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## Application of commercial poly(3,4-ethylenedioxy-thiophene):poly(styrene sulfonate) for electrochemical sensing of dopamine

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**Abstract:** In this paper, a simple and stable composite electrode based on the intrinsically conducting polymer poly(3,4-ethylenedioxythiophene):poly(styrene sulfonate) (PEDOT:PSS) and Nafion<sup>®</sup>, an ion-exchange polymer, was successfully fabricated by drop-coating the blended commercially available PEDOT:PSS aqueous dispersion and Nafion<sup>®</sup> solution on the surface of a glassy carbon electrode (GCE). PEDOT:PSS was used as the matrix, while Nafion<sup>®</sup> was employed to improve the immobilization stability of the composite films and adhesion to the electrode surface in comparison with PEDOT:PSS films. Cyclic voltammetry, differential pulse voltammetry, electrochemical impedance spectroscopy and scanning electron microscopy were utilized to characterize the properties of this composite electrode. The as-proposed composite electrode displayed good water-stability. Meanwhile, the composite electrode was applied to electrochemical sensing of dopamine, and the performance of PEDOT:PSS–Nafion<sup>®</sup> composite film was evaluated. The obtained results demonstrated that PEDOT:PSS–Nafion<sup>®</sup> composites are promising candidates for modification of electrode material used in electrochemical sensing and other electrocatalytic applications.

**Keywords:** PEDOT:PSS; Nafion<sup>®</sup>; electrocatalysis; dopamine; electrochemical sensor.

### INTRODUCTION

Poly(3,4-ethylenedioxythiophene):poly(styrene sulfonate) (PEDOT:PSS), one of the most successful commercially available intrinsically conducting poly-

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mers today, has been widely used as antistatic coatings, thermoelectric materials, electrically conducting coatings, hole injection layers, conducting layers in capacitors or as transparent conducting layers in photovoltaic devices and organic light-emitting diodes.<sup>1–4</sup> PEDOT:PSS is also an attractive material to modify electrodes foreseen for electroanalysis due to its good film forming properties, high conductivity, low redox potential, excellent electrochemical, ambient and thermal stability, and good processability,<sup>5–8</sup> Unfortunately, solution-cast films of commercially available PEDOT:PSS aqueous dispersions tend to swell and disintegrate in aqueous solutions,<sup>9–11</sup> which lead to few application in the development of chemo/bio-sensing devices. Previous studies demonstrated that water-resistant and insoluble PEDOT:PSS films could be obtained through secondary doping ionic liquids,<sup>3</sup> multivalent cations,<sup>9</sup> or bis(fluorinated phenyl azide).<sup>12</sup> Thus demonstrating that application of commercially available PEDOT:PSS in the field of chemo/bio sensing could be feasible.

Nafion<sup>®</sup> is a perfluorinated sulfonated ion-exchange polymer discovered in the late 1960s by Walther Grot of DuPont.<sup>13</sup> Its unique ionic properties are the result its hydrophobic polytetrafluoroethylene backbone chain and perfluorovinyl ether groups terminated with sulfonic cation exchange sites.<sup>14–16</sup> Nafion<sup>®</sup>, due to its good biocompatibility, antifouling capacity, chemical inertness, and thermal stability, as well as high permeability to water molecules and small cations,<sup>15–21</sup> has been widely used in electrochemistry to modify electrodes. Moreover, mixing Nafion<sup>®</sup> with other materials can improve the interface adhesion between films and electrodes.<sup>22,23</sup>

Dopamine (DA), one of the most important neurotransmitter in mammalian brain tissues, plays a significant role in the functioning of the central renal, nervous, hormonal and cardiovascular systems.<sup>24,25</sup> Deficiency of DA could be implicated in several diseases and neurological disorders, such as schizophrenia, depression, Huntington's disease, Parkinson's disease and HIV infection.<sup>25–28</sup> Thus, monitoring the concentration fluctuations of DA is of great importance. Among various methods that have been exploited for the determination of DA, electrochemical techniques<sup>7,29</sup> have been proven to be rapid, simple, sensitive, selective, and effective analytical methods. Recently, many materials have been used to fabricate modified electrode for the determination of DA, such as mesoporous silica,<sup>25</sup> carbon nanotubes<sup>27,28</sup> and gold nanoparticles.<sup>29</sup> However, hitherto, the electrochemical determination of DA using the commercially available intrinsically conducting polymer PEDOT:PSS has not been reported.

In this work, another strategy was adopted by directly introducing the ion-exchange polymer Nafion<sup>®</sup> to increase the hydrophobicity of PEDOT:PSS films, thereby a simple and water-stable PEDOT:PSS–Nafion<sup>®</sup> composite electrode was successfully fabricated using a glassy carbon electrode (GCE) drop-coated with a solution of a mixture of a commercially available water-dispersible

PEDOT:PSS polymer and the ion-exchange polymer Nafion<sup>®</sup>. The composite electrode was subsequently applied for the electrochemical sensing of dopamine. The performance of PEDOT:PSS–Nafion<sup>®</sup> composite films were evaluated.

