

Electrochemical detection of bisphenol A on a boron-doped diamond electrode by differential pulse voltammetry

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Introduction

As highlighted by Yin *et al.*,¹ bisphenol A (BPA) is used in large scale in the chemical industry, especially for the production of polycarbonates and epoxi resins. These polymers are very used in the production of baby bottles, food packaging, among other common products. However, BPA has shown a high estrogenic activity, being classified as a synthetic endocrine disruptor; it can cause anomalies in the reproductive system, cancer, among other problems.¹ Due to this unwelcome activity, analytical methods to detect and quantify BPA at low concentrations have been needed. The boron-doped diamond (BDD) electrode and differential pulse voltammetry (DPV) have appropriate characteristics for their application in the determination of several compounds. Thus, this work reports on the development of an electroanalytical method for the detection and quantification of BPA using a BDD electrode and the DPV technique.

Results and Discussion

A cathodically pretreated (-0.25 A/cm^2 , 500 s, in 0.5 M H_2SO_4) BDD (8000 ppm) electrode (CSEM, Neuchâtel, Switzerland) was used.² A 30.0 mg/L BPA standard solution in methanol was prepared; for the measurements, appropriate volumes of this solution were added to 30 mL of a 0.1 M Britton-Robson buffer solution (pH 2). A one-compartment electrochemical cell with an adaptor to hold the BDD electrode (0.62 cm^2 exposed area) was used. A Pt foil and an Ag/AgCl (3 M KCl) electrode were used as auxiliary and reference electrodes, respectively. Using optimized pH and DPV conditions, the obtained results presented a loss of the oxidation current signal as the voltammetry was redone; at the 7th cycle, this loss was reaching about 14%. BPA when oxidized presents a high tendency to polymerize, as it is common with most phenolic compounds; this behavior significantly compromises the reproducibility of the results of quantitative analysis for BPA. Thus, in order to make viable the electrochemical determination of BPA, before each determination the BDD electrode was pre-conditioned at +2.0 V vs. Ag/AgCl (3 M KCl) for a short time (10 s). This pre-conditioning renews the BDD electrode surface by causing the elimination of

any adsorbed polymeric film by hydroxyl radicals formed at this applied potential. This way, an adequate reproducibility of the BPA peak oxidation current (I_p) was attained, since successive measurements ($n = 10$) using DPV presented I_p values with deviations of only about 6%. Figure 1 shows the differential pulse (DP) voltammetric profiles obtained for several BPA concentrations and the corresponding analytical curve, which presented an excellent linearity ($r = 0.9995$) in the investigated concentration range (50 – 500 $\mu\text{g/L}$). The limit of detection (LOD) was experimentally determined, by dilutions, considering that the I_p value should be at least 3 times the background value, beside presenting a good resolution; thus an LOD value of 25 $\mu\text{g/L}$ ($0.11 \mu\text{mol/L}$) was obtained.

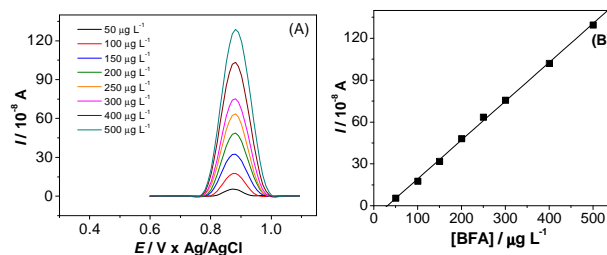


Figure 1 – (A) DP voltammograms for different BPA concentrations and respective (B) analytical curve.

The regression equation corresponding to the analytical curve shown in Fig. 1B is:

$$I / 10^{-8} \text{ A} = -8.464 \times 10^{-8} + 0.278 ([\text{BFA}] / \mu\text{g L}^{-1})$$

Conclusions

The use of an appropriately preconditioned BDD electrode and the DPV technique led to good results in the determination of BPA, allowing the quantification of quite low concentrations.

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¹ Yin, H.; Zhou, Y.; Ai, S. *J. Electroanal. Chem.* **2009**, 626, 80.

² Salazar-Banda, G. R.; Andrade, L. S.; Nascente, P. A. P.; Pizani, P. S.; Rocha-Filho, R. C.; Avaca, L. A. *Electrochim. Acta* **2006**, 51, 4612.