Exploring biochar potential for electrochemical sensing of pesticide maneb

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INTRODUCTION

Maneb (Manganese ethylenebis(dithiocarbamate), Fig. 1) could be used for the treatment of fruits and vegetables. The increase of dithiocarbamates metabolite concentrations in the environment may disrupt protein synthesis and metabolism. Therefore, a rapid, simple, and sensitive analytical approach for the analysis of MAN is needed [1].

Carbon paste electrode (CPE) modified by hardwood biochar (BC) could improve the voltammetric signal of MAN due to the high surface area and good conductivity [2].

The aim of this work was to develop a voltammetric method for the determination of MAN at CPE modified by BCs prepared at two pyrolysis temperatures, 400 °C (BC400) and 700 °C (BC700).

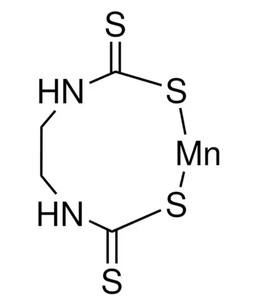
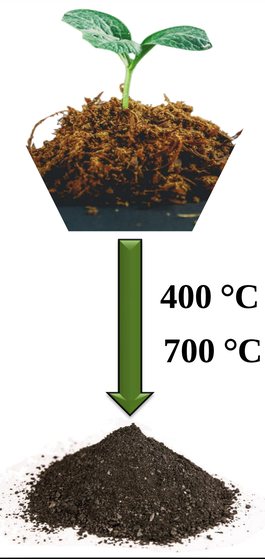


Fig. 1. Chemical structure of MAN



EXPERIMENTAL

The analytical standard of MAN was dissolved in double distilled water. Britton-Robinson (B-R) buffer as supporting electrolyte was prepared from 0.04 mol L^{-1} phosphoric acid, boric acid, and acetic acid by successive addition of 0.2 mol L^{-1} sodium hydroxide to adjust the pH value.

All voltammetric measurements were performed using the AUTOLAB PGSTAT operated *via* GPES 4.9 software (Ecochemie, The Netherlands) connected with an unmodified or BC-modified CPE as working, a saturated calomel electrode as reference, and a platinum as auxiliary electrode.

The prepared BCs was characterized by scanning electron microscopy (SEM), and specific surface area analysis (SSA).

RESULTS AND DISCUSSION

A porous structure of BCs (Fig. 2) with a high surface area and smaller pore size of BC700 (284 m^2 g^{-1}), in comparison with BC400 (176 m^2 g^{-1}).

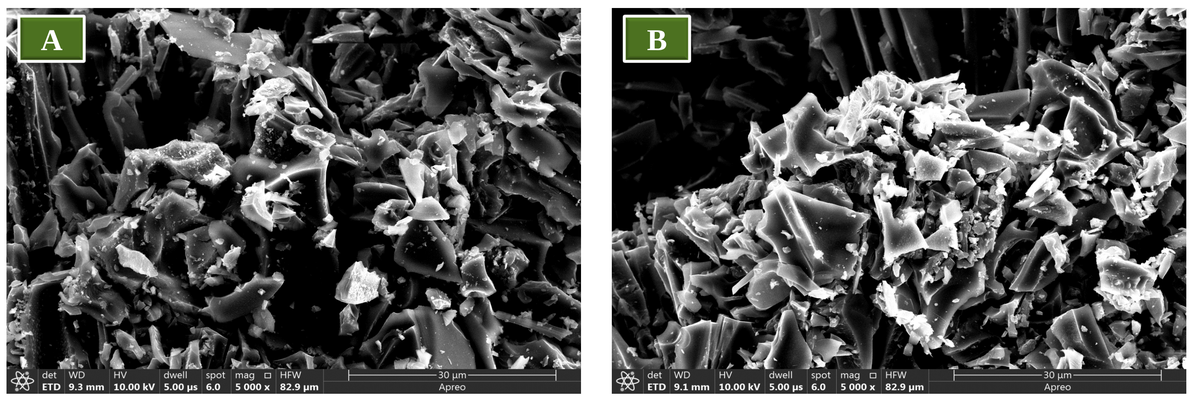


Fig. 2. Scanning electron micrographs of BC400 (A) and BC700 (B) surfaces obtained at the magnification of x 5000

Cyclic voltammetric signals (CVs) of MAN ⟶ The BC700-CPE is the most appropriate for further voltammetric measurements (Fig. 3).