## EXPERIMENTAL

### *Chemicals*

An aqueous dispersion (1.3 mass %) of PEDOT:PSS (Baytron P, Bayer AG, Germany) was used. Nafion<sup>®</sup> (5 mass %) was obtained from the DuPont Company (USA). Dopamine (DA) was purchased from Sigma–Aldrich (St. Louis, USA). Ascorbic acid was obtained from Bio Basic Inc. Uric acid was purchased from the Aladdin-Reagent Company (Shanghai, China). Glucose, citrate, cysteine, ethanol, sodium chloride, oxalate, disodium hydrogen phosphate dodecahydrate (Na<sub>2</sub>HPO<sub>4</sub>·12H<sub>2</sub>O) and sodium dihydrogen phosphate dihydrate (NaH<sub>2</sub>PO<sub>4</sub>·2H<sub>2</sub>O) were obtained from the Sinopharm Chemical Reagent Co., Ltd. 0.1 M Phosphate buffer solutions (PBS) (0.1 M) were prepared from stock solutions of 0.1 M NaH<sub>2</sub>PO<sub>4</sub> and 0.1 M Na<sub>2</sub>HPO<sub>4</sub>. All chemicals were of analytical grade and used as received without further purification. All solutions were prepared using deionized distilled water as solvent. Dopamine solutions were prepared immediately before use in each experiment.

### *Apparatus*

Electrochemical experiments were performed with a CHI660B electrochemical workstation (Shanghai Chenhua Instrument Company, China) and were realized in a conventional electrochemical cell containing a three-electrode arrangement at room temperature. The three-electrode cell assembly consisted of a saturated calomel electrode (SCE) reference electrode and a platinum wire counter electrode. The working electrode was a PEDOT:PSS–Nafion<sup>®</sup> composite electrode. Scanning electron microscopy (SEM) was realized with a VEGA TESCAN scanning electron microscope. The pH values were measured with a Delta 320 pH meter (Mettler-Toledo Instruments, Shanghai, China). The electrochemical impedance spectra (EIS) were recorded on an Autolab frequency response analyzer (AUT30, FRA2–Autolab, Eco Chemie, BV, Netherlands). The addition of a sample was performed with a micropipette (Dragonmed, Shanghai, China).

### *Preparation of the PEDOT:PSS–Nafion<sup>®</sup> composite electrodes*

A commercially available aqueous dispersion of PEDOT:PSS (1.3 mass %) was thoroughly stirred for 48 h at room temperature in order to be well distributed. The counter electrode was carefully polished with abrasive paper (1500 mesh), cleaned successively with water and acetone, and then air-dried. A bare glassy carbon electrode (GCE) was carefully polished subsequently with 0.05 μm alumina slurry until a mirror-shine surface was obtained and then successively sonicated in doubly distilled deionized water and ethanol. A mixture of an aqueous dispersion of PEDOT:PSS and a 5 mass % Nafion<sup>®</sup> solution at a 1:1 volume ratio was continuously stirred for 24 h at room temperature, whereby a PEDOT:PSS–Nafion<sup>®</sup> solution was obtained. A PEDOT:PSS–Nafion<sup>®</sup> composite electrode (PEDOT:PSS–Nafion<sup>®</sup>/GCE) was prepared by directly drop-coating 5 μL PEDOT:PSS–Nafion<sup>®</sup> mixture on a GCE that was then dried at room temperature under a clean environment. All the fabricated electrodes were stored at 4 °C until use. The fabrication procedure of PEDOT:PSS–Nafion<sup>®</sup>/GCE is schematically illustrated in Fig. 1.

## RESULTS AND DISCUSSION

*Surface morphology of the PEDOT:PSS–Nafion<sup>®</sup> films*

SEM was employed to investigate the surface morphology of PEDOT:PSS–Nafion<sup>®</sup> films. Compared with the regular, compact and homogeneous structure of pure PEDOT:PSS films,<sup>30</sup> the surface morphology of PEDOT:PSS–Nafion<sup>®</sup> films were found to be slightly irregular, and there were some small pore distributed relatively homogeneous (see SEM in Fig. 1), which suggested that the mixture of water-dispersible PEDOT:PSS and Nafion<sup>®</sup> had been mixed well, and the slightly rough structure may be very beneficial for the adsorption of analytes.

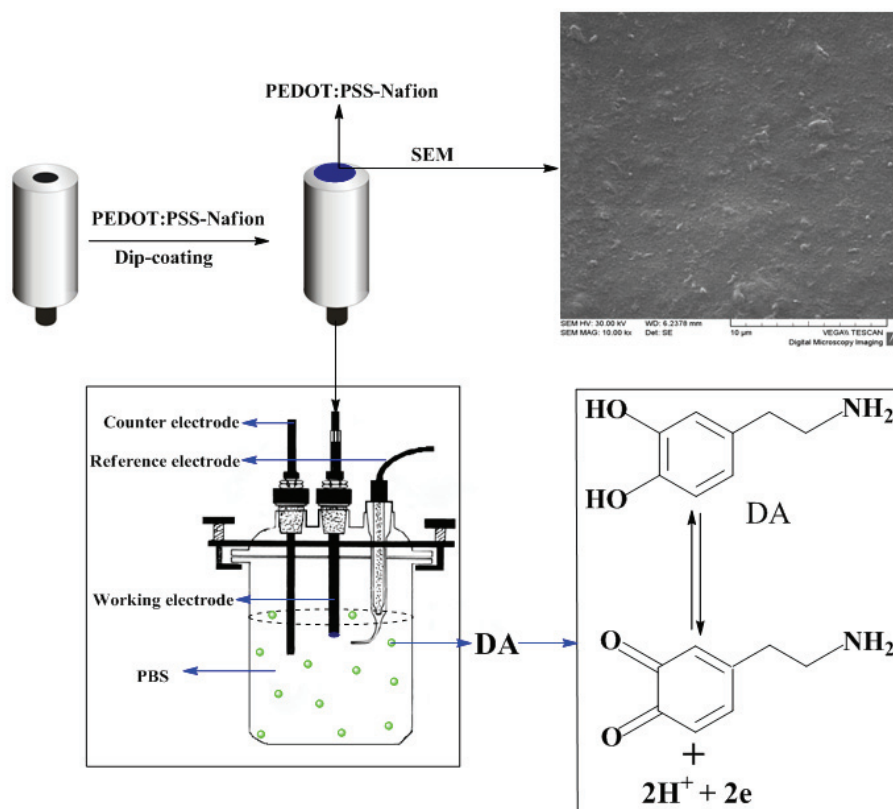


Fig. 1. The procedure for the fabrication of PEDOT:PSS–Nafion<sup>®</sup>/GCE and an SEM image of a PEDOT:PSS–Nafion<sup>®</sup> composite film.

