Graphene-PEDOT:PSS modified Screen Printed Carbon Electrode for Electrochemical Sensing

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Graphene is an ideal material for electrochemistry because of its very large two-dimensional electrical conductivity, excellent electron transfer rate, huge specific surface area and low cost. In addition, it is considered a more practical electrode material than carbon nanotubes (CNTs) counterpart because it can be cheaply produced from low cost graphite with no metallic impurity [1-2].

In this work, a electrochemically synthesized graphene-PEDOT:PSS (GP-PEDOT:PSS) is presented as a new electroactive material that is utilized for the first time to modify screen printed carbon paste electrode (SPCE) by inkjet printing technique. The electrochemical characteristics of the inkjet printed SPCE electrode is characterized by cyclic voltammetry (CV) for detection of salbutamol.

Two graphite rods were placed in an electrolysis cell filled with the PEDOT:PSS electrolyte and a constant potential of 8 V was applied between electrodes for 5 hours to obtain stable GP-PEDOT:PSS dispersion with intended graphene concentrations. The dispersed product was centrifuged at 1200 rpm to separate large agglomerates and supernatant portion of the dispersion was then decanted. The GP-PEDOT:PSS solution was used as an ink for inkjet printing on SPCE by the commercial Dimatrix material inkjet printer. Five layers of GP-PEDOT:PSS material were coated over 3x5 mm^2 electrode area. The surface morphologies of fabricated electrochemical electrodes were examined by SEM (Fig. 1). It is seen that uncoated SPCE electrode has rough surface with large grain size of several microns and surface becomes smoothen after inkjet printing with PEDOT:PSS or GP-PEDOT:PSS.

Cyclic voltammetric response of GP-PEDOT:PSS modified SPCE electrode in 1 mM salbutamol solution was compared to those of PEDOT:PSS modified and unmodified SPCE electrodes as shown in Fig. 2. It is found that the oxidation peak amplitudes of PEDOT:PSS modified and GP-PEDOT:PSS modified SPCE electrodes are approximately 30 and 150 times higher than that of unmodified SPCE electrode, respectively. The dramatic enhancement can be attributed to huge reactive surface area, high electronic conductivity and excellent electron transfer rate of graphene and PEDOT:PSS. Cyclic voltammetric responses of electrodes with different numbers of inkjet printing GP-PEDOT:PSS layers are shown Fig. 3 (a). It can be seen that the oxidation peak of salbutamol is considerably affected by the number of inkjet printing layers. The oxidation peak amplitude is then plotted as a function of number of inkjet printing layers as shown in Fig. 3 (b). It is evident that the current amplitude initially increases as the number of layers increases from 1 to 4 and then begins to decrease. Hence, the optimal number of printing layers is 4. From concentration depedent study, good analytical features with wide dynamic working range of more than 500 µM and low detection limit (3S/N) of 1.25 µM are obtained. Therefore, electrode based on inkjet printed GP-PEDOT:PSS layer is a promising candidate for advanced electrochemical sensing applications.

References

[1] Alwarappan, S.; Erdem, A.; Liu, C.; Li, C.-Z. J. Phys. Chem. C 2009, 113, 8853

[2] Pumera, M.; Ambrosi, A.; Bonanni, A.; Chng, E.L.K. Poh, H. L., Trends. Anal. Chem. 2010, 29, 954.

