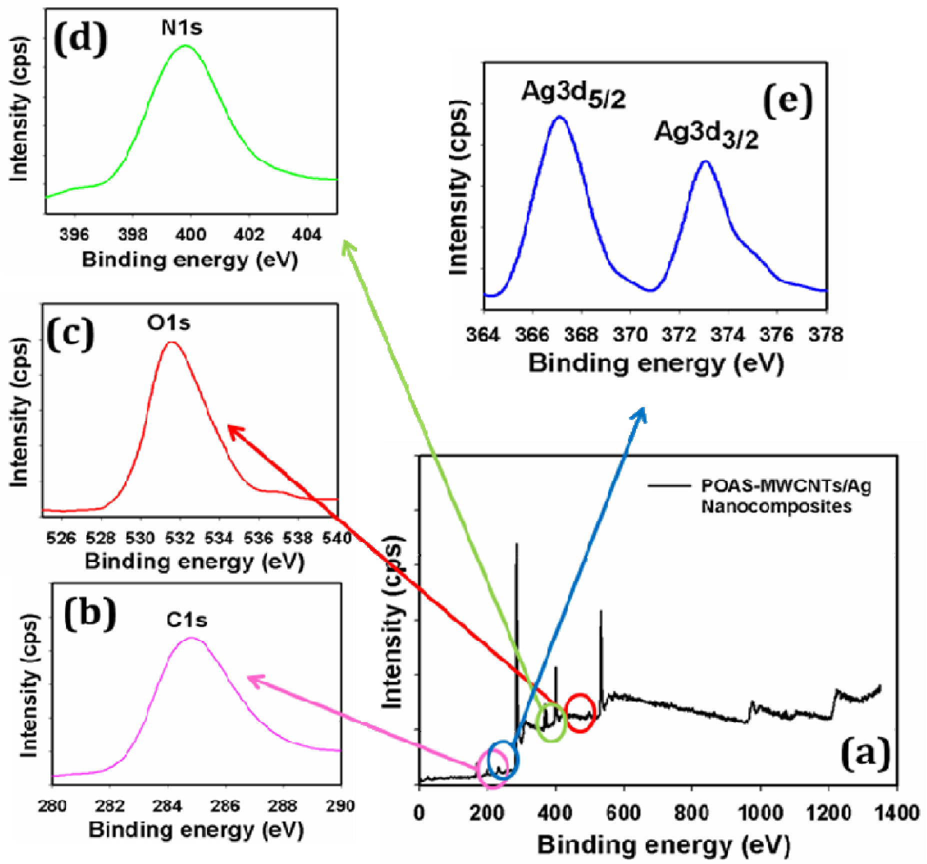


Figure 1. Study of X-ray photoelectron spectroscopy for POAS–Ag/MWCNTs nanocomposites. (a) Full spectrum of POAS–Ag/MWCNTs nanocomposites, (b) C1s level, (c) O1s level, (d) N1s level, and (e) Ag3d level of acquired with MgKα1 radiations. X-ray beam-spot size is 400.0 µm; Pass-energy is 200.0 eV; Pressures less than 10^{-8} Torr.

The FESEM was investigated the morphology and size of the particles in the hybrid nanocomposite materials that fabricated onto flat GCE electrode using conducting binders. Figure 2 exhibits the representative FESEM image of POAS–Ag/MWCNTs fabricated onto GCE. The formed aggregated silver nanoparticles are poly-dispersed and irregular morphological arrangement into the composite materials. The bright-spots shows in the FESEM image may be due the silver particles aggregation presented into the hybrid nanocomposite materials. Thus, the FESEM images exhibits the evidence for the presence of aggregated silver nanoparticles into polymer hybrid matrix with MWCNTs. Finally, it is exhibited prominently from the FESEM images that the simple methodology of synthesized hybrid products are nanostructure of POAS–Ag/MWCNTs, which exhibits in aggregated and high-density nanocomposites of polymer hybrid matrix with MWCNTs.