*Electrochemical characterization of PEDOT:PSS–Nafion<sup>®</sup> films*

The cyclic voltammograms (CVs) of different electrodes in 0.1 M KCl containing 10 mM [Fe(CN)<sub>6</sub>]<sup>4-/3-</sup> as a redox couple are shown in Fig. 2A: a) bare GCE, b) PEDOT:PSS/GCE and c) PEDOT:PSS–Nafion<sup>®</sup>/GCE. All elec-

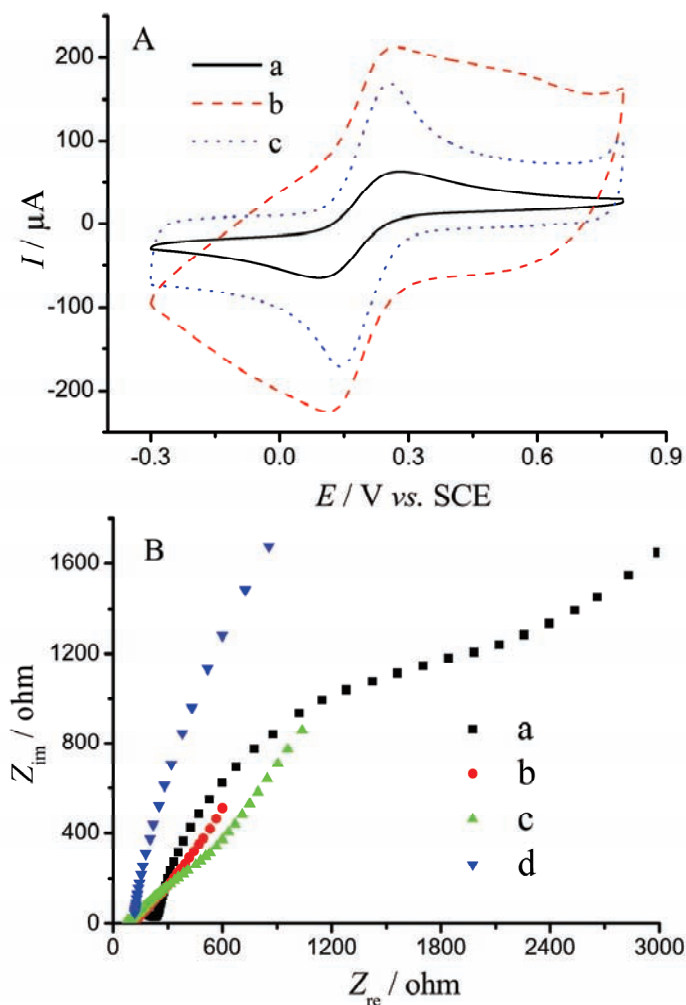


Fig. 2. A) CVs of different electrodes in a 0.1 M KCl solution containing 10 mM  $[\text{Fe}(\text{CN})_6]^{4-/3-}$ : a) bare GCE, b) PEDOT:PSS/GCE and c) PEDOT:PSS-Nafion<sup>®</sup>/GCE; Scan rate: 50 mV s<sup>-1</sup>. B) Nyquist plots of a) bare GCE, b) PEDOT:PSS/GCE, c) PEDOT:PSS-Nafion<sup>®</sup>/GCE and d) Nafion<sup>®</sup>/GCE in the same solution.

trodes showed a pair of quasi-reversible redox peaks. Although the currents of the anodic and cathodic peaks at PEDOT:PSS/GCE were higher than at the other electrodes (the electrical conductivity of pure PEDOT:PSS films was 3.380 S cm<sup>-1</sup>), pure PEDOT:PSS/GCE was extremely hygroscopic<sup>10,31</sup> and tended to swell or disintegrate in the aqueous media.<sup>11</sup> With the introduction of small amounts of Nafion<sup>®</sup> into PEDOT:PSS, the PEDOT:PSS-Nafion<sup>®</sup> displayed a decrease of electrical conductivity due to the increasing impedance of the com-

posite films (the electrical conductivity of the PEDOT:PSS–Nafion<sup>®</sup> composite film with a volume ratio of 1;1 was 0.246 S cm<sup>-1</sup>), which is in accordance with previous reports,<sup>23</sup> a pair of well-defined quasi-reversible redox peaks appeared on the CV curve of PEDOT:PSS–Nafion<sup>®</sup>/GCE. Moreover, the potential difference ( $\Delta E_p$ ) between the anodic and cathodic peaks at PEDOT:PSS–Nafion<sup>®</sup>/GCE (107 mV) was smaller than that at the bare GCE (174 mV) and PEDOT:PSS/GCE (136 mV), indicating better reversibility of electrochemical reaction at the PEDOT:PSS–Nafion<sup>®</sup>/GCE.

