

## RESEARCHNOTE

***Periplaneta americana* Linn (BLATTODEA:BLATTIDAE) AS SOURCE OF CHITIN COMPONENT OF METAL SENSOR****Elmer-Rico E. Mojica<sup>1</sup> and Jose Maria Vito P. Palafox<sup>2</sup>**

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**ABSTRACT**

Chitin was extracted from *Periplaneta americana* and used as a component of a metal sensor, which was then able to electrochemically detect the presence of lead ions (Pb<sup>2+</sup>). The sensor with chitin from the cockroach wing generated a higher signal than that with chitin from the other parts of the insect body.

**Keywords:** cockroaches, lead detection

**Abbreviations:** CME - chemically modified electrode, NaOH - sodium hydroxide, HCl - hydrochloric acid, CPE - carbon paste electrode, DPASV - differential pulse anodic stripping voltammetry.

Chitin, a polymer of *N*-acetyl- $\beta$ -D-glucosamine, is a major component of insect cuticle. Gravimetric analysis revealed that the chitin content constitutes up to 40% of the exuvial dry mass depending on the insect species and varies considerably with the different cuticle types even in a single organism (Kramer et al., 1995, *Insect Biochem. Mol. Biol.* 25:1067-1080). It functions as light but mechanically strong scaffold material and is always associated with cuticle proteins that mainly determine the mechanical properties of the cuticle. Chitin was found effective in removing heavy metal ions in solution (Kapuan et al 1991, *Fisheries Res. J. Phillip.* 6(2):69-76). Another study made use of this same material as a remediating agent which binds with Fe<sup>2+</sup> and Cu<sup>2+</sup> in wastewater effluents (Santo et al 2001, *Proc 17<sup>th</sup> Phil Chem Congress* p. 59).

Electrochemistry has provided viable protocols in metal analysis in environmental samples. One of the products of electrochemistry is chemically modified electrodes (CMEs), which have been introduced for the voltammetric analyses of trace metals. A CME is advantageous because of its faster response, ease of fabrication, low cost and suitability for miniaturization (Wang 2000, *Analytical Electrochemistry*: 195). This type of electrode utilizes chemical and biological-modifying moieties such as ligands, redox mediators, algae, enzymes and tissues. Chitin is one material that binds with metals and the possibility of using chitin as component of metal sensor was explored.

It is possible to utilize the exoskeleton of cockroach as source of chitin. In this study, chitin was isolated from exoskeleton of *Periplaneta americana* L. (American cockroach), considered one of the major household pests. The wings and the exoskeleton of all the other body parts of the cockroach were separated, treated first with 10 mL of 2.5 N NaOH, and then with 1.7 N HCl at room temperature for 8 hours in each treatment (Austin 1977, [German Patent 2, 707:164]). The collected chitin was thoroughly washed with distilled water and dried in oven at 90°C for 48 hours. The washed and dried chitin was then used as component of a metal sensor that can electrochemically detect lead ions. The cockroach chitin was mixed with carbon powder and mineral oil to form a paste. A portion of the paste was packed into the end of a hard plastic tube (with a thickness of 2 mm diameter) where a copper rod was inserted to establish electrical contact (Figure 1).

All voltammetric measurements were performed in Metrohm VA 693 processor connected via the RS 232 interface to the computer with a VA 693 back-up software compatible with the Metrohm output data. A platinum auxiliary electrode and Ag/AgCl reference were used. All potentials were measured against the Ag/AgCl electrode.

The electrode containing the chitin from cockroach was immersed in 10 mL of lead (II) sample solution in a preconcentration cell with constant stirring for a constant accumulation time. The electrode was then taken out of the preconcentration cell, rinsed with water and transferred to the voltammetric cell containing 0.1 M hydrochloric acid solution as supporting electrolyte.