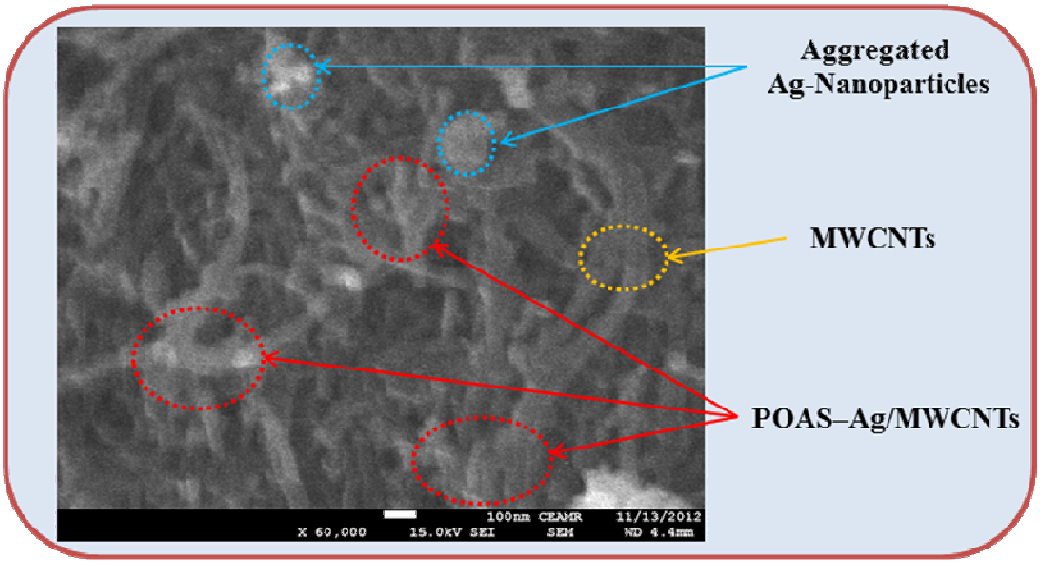
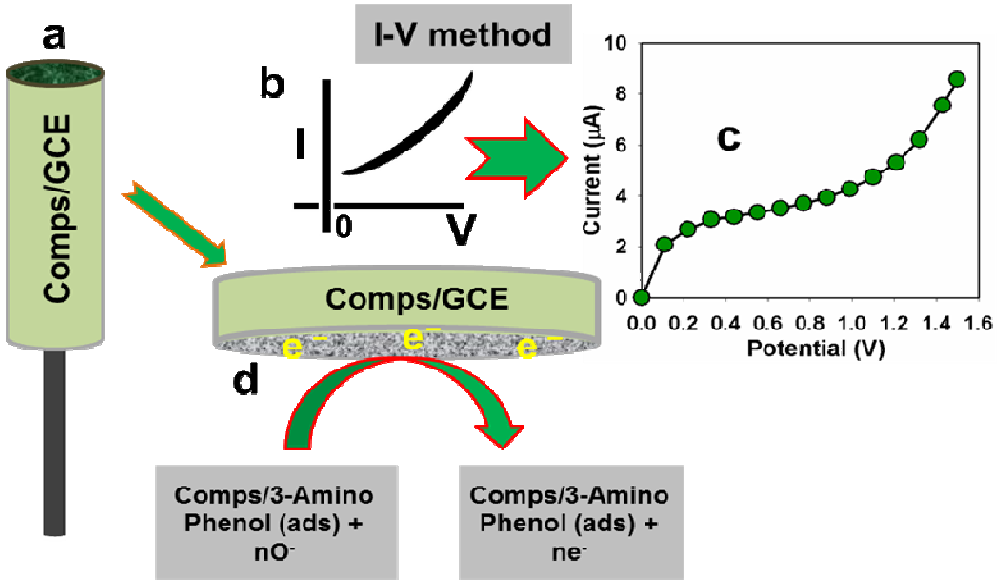