EIS can be used as an efficient tool for describing the electron transfer properties of different composite electrodes. The results of EIS are illustrated in Fig. 2B on a) bare GCE, b) PEDOT:PSS/GCE, c), PEDOT:PSS–Nafion<sup>®</sup>/GCE and d) Nafion<sup>®</sup>/GCE using 10 mM [Fe(CN)<sub>6</sub>]<sup>3-/4-</sup> redox couple as the indicator. The EIS was recorded at a potential of 0.17 V and the frequency range was 10 kHz to 100 mHz. The electron-transfer resistance ( $R_{ct}$ ) value of PEDOT:PSS/GCE (almost like a straight line) was much lower than that of the bare GCE, which was attributed to the high conductivity of the PEDOT:PSS films that facilitated fast electron transfer between the solution and the electrode interface. For PEDOT:PSS–Nafion<sup>®</sup>/GCE, the  $R_{ct}$  value was between those of PEDOT:PSS/GCE and Nafion<sup>®</sup>/GCE, which is consistent with the results of CV. Therefore, these results demonstrated that the PEDOT:PSS–Nafion<sup>®</sup>/GCE had relatively better electrochemical ability and faster electron transfer, and that composite electrode could be utilized as the working electrode.

#### *Electrochemical activity of DA at the PEDOT:PSS–Nafion<sup>®</sup>/GCE*

To assess the performance of PEDOT:PSS–Nafion<sup>®</sup> composite electrodes, dopamine (DA) was selected for application of the fabricated electrochemical sensor. The CVs of different electrodes taken at a scan rate of 50 mV s<sup>-1</sup> in 0.1 M PBS (pH 7.0) and 40  $\mu$ M DA are shown in Fig. 3. Compared with the oxidation peak currents at a bare GCE and Nafion<sup>®</sup>/GCE, those at PEDOT:PSS/GCE and PEDOT:PSS–Nafion<sup>®</sup>/GCE were remarkably increased, which was attributed to the fact that PEDOT:PSS films have a moderate conductivity.<sup>5,32</sup> However, the PEDOT:PSS/GCE was not very stable and easily swelled or disintegrated in PBS, and the redox peak of DA was very weak. At bare GCE, a pair of redox peaks were observed for the detection of 40  $\mu$ M DA. The oxidation and reduction peak potentials occurred at 0.404 and 0.058 V, respectively. At PEDOT:PSS–Nafion<sup>®</sup>/GCE, a well-defined redox wave of DA was observed with the anodic peak potential at 0.269 V and the corresponding cathodic peak potential at 0.098V. The oxidation and reduction peak currents were significantly increased and the electron transfer process to DA was more reversible. These results once again indicated that the determination of DA is feasible at a PEDOT:PSS–Nafion<sup>®</sup>/GCE.

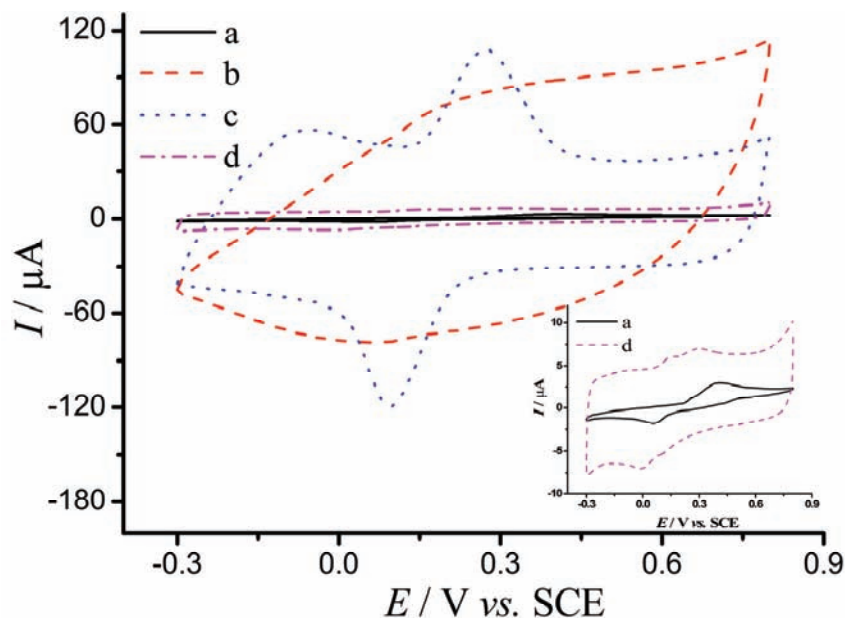


Fig. 3. CVs of different electrodes in 0.1 M PBS (pH 7.0) and 40  $\mu\text{M}$  DA: a) bare GCE, b) PEDOT:PSS/GCE, c) PEDOT:PSS–Nafion<sup>®</sup>/GCE and d) Nafion<sup>®</sup>/GCE. Scan rate: 50  $\text{mV s}^{-1}$ . Inset: CVs of bare GCE and Nafion<sup>®</sup>/GCE in 40  $\mu\text{M}$  DA.