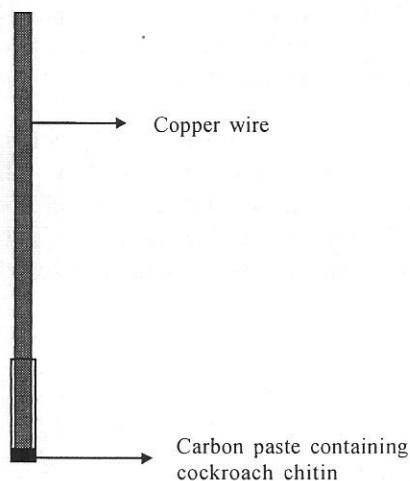


Figure 1. Modified carbon paste electrode containing chitin from cockroach

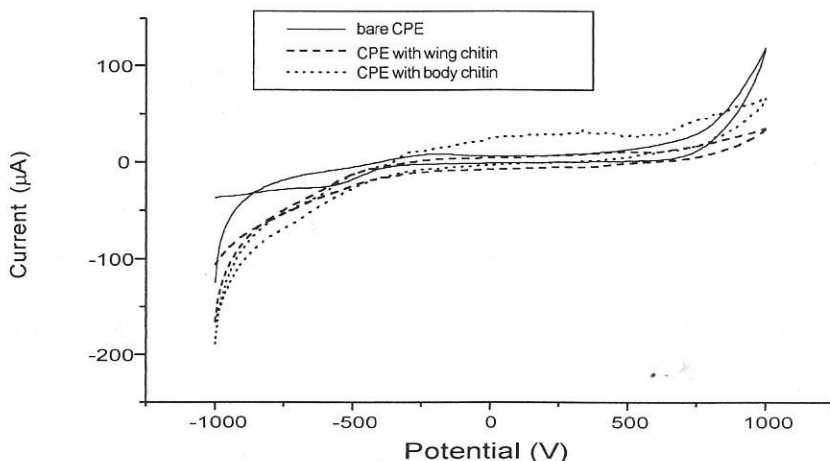
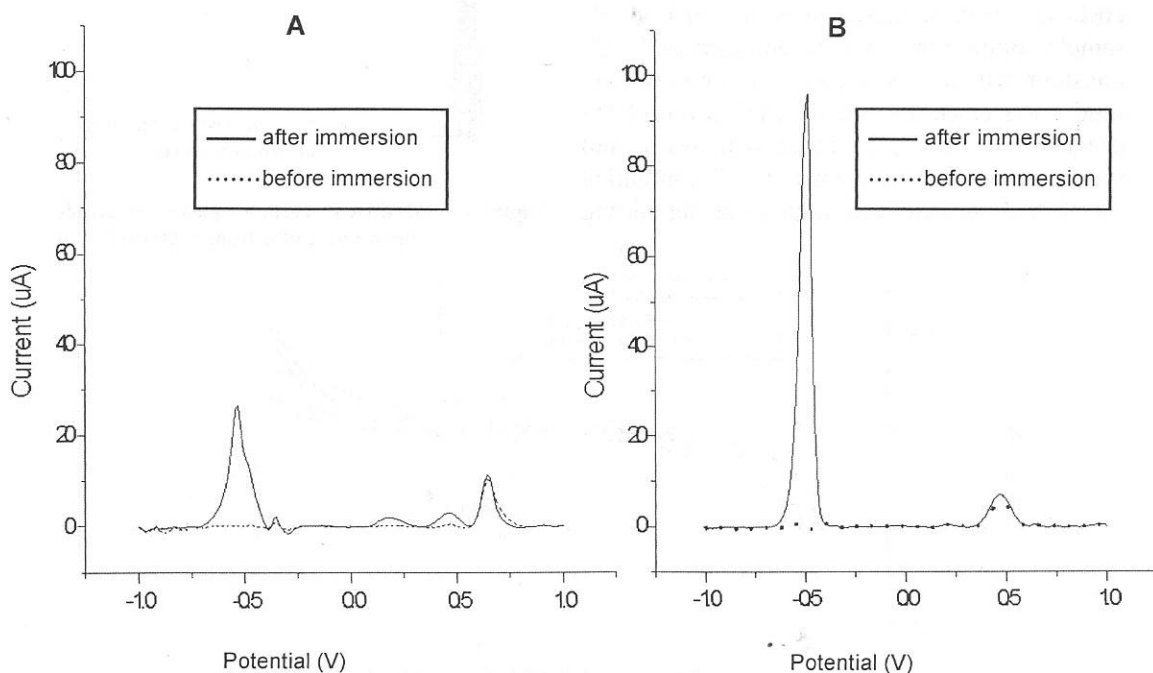


Figure 2. Cyclic voltammograms of carbon paste electrode (CPE) with and without cockroach chitin component.

Cyclic voltammetry was performed using the modified electrode at a potential range of  $-1000$  to  $1000$  mV. It is usually employed as a preconditioning mechanism to effectively eliminate any extraneous matter incorporated onto the electrode surface. In this instance, the surface area of the binding sites for the analyte increased. The results of cyclic voltammetry of bare and modified electrodes are shown in Figure 2. The two modified electrodes showed voltammogram different from each other and from that of the bare carbon paste electrode (CPE). Broadening of the cyclic voltammograms particularly in the modified carbon paste electrode was observed and this would suggest the inherent redox reaction of the modifier at minimal extent. The potential window of the modified chitin electrode was determined to be within the range of  $-1000$  mV to  $+1000$  mV and from this potential range, the modified electrode is inert and may be used to detect electroactive species like lead ions.

Differential pulse anodic stripping voltammetry (DPASV) was also performed by comparing voltammetric readings before and after pre-concentration at  $100$  mg/L lead solution which was prepared by diluting lead standard solution ( $1000$  mg/L) obtained from J.T. Baker with deionized distilled water.

A distinct peak was observed at around  $-0.5$  V after accumulation of the modified electrode in lead solution. This was observed in both wing and body chitin-modified electrodes (Figure 3). However, the signal generated in the wing chitin-modified electrode was much higher than that of the body chitin-modified electrode, although both of them had 20% chitin incorporated. It was possible that more lead ions bound with the wing chitin-modified electrode than in the other one.



**Figure 3.** Differential pulse anodic stripping voltammograms of carbon paste electrodes (CPE) incorporated with chitin from cockroach body (A) or wings (B) before and after immersion of the electrodes in  $100$   $\mu$ g/L lead solution