Figure 2. FESEM of POAS–Ag/MWNTs nanocomposites onto GCE electrode

Applications: Detection of 3-methoxy phenol with nanocomposites/GCE:

The potential application of POAS–Ag/MWCNTs nanocomposites assembled onto GCE as chemical sensor (especially 3-methoxy phenol analyte in buffer system) has been executed for measuring and detecting target chemical. Enhancement of the POAS–Ag/MWCNTs nanocomposites/GCE as chemical sensors is in the initial stage and no other reports are available. The POAS–Ag/MWCNTs nanocomposites/GCE sensors have advantages such as stability in air, non-toxicity, chemical inertness, electro-chemical activity, simplicity to assemble, ease in fabrication, and chemo-safe characteristics. As in the case of 3-methoxy phenol sensors, the current response in I-V method of POAS–Ag/MWCNTs nanocomposites/GCE considerably changes when aqueous phenolic analyte is adsorbed. The POAS–Ag/MWCNTs nanocomposites/GCE was applied for fabrication of chemi-sensor, where 3-methoxy phenol was measured as target analyte. The fabricated-surface of POAS–Ag/MWCNTs nanocomposites sensor was prepared with conducting binders (EC & BCA) on the GCE surface, which is presented in the Scheme 2a. The fabricated GCE electrode was put into the oven at low temperature (60.0 ^{o}C) for 2.0 hrs to make it dry, stable, and uniform the surface totally. I-V signals (Scheme 2b) of 3-methoxy phenol chemical sensor are anticipated having POAS–Ag/MWCNTs nanocomposites/GCE on thin-film as a function of current versus potential. The resultant electrical responses of target 3-methoxy phenol are investigated by simple and reliable I-V technique using POAS–Ag/MWCNTs nanocomposites/GCE, which is presented in Scheme 2c. The holding time of electrometer was set for 1.0 sec. A significant amplification in the current response with applied potential is noticeably confirmed. The simple and possible reaction mechanism is generalized in Scheme 2d in presence of 3-methoxy phenol on POAS–Ag/MWCNTs nanocomposites/GCE sensor surfaces by I-V method. In presence of POAS–Ag/MWCNTs nanocomposites, the electrons are released in presence of 3-methoxy phenol by adsorbing reduced oxygen, which improved and enhanced the current responses against potential during the I-V measurement at room conditions.



Scheme 2. Schematic view of (a) POAS–Ag/MWCNTs nanocomposites coated GCE with conducting coating binders, (b) detection I-V method (theoretical), (c) observed I-V responses by POAS–Ag/MWCNTs nanocomposites/GCE, and (d) proposed adsorption mechanisms of 3-methoxy phenol detection in presence of POAS–Ag/MWCNTs nanocomposites onto flat-GCE. Surface area of GCE: 0.0316 cm^2; Method: I-V. Delay time: 1.0 s

The POAS–Ag/MWCNTs nanocomposites were employed for the detection of 3-methoxy phenol in liquid phase. I-V responses were measured with POAS–Ag/MWCNTs nanocomposites coated thin-film (in two electrodes system). In experimental section, it was already outlined the 3-methoxy phenol sensing protocol using the POAS–Ag/MWCNTs nanocomposites/GCE modified electrode. The concentration of 3-methoxy phenol was varied from 0.4 nM to 40.0 mM by adding de-ionized water at different proportions. It is studied the control experiment about the uncoated and nanocomposites-coated electrode using I-V method and presented in Figure 3. Here, Fig. 3(a) is represented the I-V responses for uncoated-GCE (gray-dotted) and POAS–MWCNTs/Ag-nanocomposites-coated-GCE (orange-dotted) electrodes. In PBS system, the POAS–Ag/MWCNTs nanocomposites/GCE electrode shows that the reaction is reduced slightly owing to the presence of nanocomposites on bare-GCE surface. A considerable enhancement of current value with applied potential is demonstrated with fabricated POAS–Ag/MWCNTs nanocomposites/GCE in presence of target 3-methoxy phenol analyte, which is presented in Fig. 3(b). The orange-dotted and red-dotted curves were indicated the response of the fabricated film after and injecting 25.0 μL 3-methoxy phenol in 10.0 mL PBS solution respectively measured by fabricated POAS–Ag/MWCNTs nanocomposites/GCE films. Significant increases of current are measured after injection of target component in regular interval.