Figures

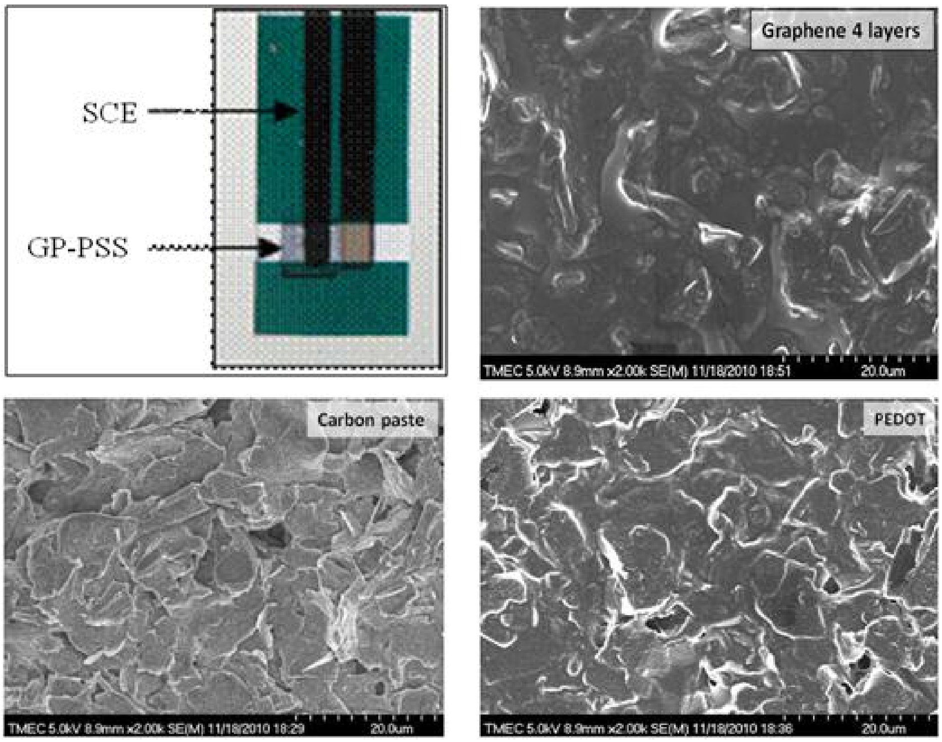

Fig. 1 Photograph of fabricated electrode and SEM micrographs of SPCE electrode, inkjet printed PEDOT:PSS on SPCE electrode and printed GP-PEDOT:PSS on SPCE electrode.

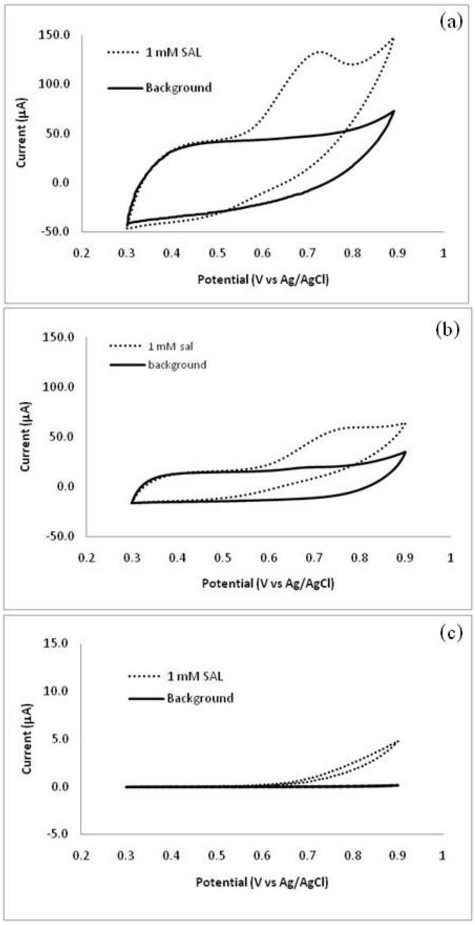

Fig. 2 The oxidation of 1 mM salbutamol on (a) GP-PEDOT:PSS and (b) PEDOT electrode and (c) SPCE electrode. Scan rate was 100mVs−1. 50 mM PBS: pH 7.0.

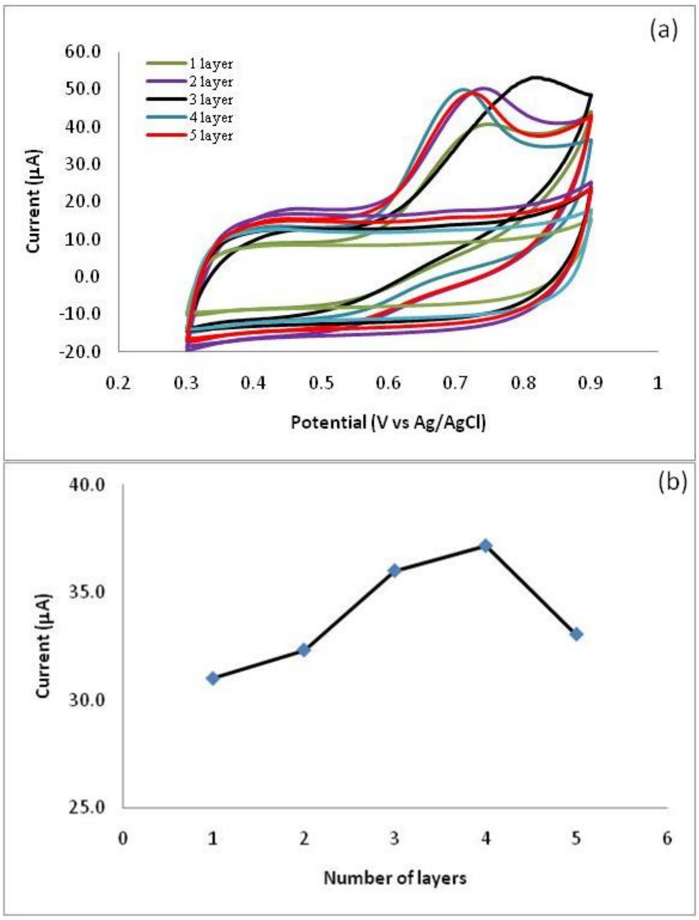

Fig. 3 (a) Cyclic voltammograms obtained at various number of printed GP-PEDOT:PSS layers on SPCE electrode. (b) Relationship between current response and number of GP-PEDOT:PSS layers. Scan rate was 100mVs−1. 50 mM PBS: pH 7.0.