#### Effect of the scan rate towards DA

The effect of the scan rate on the electrochemical behavior of DA at PEDOT:PSS–Nafion<sup>®</sup>/GCE was studied by CV, and the results are shown in Fig. 4A. With increasing scan rate from 25 to 100  $\text{mV s}^{-1}$ , the oxidation peak current ( $I_{\text{pa}}$ ) and reduction peak current ( $I_{\text{pc}}$ ) were in linear relationship to the scan rate ( $\nu$ ). The regression equations were:  $I_{\text{pa}} (\mu\text{A}) = 1.78 - 7.45\nu$  and  $I_{\text{pc}} (\mu\text{A}) = -2.06 - 18.54\nu$  ( $\nu$  in  $\text{mV s}^{-1}$ ), with correlation coefficients of 0.998 and 0.995, respectively. This indicates that the DA molecules can be adsorbed onto the electrode surface, and the electrochemical oxidation of DA at the PEDOT:PSS–Nafion<sup>®</sup>/GCE was an adsorption-controlled process.<sup>29</sup>

#### Effect of pH values towards DA

The effect of pH value on the determination of DA at PEDOT:PSS–Nafion<sup>®</sup>/GCE in PBS within the range from 2.0 to 8.0 was investigated by CV and the results are shown in Fig. 5A. The pH value had a significant influence on both the redox peak potentials and peak currents. The relationship between the oxidation peak currents and pH value is presented in Fig. 5B. The results showed that the peak current of DA increased with increasing pH value until the highest peak current and the best peak shape were obtained at pH 7.0, while the peak current decreased dramatically when the pH value exceeded 7.0, which was pro-

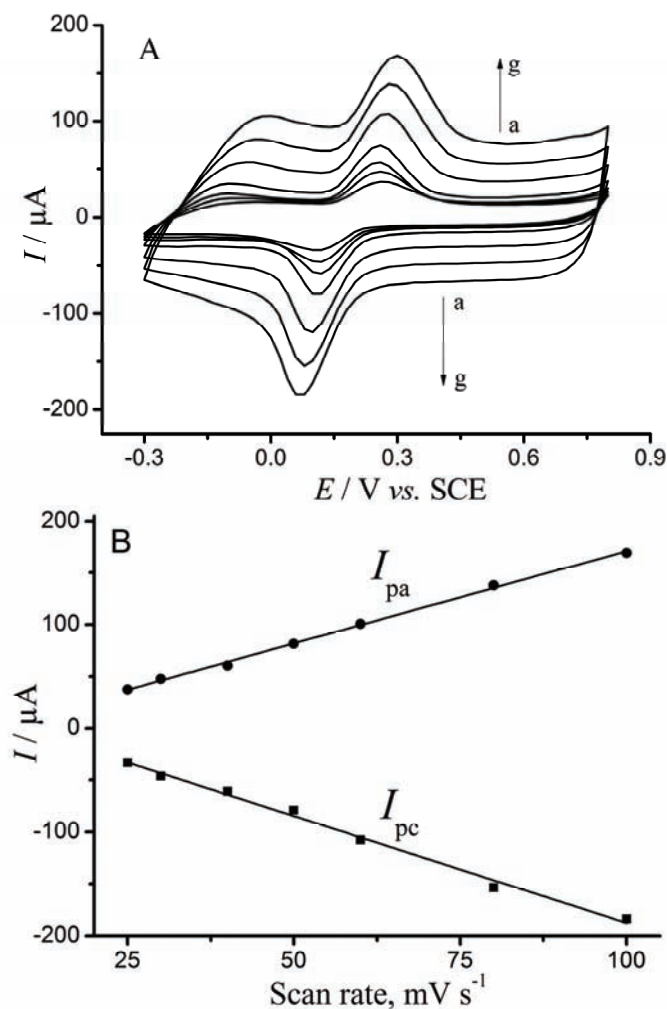


Fig. 4. A) CVs of 40  $\mu\text{M}$  DA in 0.1 M PBS (pH 7.0) at scan rates of 25, 30, 40, 50, 60, 80 and 100  $\text{mV s}^{-1}$  (from a to g) and B) the plots of redox peak currents vs. the scan rate.

bably due to the charge interactions between DA and electrode surface. In addition, the relationship between the oxidation peak potentials ( $E_{pa}$ ) and pH values was also investigated and the results are shown in Fig. 5C. It can be observed that the  $E_{pa}$  shifted negatively as the pH value was increased, indicating that protons were involved in the electrode reaction. The curve presents two straight lines in the pH range 2.0–8.0. The regression equations were  $E_{pa} (\text{V}) = 0.4956 - 0.0156\text{pH}$  ( $R^2 = 0.9946$ ) at the lower pH values 2.0–6.0 with a slope of  $15.6 \text{ mV pH}^{-1}$ , which is smaller than the theoretical value of  $-57.6 \text{ mV pH}^{-1}$ . While the regression equations was  $E_{pa} (\text{V}) = 0.9901 - 0.995\text{pH}$  ( $R^2 = 0.9853$ ) at the higher