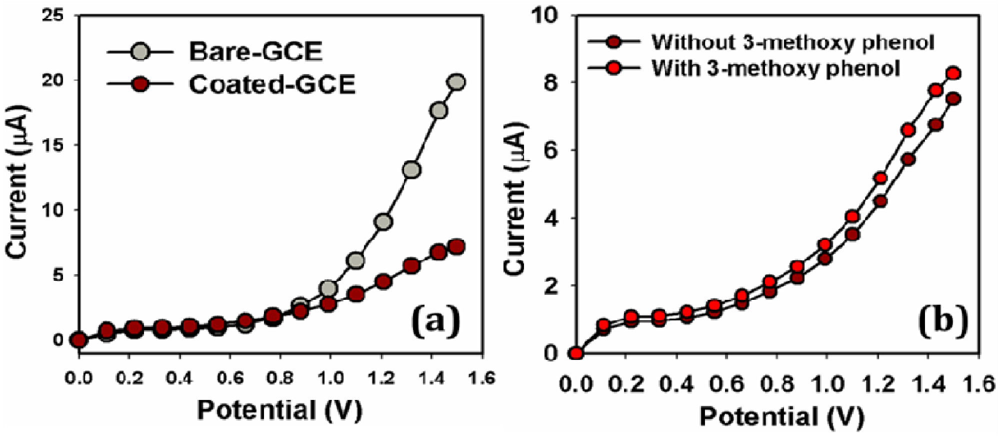


Figure 3. Study of control experiment. I-V responses of (a) GCE (without nanocomposites) and nanocomposites/GCE (with POAS–Ag/MWCNTs nanocomposites); (b) Nanocomposites/GCE (in absence) and 3-methoxy phenol /nanocomposites/GCE (in presence) of 3-methoxy phenol in the solution system.

I-V responses to varying 3-methoxy phenol concentration (0.4 nM to 40.0 mM) on thin POAS–Ag/MWCNTs nanocomposites/GCE were investigated (time delaying, 1.0 sec) and presented in the Fig. 4(a). Analytical parameters (such as sensitivity, detection limit, linearity, and linear dynamic range etc) were calculated from the calibration curve (current vs. concentration), which was presented in Fig. 4(b). A wide range of 3-methoxy phenol concentration was selected to study the possible detection limit (from calibration curve), which was examined in 0.4 nM to 40.0 mM. The sensitivity was calculated from the calibration curve, which was close to ~3.829 μAcm^{-2}mM^{-1}. The linear dynamic range of the POAS–Ag/MWCNTs nanocomposites/GCE sensor was employed from 0.4 nM to 0.4 mM (linearly, r^2=0.9938), where the detection limit was calculated about ~0.36 ±0.05 nM (ratio, $^{3N}/_{S}$). The POAS–Ag/MWCNTs nanocomposites/GCE was exhibited mesoporous behaviours, where the electrical resistance decreases under the presence of target 3-methoxy phenol in PBS phase. The film resistance was decreased gradually (increasing the resultant current) upon increasing the 3-methoxy phenol concentration in bulk system.

