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An electrochemical sensor based on poly (solochrome dark blue) film coated electrode for the determination of dopamine and simultaneous separation in the presence of uric acid and ascorbic acid: A voltammetric method

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Abstract

In this paper, the carbon paste electrode (CPE) was modified with poly- Solochrome dark blue (poly-SDB), through polymerization process, and it was used for the sensitive and selective determination of dopamine (DA). The simultaneous determination of Dopamine (DA) Ascorbic acid (AA) and Uric acid (UA) in 0.1 M Phosphate buffer solution (PBS) of pH 6.0 was carried out by employing differential pulse voltammetric technique (DPV). The effect of pH, concentration, scan rate, accumulation time, repetability and reproducibility of DA was studied at poly-SDB film modified electrode. The poly-SDBCPE exhibited a strong electrocatalytic action toward the oxidation of DA, AA and UA. The overlapping voltammetric response of biomolecules separated in to three well defined peaks with lower oxidation potential and significant increase in the anodic peak currents in the presence of poly-SDBCPE was achieved. The results showed a good sensitivity, selectivity and high reproducibility of electro synthesized polymer electrode. The limit of detection, limit of quantification and correlation coefficient of DA at poly-SDBCPE was 0.8 μM, 2.8 μM and 0.99765 respectively. The effect of interference was studied by DPV technique. The developed modified electrode was used for the analysis of DA in pharmaceutical formulations with satisfactory results. The interfacial electron transfer behavior of DA was studied by electrochemical impedance spectroscopy (EIS) and results showed that the charge transfer rate was enhanced at poly- SDBCPE, when compared with bare CPE, glassy carbon electrode (GCE) and platinum electrode (Pt).

(a) Proton/electron transfer mechanism of solochrome dark blue. (b) The electrode mechanism of poly SDB CPE toward DA.

Figure options

Fig. 1.

(A) Cyclic voltammograms for the electrochemical polymerization of solochrome dark blue at CPE in 0.1 M PBS of pH 7.0 at the scan rate of 100 mV s^{-1}. Inset plot of no. of polymerization cycles Vs peak currents.

Figure options

Fig. 2.

(A) Cyclic voltammograms for the electrochemical response of 2×10^{-4} M DA at bare CPE (solidline) and poly-SDBCPE (dotted line) in 0.1 M PBS (pH 6.0) at scan rate of 100 mV s^{-1}. (B) Differential pulse voltammograms obtained at poly-SDBCPE in 0.1 M PBS solution in different pH values of (a) 4.5, (b) 5.0, (c) 6.0, (d) 7.0, (e) 8.0, (f) 9.0, (g) 10.0.

Figure options

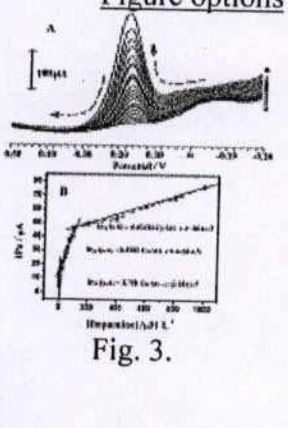

Fig. 3.

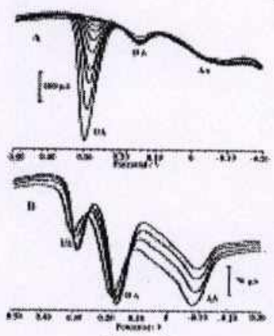

Fig. 6.

(A) Differential pulse voltammograms of (a) 9×10^{-6} M, (b) 2×10^{-5} M, (c) 4×10^{-5} M, (d) 8×10^{-5} M, (e) 1.2×10^{-4} M, (f) 1.6×10^{-4} M, (g) 2×10^{-4} M, (h) 2.6×10^{-4} M, (i) 3.0×10^{-4} M, (j) 4.0×10^{-4} M of UA in PBS pH 6.0 in the presence of 2×10^{-5} M DA and 4×10^{-5} M AA at poly- SDBCPE. (B) Differential pulse voltammograms of (a) 5×10^{-4} M, (b) 1.0×10^{-3} M, (c) 2×10^{-3} M, (d) 4×10^{-3} M of AA in PBS pH 6.0 in the presence of 4×10^{-5} M DA and 4×10^{-5} M UA at poly- SDBCPE.

Figure options

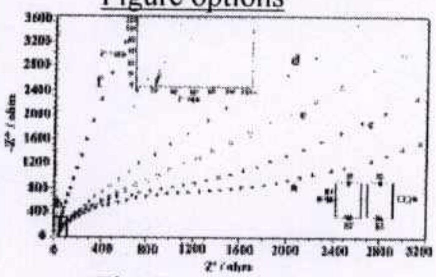

Fig. 7.

EIS spectrum 0.1 M PBS pH (6.0)/1 mM $K_3[Fe(CN)_6]/K_4[Fe(CN)_6]$/2 × 10^{-4} M DA. (a) Bare CPE, (b) poly-SDBCPE, (c) Bare GCE, (d) poly-SDB/GCE, (e) Bare Pt, (f) poly-SDB/Pt, inset equivalent circuit at poly-SDBCPE.

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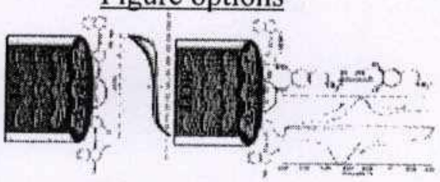


Figure options

Table 1.