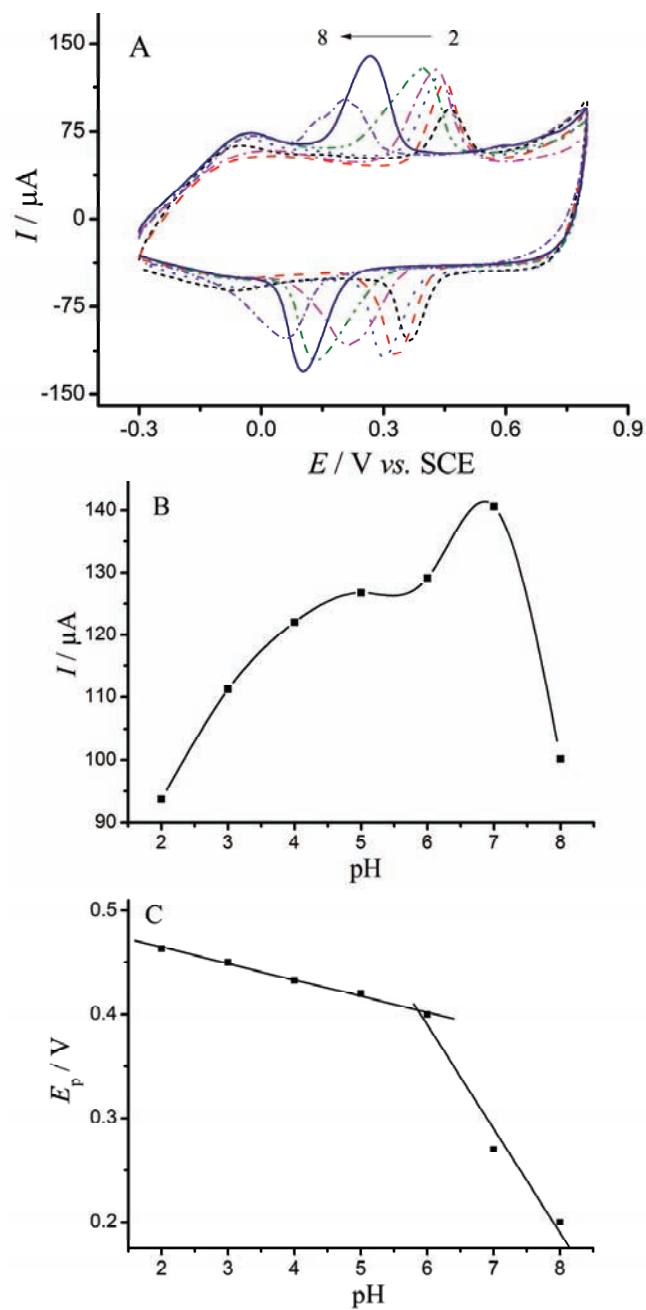


Fig. 5. A) CVs in 40  $\mu\text{M}$  DA and 0.1 M PBS at different pH values: 2.0, 3.0, 4.0, 5.0, 6.0, 7.0 and 8.0. Effects of the pH value on: B) the oxidation peak currents and C) the oxidation peak potentials for the oxidation of 40  $\mu\text{M}$  DA. Scan rate: 50  $\text{mV s}^{-1}$ .

pH value between 6.0–8.0. The slope in this pH range was  $99.5 \text{ mV pH}^{-1}$ , which is high than the theoretical value. The reason for this is yet unclear. However, the pH value has an influence on both the peak potential and peak current, revealing that electron transfer and proton transfer participated in the reaction. Considering the physiological pH (7.4), pH 7.0 was chosen as optimal pH value of PBS.

#### Determination of DA

The determination of DA concentration at a PEDOT:PSS–Nafion<sup>®</sup>/GCE was performed by differential pulse voltammetry (DPV) in 0.1 M PBS (pH 7.0) and the results are shown in Fig. 6A. As can be seen in Fig. 6B, the oxidation peak current of DA was linearly proportional to its concentration in the range of 0.10 to 50  $\mu\text{M}$ . The regression equation was  $I_{\text{pa}} (\mu\text{A}) = 9.04 + 0.41c$  ( $c$  in  $\mu\text{M}$ ) ( $R^2 = 0.996$ ) with a detection limit of 0.03  $\mu\text{M}$  ( $S/N = 3$ ), where  $c$  is the concentration of DA. Compared with most of the modified electrodes reported in the literature (listed in Table I),<sup>24,27,33–37</sup> the fabricated PEDOT:PSS–Nafion<sup>®</sup>/GCE exhibited a good sensing performance.

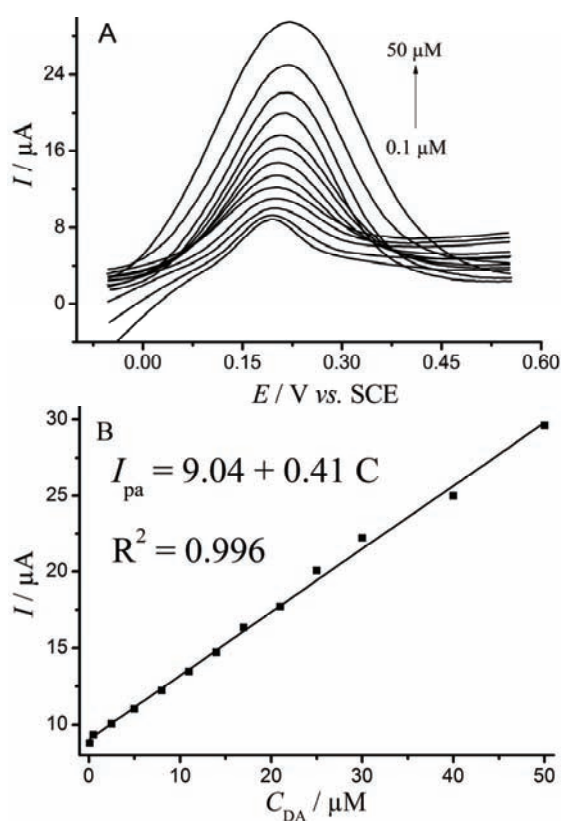


Fig. 6. A) DPVs in various concentrations of DA and 0.1 M PBS (pH 7.0) at a PEDOT:PSS–Nafion<sup>®</sup>/GCE. DA concentrations: 0.1, 0.5, 2.5, 5.5, 8, 11, 13, 17, 21, 25, 30, 40 and 50  $\mu\text{M}$ . Scan rate:  $50 \text{ mV s}^{-1}$ . B) Linear relationship between peak current and the concentration of DA.