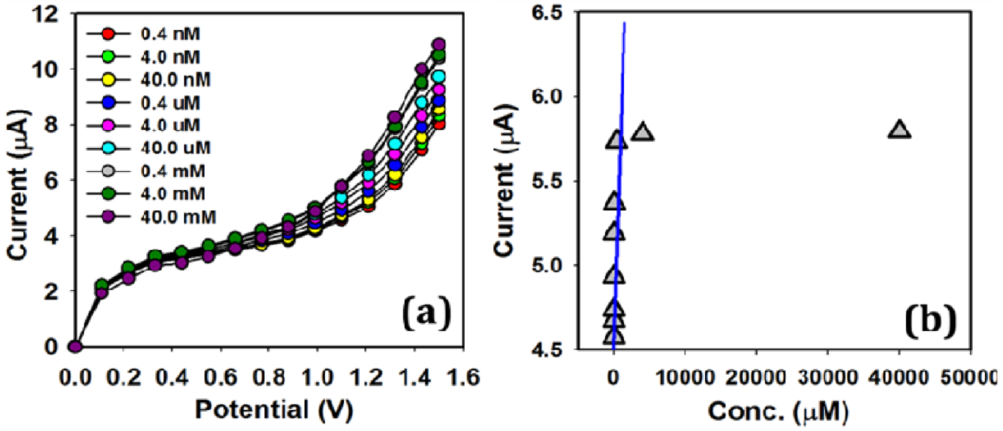


Figure 4. Analysis of chemical responses. I-V responses of (a) concentration variations (0.4 nM ~ 40.0 mM) of 3-methoxy phenol , (b) calibration plot of POAS–Ag/MWCNTs nanocomposites fabricated GCE electrode (at +0.5V).

In two-electrode system, I-V characteristic of the POAS–Ag/MWCNTs nanocomposites/GCE is activated as a function of 3-methoxy phenol concentration at room conditions, where improved current response is observed. As obtained, the current response of the POAS–Ag/MWCNTs nanocomposites-film is increased with the increasing concentration of 3-methoxy phenol; however similar phenomena for toxic chemical detection have also been reported earlier [27-31]. For a low concentration of 3-methoxy phenol in liquid medium, there is a smaller surface coverage of 3-methoxy phenol molecules on POAS–Ag/MWCNTs nanocomposites/GCE film and hence the surface reaction proceeds steadily. By increasing the 3-methoxy phenol concentration, the surface reaction is increased significantly (gradually increased the response as well) owing to large surface area contacted with 3-methoxy phenol molecules. Further increase of 3-methoxy phenol concentration on POAS–Ag/MWCNTs nanocomposites/GCE surface (measoporous), it is exhibited a more rapid increased the current responses, due to larger surface covered by 3-methoxy phenol chemical. Usually, the surface coverage of 3-methoxy phenol molecules on POAS–Ag/MWCNTs nanocomposites/GCE surface is reached to saturation, based on the regular enhancement of current responses.

Selectivity was studied for 3-methoxy phenol sensor in presence other chemicals like acetaldehyde, hydrazine, methanol, 3-methoxy phenol, dichloromethane, tetrahydrofuran, acetone, pyridine, phenol, ethanol, n-Hexane, and blank (only buffer) using the POAS–Ag/MWCNTs nanocomposites/GCE, which is presented in Figure 5(a). The concentrations of all analytes are kept constant at 0.1µM level in PBS system. From the current response of each individual analytes, it is calculated the percentile of responses at +0.5V of acetaldehyde (1.41%), hydrazine (2.78%), methanol (2.20%), 3-methoxy phenol (80.37%), dichloromethane (0.74%), tetrahydrofuran (4.6%), acetone (2.57%), pyridine (3.38%), ethanol (2.81%), n-Hexane (0.50%), phenol (4.8%), and blank (0%) with POAS–Ag/MWCNTs nanocomposites/GCE sensors. Here, it is clearly demonstrated the POAS–Ag/MWCNTs nanocomposites/GCE electrode sensor is most selective toward 3-methoxy phenol (80.3%) compared with other chemicals, which is presented in Figure 5(b).

