Electrochemical Analysis of Fenuron Herbicide by a Carbon Paste Electrode Modified by a Functionalized NiAl-layered Double Hydroxide

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Abstract

Environmental pollution by usage of pesticides as fenuron increases health risk, due to carcinogenic and teratogenic properties of these compounds. There are needs to develop a rapid and cheaper detection methods for quantification of fenuron. In this work, an inorganic-organic composite material was obtained by intercalation of sodium dioctylsulfosuccinate (DSS) within the interlayer space of a Nickel-Aluminum Layered Double Hydroxide (NiAl-LDH). The structure of the pristine LDH and the intercalated-LDH was confirmed using Fourier transform infrared spectroscopy, X-ray diffraction and thermal analysis. The modified LDH was used to elaborate an amperometric sensor for fenuron herbicide by differential pulse voltammetry (DPV) via a carbon paste electrode (CPE). The electrochemical procedure for fenuron analysis was based on the immersion of the working electrode in the electrolytic solution containing appropriate amount of herbicide, followed by voltammetry detection without any preconcentration step. The peak current obtained on the CPE modified by the organo-LDH was 2-fold higher in comparison with the pristine LDH/CPE. The observed increase in the signal of fenuron was attributed to the high organophilic character of this composite material induced by the modification using DSS. The effects of some experimental parameters (pH of medium and percentage of the modifier in the paste) on the stripping response were investigated in order to optimize the sensitivity of the organo-LDH modified electrode. Linear calibration curves were obtained in the fenuron concentration ranging from 0.5 to 1 $\mu\text{mol.L}^{-1}$ and 1 to 5 $\mu\text{mol.L}^{-1}$. The limit of detection (LOD) calculated on the basis of a signal-to-noise ratio of 3 was $1.8 \times 10^{-9} \text{ mol.L}^{-1}$ (low concentration range) and the limit of quantification (LOQ) was $6 \times 10^{-9} \text{ mol.L}^{-1}$. The interference effect of various inorganic ions likely to influence the stripping determination of the fenuron was also examined, and the applicability of the method was verified by the determination of fenuron in a river sample collected down-town Yaoundé.

Full-text

Due to technical limitations, full-text HTML conversion of this manuscript could not be completed. However, the manuscript can be downloaded and accessed as a PDF.

Tables

Due to technical limitations, table 1-2 is only available as a download in the Supplemental Files section.

Figures

Figure 1

(A) FTIR spectra of: (a) NiAl and (b) NiAl-DSS; (B) Powdered XRD pattern of (a) NiAl and (b) NiAl-DSS; (C) TGA of (a) NiAl and (b) NiAl-DSS ; (D) DTG traces of NiAl-DSS.

Figure 2

Multicyclic voltammograms of FEN 5x10-5 M recorded in acetate buffer solution 0.1M (pH 4.7) at 50 mv/s on (a) CPE, (b) CPE/NiAl and (c) CPE/NiAl-DSS. (d) superimposition of the first scans recorded on EPC (1), CPE/NiAl (2) and CPE/NiAl-DSS (c).

Figure 3

(A) Influence of scan rate (v) on the peak current of 5×10^{-5} M FEN on CPE/NiAl-DSS ($v = 25\text{--}125 \text{ mV.s}^{-1}$). (B) Plot of the anodic peak current vs $v^{1/2}$. (C) $\log(i_p)$ vs $\log(v)$. (D) Plot of variation of the peak potential with logarithm of the scan rate for the oxidation peak of FEN

Figure 4

(A) Cyclic voltammograms of FEN 5x10⁻⁵M recorded in acetate buffer solution 0.1M (pH 4.7) at 50 mv/s on (a) EPC, (b) CPE/NiAl-DSS (1%), (c) CPE/NiAl-DSS (5%), (d) CPE/NiAl-DSS (3%), (e) CPE/NiAl-DSS (2%), (B) Variation of the current as a function of the percentage of NiAl-DSS in CPE.

Figure 5

(A) Influence of pH medium on DPV response of FEN. (B) (bleu line) Effect of medium pH on the anodic peak current of FEN on a CPE/NiAl-DSS and (black line) Variation of the peak potential versus pH of medium.

Figure 6

Calibration plots and current response obtained for FEN sensing at CPE modifier with NiAl-DSS (prepared with 2% of NiAl-DSS in the composition of the paste) in the concentration range 0.5 to 1 $\mu\text{mol/L}$ and 1 to 5 μmol in 0.1 acetate buffer solution (pH 4.7) prepared with deionized water.

Supplementary Files

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