TABLE I. Comparison of different modified electrodes for the determination of DA; 6A2MBT: 6-amino-2-mercaptobenzothiazole; EPPGE: edge-plane pyrolytic graphite electrode; PEDOT–PANS: poly[3,4-ethylenedioxythiophene-*co*-(5-amino-2-naphthalenesulfonic acid)]; NBAR: *p*-nitrobenzenazo resorcinol; GCE: glassy carbon electrode; CNT: carbon nanotubes; IL: ionic liquid; RGO: reduced graphene oxide; CNOs: carbon nano-onions; PDDA: poly(diallyldimethylammonium chloride); AABA: 3-acrylamidophenylboronic acid; ACS: acetate buffer solution; *LCR*: linear concentration range; *LOD*: limit of detection

Electrode	Electrolyte	<i>LCR</i> / $\mu\text{M}$	<i>LOD</i> / $\mu\text{M}$	Reference
6A2MBT/Au	PBS (pH 7.2)	1–642	0.157	24
SWCNT–Fe <sub>2</sub> O <sub>3</sub> /EPPGE	PBS (pH 7.0)	3.2–31.8	0.36	27
PEDOT–PANS/GCE	ACS (pH 5.0)	2–8	0.5	33
polyNBAR/GCE	PBS (pH 4.0)	5–25	0.3	34
RGO/AuNPs/GCE	PBS (pH 7.4)	1–60	0.02	35
CNOs/PDDA /GCE	PBS (pH 5.0)	50–400	10	36
MWCNT/poly(AABA)/GCE	PBS (pH 7.4)	0.05–2	0.02	37
PEDOT:PSS–Nafion <sup>®</sup> /GCE	PBS (pH 7.0)	0.1–50	0.03	This work

#### Interference, stability and reproducibility studies

The reproducibility of PEDOT:PSS–Nafion<sup>®</sup>/GCE was studied by measurement the peak current response of 40  $\mu\text{M}$  DA in 0.1 M PBS (pH 7.0) by CV. The relative standard deviation (*RSD*) of the oxidation peak currents during 20 successive measurements was 1.3 %, indicating good reproducibility (shown in Fig. 7). When the electrode was kept at 4 °C for two weeks, the peak currents remained at 96 % of their initial values. These results revealed that PEDOT:PSS–Nafion<sup>®</sup>/GCE had excellent water-stability, implying that Nafion<sup>®</sup> can improve the swelling and disintegration properties of PEDOT:PSS and lower the swelling of the modified electrode in aqueous media.<sup>23,38</sup>

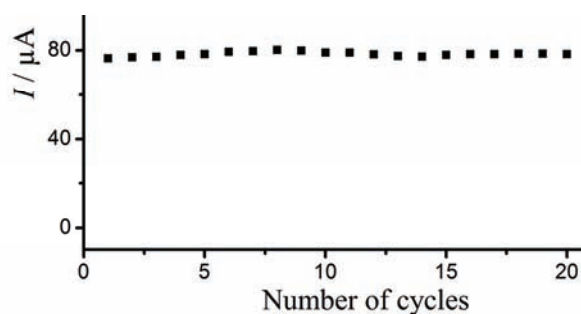


Fig. 7. The stability of a PEDOT:PSS–Nafion<sup>®</sup>/GCE in 0.1 M PBS (pH 7.0) containing 40  $\mu\text{M}$  DA. Scan rate: 50  $\text{mV s}^{-1}$ .

The possible interferences for DA determination were evaluated by the response current–time (*I–t*) curve and DPV. The *I–t* curve presented in Fig. 8A shows that addition of 10  $\mu\text{M}$  DA caused a noticeable change in the current res-