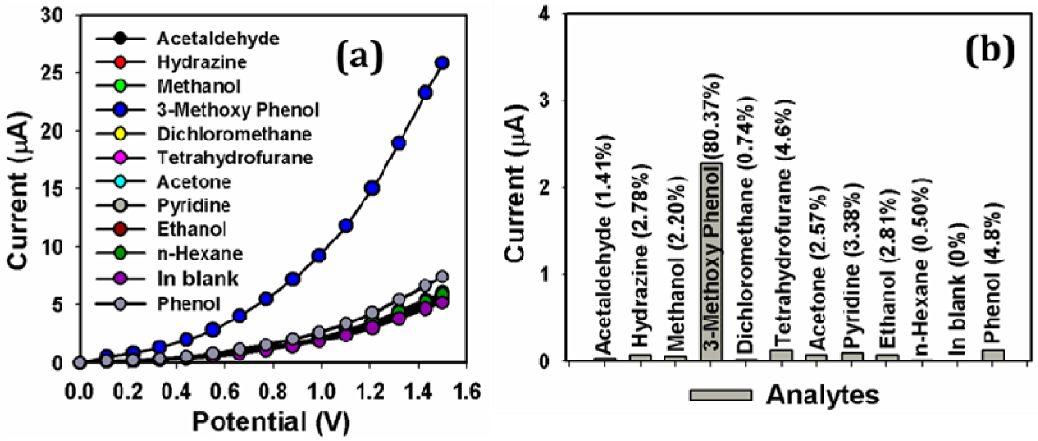


Figure 5. **Selectivity study with analytes by POAS–Ag/MWCNTs nanocomposites/GCE electrodes**. (a) I-V responses of various analytes and (b) Current responses in percentile of analytes at +0.5V (3-methoxy phenol); Analyte concentration was taken at 0.1µM. Potential range: 0 to +1.5V; Delay time: 1.0 sec.

To check the reproducibly and storage stabilities, I-V response for POAS–Ag/MWCNTs nanocomposites/GCE sensor was examined and presented in Figure 6(a). After each experiment (each runs), the fabricated POAS–Ag/MWCNTs nanocomposites/GCE substrate was washed thoroughly with the phosphate buffer solution and observed that the current response was not significantly decreased. The current loss in each experiment is calculated and presented in the Figure 6(b). Here it is observed the current loss in each reading is negligible compared to initial response of sensors using POAS–Ag/MWCNTs nanocomposites/GCE. A series of six successive measurements of 0.1µM 3-methoxy phenol in 0.1 M PBS yielded a good reproducible signal at POAS–Ag/MWCNTs nanocomposites/GCE sensor with a relative standard deviation (RSD) of 2.1%. The sensitivity was retained almost same of initial sensitivity up to seven days, after that the response of the fabricated POAS–Ag/MWCNTs nanocomposites/GCE electrode gradually decreased. The 3-methoxy phenol chemical sensor based on POAS–Ag/MWCNTs nanocomposites/GCE is displayed good reproducibility and stability for over week and no major changes in sensor responses are found. After a week, the chemical sensor response with POAS–Ag/MWCNTs nanocomposites/GCE was slowly decreased, which may be due to the weak-interaction between fabricated POAS–Ag/MWCNTs nanocomposites/GCE active surfaces and 3-methoxy phenol chemical.