Detection of DA in injection samples ($n = 4$).

Graphical abstract

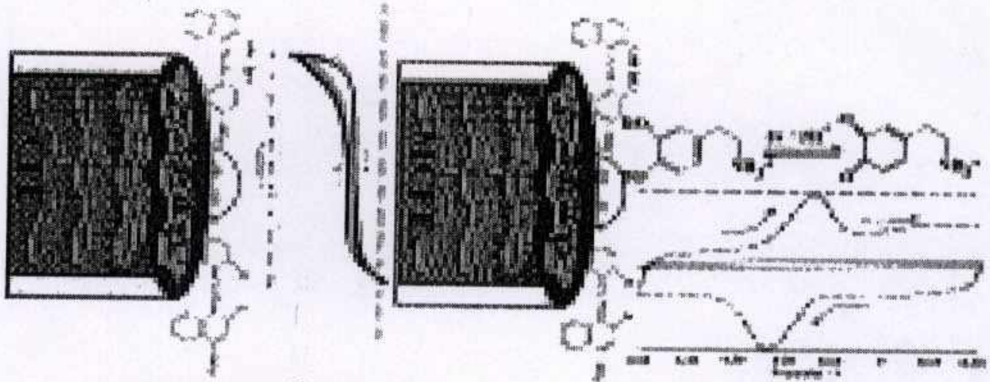


Figure options

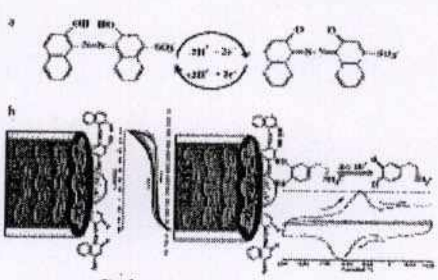
Highlights

► A simple procedure for the fabrication of poly- SDBCPE. ► CPE modified with SDB was of high sensitive and selective in determining DA. ► Poly-SDBCPE exhibited good reproducibility, stability and low detection limit. ► Poly-SDBCPE was applied for determination of AA and UA in the presence of DA. ► Poly-SDBCPE was useful in determining DA in pharmaceutical formulations.

Keywords

- Dopamine;
- Poly-Solochrome dark blue;
- Pharmaceutical formulations;
- Cyclic voltammetry;
- Differential pulse voltammetry;
- Electrochemical impedance spectroscopy

Figures and tables from this article:



Scheme 1.

(A) A differential pulse voltammograms of DA for the different concentrations (a) 5×10^{-6} M, (b) 6×10^{-6} M, (c) 7.0×10^{-6} M, (d) 8×10^{-6} M, (e) 9×10^{-6} M, (f) 1×10^{-5} M, (g) 2×10^{-5} M, (h) 3×10^{-5} M, (i) 4×10^{-5} M, (j) 5×10^{-5} M, (k) 6×10^{-5} M, (l) 7×10^{-5} M, (m) 8×10^{-5} M, (n) 9×10^{-5} M, (o) 1×10^{-4} M, (p) 2×10^{-4} M, (q) 4×10^{-4} M, (r) 6×10^{-4} M, (s) 8×10^{-4} M, (t) 1×10^{-3} M, (u) 5×10^{-3}. (B) Calibration plot of DA concentration.

Figure options

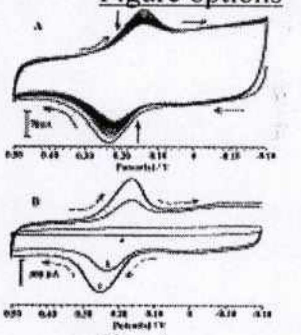


Fig. 4.

(A) Cyclic voltammograms for 20 multiple cycle of 2×10^{-4} M DA in 0.1 M PBS solution of pH 6.0 at a scan rate of 100 mV s^{-1}. (B) Cyclic voltammogram for the electrochemical response of 2×10^{-4} M DA at bare CPE (a), poly-SDBCPE (b) and poly-SDBCPE/SDS (c) in 0.1 M PBS pH (6.0) at scan rate of 100 mV s^{-1}.

Figure options

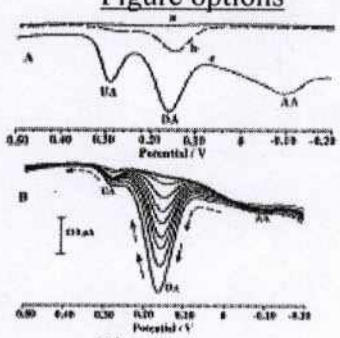


Fig. 5.

(A) Differential pulse voltammetric curve for simultaneous determination of the 4.0×10^{-5} M DA, 5×10^{-4} M AA and 5×10^{-4} M UA, at poly–SDBCPE (solid line) and at bare CPE (dotted line). (B) Differential pulse voltammograms of (a) 9×10^{-6} M, (b) 1×10^{-5} M, (c) 2×10^{-5} M, (d) 4×10^{-5} M, (e) 6×10^{-5} M, (f) 8×10^{-5} M, (g) 1×10^{-4} M, (h) 1.2×10^{-4} M, (i) 1.6×10^{-4} M, (j) 2.0×10^{-4} M of DA in PBS pH 6.0 in the presence of 2×10^{-5} M AA and 4×10^{-5} M UA at poly- SDBCPE.

Figure options