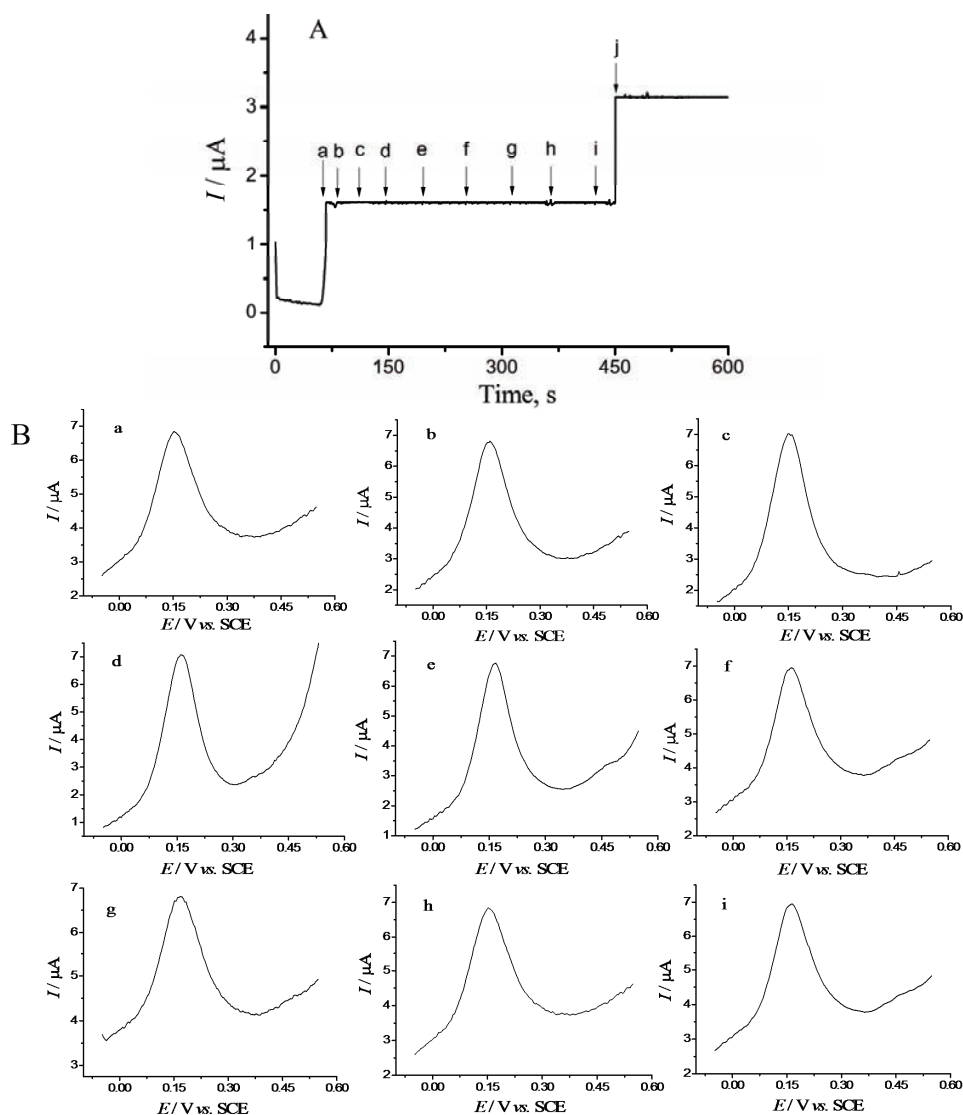


Fig. 8. A) The responses for interferents tested at a PEDOT:PSS-Nafion<sup>®</sup>/GCE by the amperometric method at an applied potential 0.3 V vs. SCE in 0.1 M PBS (pH 7.0). The injection of the potentially interfering compounds were a) 10  $\mu\text{M}$  DA, b) 100  $\mu\text{M}$  ascorbic acid, c) 100  $\mu\text{M}$  uric acid, d) 100  $\mu\text{M}$  cysteine, e) 1 mM glucose, f) 1 mM sodium citrate, g) 1 mM ethanol, h) 1 mM sodium chloride, i) 1 mM oxalic acid and j) 10  $\mu\text{M}$  DA. B) The corresponding responses for interferents tested by DPV.

ponse. Then, addition of 10-fold amounts of ascorbic acid, uric acid and cysteine and 100-fold amounts of glucose, sodium citrate, ethanol, sodium chloride and oxalic acid were successively added, which had no obvious influence on the

electrode response, with deviations below 5 %. Then, 10  $\mu\text{M}$  DA was added again, which caused the current to change significantly. This implied that the fabricated PEDOT:PSS–Nafion<sup>®</sup>/GCE had good selectivity, which may be largely attributed to the strong anti-interferent ability of Nafion<sup>®</sup>.<sup>39</sup> Moreover, the interference experiments were repeated using the common DPV technique. From Fig. 8B, it can be seen that again no obvious influence for most of the interfering substance was evidenced by the DPV method, while added ascorbic acid, uric acid or cysteine had a slight influence. Once again, the good selectivity of the PEDOT:PSS–Nafion<sup>®</sup>/GCE was indicated.

### CONCLUSIONS

In summary, the commercially available water-dispersible PEDOT:PSS and the ion-exchange polymer Nafion<sup>®</sup> were successfully used to fabricate a simple water-stable and conducting composite PEDOT:PSS–Nafion<sup>®</sup>/GCE for sensing applications. Due to the high conductivity of PEDOT:PSS and strong adsorptive ability of the binding agent Nafion<sup>®</sup>, the PEDOT:PSS–Nafion<sup>®</sup>/GCE showed good electrochemical activities, excellent reproducibility and water-stability, fast electrode transfer, and low swell and disintegration. This composite electrode was used for the detection of DA with a fast current response, good selectivity, and strong anti-interferent ability, which provided a promising method for modified electrode materials. This work also enlarges the application of PEDOT:PSS in chemo/bio-sensing.

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### ИЗВОД

#### ПРИМЕНА КОМЕРЦИЈАЛНОГ ПОЛИ(3,4-ЕТИЛЕН-ДИОКСИТИОФЕН):ПОЛИСТИРЕН СУЛФОНАТА ЗА ЕЛЕКТРОХЕМИЈСКУ ДЕТЕКЦИЈУ ДОПАМИНА

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У раду је успешно направљена једноставна и стабилна композитна електрода на бази проводног полимера поли(3,4-етилендиокситиофен):полистирен-сулфонат (PEDOT:PSS) и јоноизмењивачког полимера, Nafion<sup>®</sup>, тако што је на површину електроде од стакластог угљеника нанета кап смеше комерцијално доступне водене дисперзије PEDOT:PSS и раствора Nafion<sup>®</sup>. PEDOT:PSS је имао улогу матрице, док је Nafion<sup>®</sup> примењен у циљу повећања стабилности композитног филма и његове адхезије на површини електроде. За карактеризацију описане композитне електроде коришћене су методе цикличне волтаметрије, диференцијалне пулсне волтаметрије, спектроскопије електрохемијске импеданције и скенирајуће електронске микроскопије. Електрода је пока-

зала добру стабилност у води, а затим је примењена за електрохемијску детекцију допамина. Одређивање њених перформанси при детекцији овог једињења је показало да композитни филм PEDOT:PSS има потенцијалну примену у електрохемијским сензорима и електрокатализаторима.

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