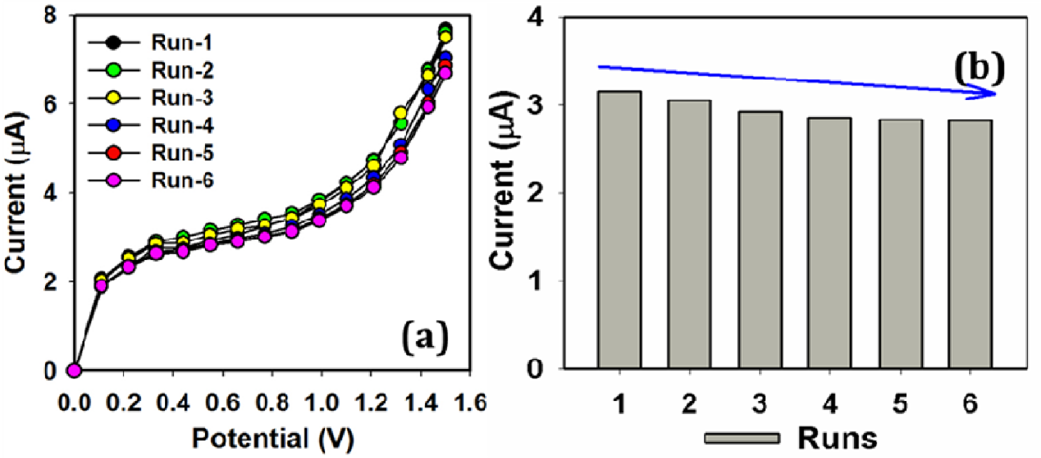


Figure 6. **Reproducibility study with analytes (0.1µM) using POAS–Ag/MWCNTs nanocomposites/GCE electrodes.** (a) I-V responses of all reproducible signals (Run-1 to Run-6) with 3-methoxy phenol, and (b) Current responses of analyte at +0.5V (3-methoxy phenol); Analyte concentration was taken at 0.1µM. Potential range: 0 to +1.5V; Delay time: 1.0 sec

The significant result was achieved by POAS–Ag/MWCNTs nanocomposites/GCE, which can be employed as proficient electron mediators for the development of efficient chemical sensors. Actually the response time was around 10.0 sec for the fabricated POAS–Ag/MWCNTs nanocomposites/GCE to reach the saturated steady-state level. The higher sensitivity of the fabricated POAS–Ag/MWCNTs nanocomposites/GCE could be attributed to the excellent absorption (porous surfaces in POAS–Ag/MWCNTs nanocomposites/binders/GCE) and adsorption ability, high catalytic-decomposition activity, and good biocompatibility of the POAS–Ag/MWCNTs nanocomposites. The estimated sensitivity of the fabricated sensor is relatively higher and detection limit is comparatively lower than previously reported chemical sensors based on other nano-composites or nano-materials modified electrodes measured by I-V systems [32-35]. Due to high specific surface area, POAS–Ag/MWCNTs nanocomposites provides a favourable nano-environment for the 3-methoxy phenol detection with good quantity. The high sensitivity of POAS–Ag/MWCNTs nanocomposites/GCE provides high electron communication features which enhanced the direct electron transfer between the active sites of POAS–Ag/MWCNTs nanocomposites and coated-GCE. The POAS–Ag/MWCNTs nanocomposites/GCE system is demonstrated a simple and reliable approach for the detection of toxic chemicals. It is also revealed that the significant access to a large group of chemicals for wide-range of ecological and biomedical applications in environmental and health-care fields respectively.

Conclusion:

The POAS–Ag/MWCNTs nanocomposites has been prepared using simple adsorption technique and sensor fabricated with the conducting coating binders onto flat glassy carbon electrodes, which displayed higher sensitivity and selective for chemical sensing applications. The analytical performances of the fabricated 3-methoxy phenol sensors are excellent in terms of sensitivity, detection limit, linear dynamic ranges, selectivity, and in short response time. POAS–Ag/MWCNTs nanocomposites/GCE assembly is exhibited higher-sensitivity (~3.829 $\mu Acm^{-2}mM^{-1}$) and lower-detection limit (~0.36±0.05 nM) with good linearity in short response time, which efficiently utilized as chemi-sensor for 3-methoxy phenol onto POAS–Ag/MWCNTs nanocomposites/GCE. This novel approach is introduced a well-organized route of efficient chemical sensor development for environmental pollutants and health-care fields in broad scale.

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