SQUARE WAVE VOLTAMMETRY MEASUREMENT OF HEAVY METALS: ASSESSMENT OF CARBON PASTE ELECTRODES TREATED WITH ORGANIC COMPOUNDS

Chandani Deepak Bharatbhai
Research Scholar
Department of Chemistry
Sunrise University, Alwar, Rajasthan.
deepakchandani095@gmail.com

Dr. Devesh Kumar
Research Guide
Department of Chemistry
Sunrise University, Alwar, Rajasthan.

Abstract
Utilizing the Square Wave Voltammetry method, three organic compounds were employed to modify carbon paste electrodes for the study of several metals (Pb^2+, Cd^2+, and Cu^2+). It has been shown how the changed electrodes affect electrochemical behavior. MO-CPEs provide greater sensitivity. The detection thresholds reached across all analyses were close to 10-8 mol/L.
Keywords: *Chemically modified carbon paste electrode; Square wave voltammetry; Heavy metals.*

Introduction
Electrochemical sensors have seen widespread use in recent years because to their benefits including high sensitivity, quick reaction times, simplicity, cheap cost, and automated systems. With the invention of new materials and inventive manufacturing techniques, research into the creation of electrochemical sensors for the detection of heavy metals has significantly increased over the last several decades.

Due to their distinct qualities, such as a large surface area and good adsorption capacity, organic layer assembly onto surfaces has recently been extensively exploited in the construction of electrochemical sensors.

Chemically altered carbon paste electrodes provide a number of advantageous characteristics, including simplicity of use and suitability for anodic oxidations. In the recent years, many carbon paste modifiers have been described for the electrochemical stripping analysis of heavy metals.

Recently, techniques using radical-based processes have been created for the alteration of carbon surfaces with layers of organic species bonded covalently. To functionalize electrodes for analytical uses, such as the electroanalysis of heavy metals, mono- or multilayers are deposited onto the surfaces of carbon paste.

In this study, an innovative electrochemical sensor was created by adding organic molecules to paste carbon electrodes. These electrodes were used to chemically preconcentrate several heavy metals at low concentrations. By forming complexes with these ions, the organic molecules modified carbon paste electrode may preconcentrate heavy metals from aqueous solution to the surface of the modified CPE, considerably enhancing the sensitivity of its detection. The experimental results reveal that certain MO-CPEs have a large operating linear range of concentrations, appropriate selectivity, high sensitivity, and repeatability for the measurement of heavy metals in water samples. The benefits of the MO-CPEs are their low solubility in water and straightforward production and purifying processes.

Experimental
Reagents and chemicals
The finest grade chemicals were used throughout. Without additional purification, Aldrich's spectroscopic grade RWB graphite powder (from Ringsdorff-Werke GmbH in Bonn-Bad Godesberg, Germany) was

utilized. From Merck compounds, CuSO4, PbSO4, and CdSO4 were obtained. All solutions were made using deionized water. In our lab, all organic compounds were created.

Apparatus

The general purpose electrochemical systems data processing software (voltalab master software) was used to control a voltalab potentiostat (model PGSTAT 100, Eco Chemie B.V., Utrecht, The Netherlands) in order to conduct electrochemical experiments.

A typical one-compartment, three-electrode cell was used for all electrochemical studies. SCE served as the counter electrode and as the reference electrode. This reference electrode served as the reference for all electrode potentials. MO-CPE served as the working electrode.

Electrode preparation

By combining paraffin oil with carbon powder, the unaltered carbon paste was created. By replacing equivalent quantities of the carbon powder with the organic molecules, adding the paraffin oil, and then completely hand-mixing in a mortar and pestle, organic molecules-modified carbon paste electrodes were created. The surface of the electrode was polished and the resultant paste was put within.

The molecule (A), including the diazonium reduction in the electrochemical measuring cell, is substantially similar to that described in the literature [8]. The diazonium transfers one electron to the electrode surface before changing into an aryl radical, which forms a covalent connection with the electrode surface.

We discover that molecules B and C use a similar process to create an organic coating on the electrode surface.

In the supporting electrolyte, the cyclic voltammograms (CVs) of the MO-CPE and CPEs were captured. No redox peaks were seen in cycles between -1.5 and 1.5 V

Table 1: Parameters obtained from the calibration plot, for CPE modified by molecule A.

Parameters	Pb(II)
Equation	35.76 [Pb(II)] (µmol l-1)+0.0295
R2	0.9852
Pente (mol L-1)	35.76
D.L. (×107 mol L-1)	5.7
Q.L. (×10-6 mol L-1)	6.23
R.S.D (%)	6.8%

Table 2: Parameters obtained from the calibration plot, for CPE modified by molecule B.

Parameters	Cd (II)
Equation	75.23 [Cd(II)] (µmol l-1)+0.075
R2	0.9802
Pente (mol L-1)	75.23
D.L. (×106 mol L-1)	8.24
Q.L. (×106 mol L-1)	7.43
R.S.D (%)	5.0%

The CVs for Pb(II) solutions produced at CPE and modified with molecule A are shown in Figure 5. The reduced species of lead is created by the cathodic scan and is then deposited on the electrode. The oxidation process, which leads to the present peak of this signal (the anodic peak), is favored by this deposition. With an increase in Pb^{2+} content, the peak current increased.

The CVs for the Cd(II) solution obtained at CPE modified with molecule B and the Cu(II) solution obtained at CPE modified

with molecule C are shown in Figures 6 and 7, respectively.

All three examples exhibit the same electrochemical behavior; oxidation and the release of Pb(II) occur at negative potential values, showing that the complex created is less stable than those formed in the cases of molecules B and C.

Conclusion

Organic molecules were successfully added to the Carbon Paste Electrode (CPE). Using MO-CPEs with excellent repeatability, low-level heavy metal detection was made possible. The procedure is straightforward, quick, and repeatable. The production of metal complexes in the organic films raises the concentration of the examined metals at the surface of the MO-CPEs.

References

1. *Gao H, Qi X, Chen Y, Sun W (2011) Electrochemical deoxyribonucleic acid biosensor based on the self-assembly film with nanogold decorated on ionic liquid modified carbon paste electrode. Anal Chim Acta 704: 133-138.*
2. *Wang J (2003) Nanoparticle-based electrochemical DNA detection. Anal Chim Acta, 500: 247-257.*
3. *Gomdje VH, Ngono TRL, El S, Qouatli, Najih R, et al. (2013) Acta Tech Corv 5: 139-142.*
4. *Hernandez OE, Rodriguez IN, Hidalgo JLH, Reguera E (2007) Evaluation of carbon paste electrodes modified with 1-furoylthioureas for the analysis of cadmium by differential pulse anodic stripping voltammetry. Sensors and Actuators B 123: 488-494.*
5. *Kalcher K (1990) Chemically modified carbon paste electrodes in voltammetric analysis. Electroanalysis 2: 419-433.*
6. *Paneli MG (1993) Applications of adsorptive stripping voltammetry in the determination of trace and ultratrace metals. Electroanalysis 5: 355-373.*
7. *Stockhausen V, Ghilane J, Martin P, Trippé-Allard G, Randriamahazaka H, et al. (2009) Grafting Oligothiophenes on Surfaces by Diazonium Electroreduction: A Step toward Ultrathin Junction with Well-Defined Metal/Oligomer Interface. Am Chem Soc 131: 14920-14927.*