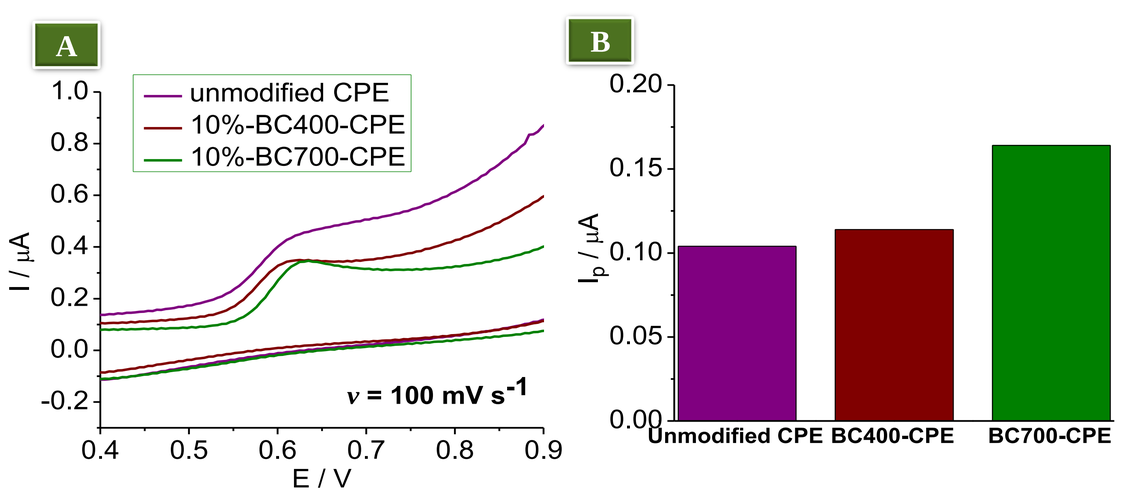


Fig. 3. CVs of MAN recorded with an unmodified CPE, BC400-CPE, and BC700-CPE (A). MAN anodic peak intensities for the different CPEs (B)

Anodic peak current (I_p) of MAN at around 0.65 V linearly increased with the *v* (Fig. 4) ⟶ Adsorption-controlled electrode process.

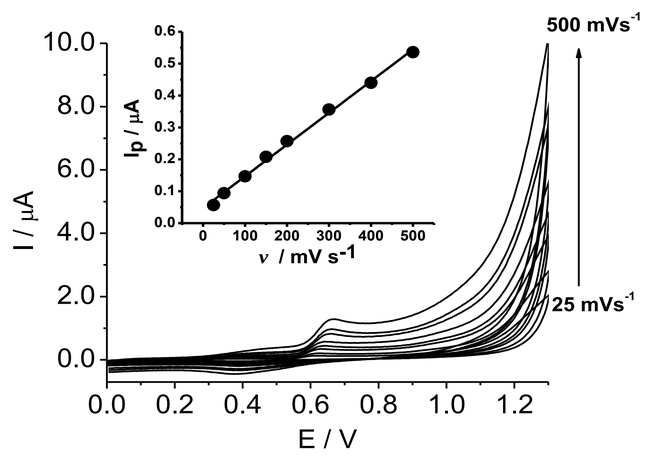


Fig. 4. CVs in B-R pH 7.0 containing 4.17 µg mL^{-1} MAN recorded by BC700-CPE at the different v. Dependencies of the I_p on the v (inset)

Differential pulse adsorptive stripping voltammetric (DP-AdSV) measurements: • The I_p of MAN linearly increased in a wide concentration range (Fig. 5A) with good reproducibility (Fig. 5B).

• A sensitive DP-AdSV method and BC700-CPE as an electrochemical sensor with detection limit of 0.015 µg mL^{-1} MAN.

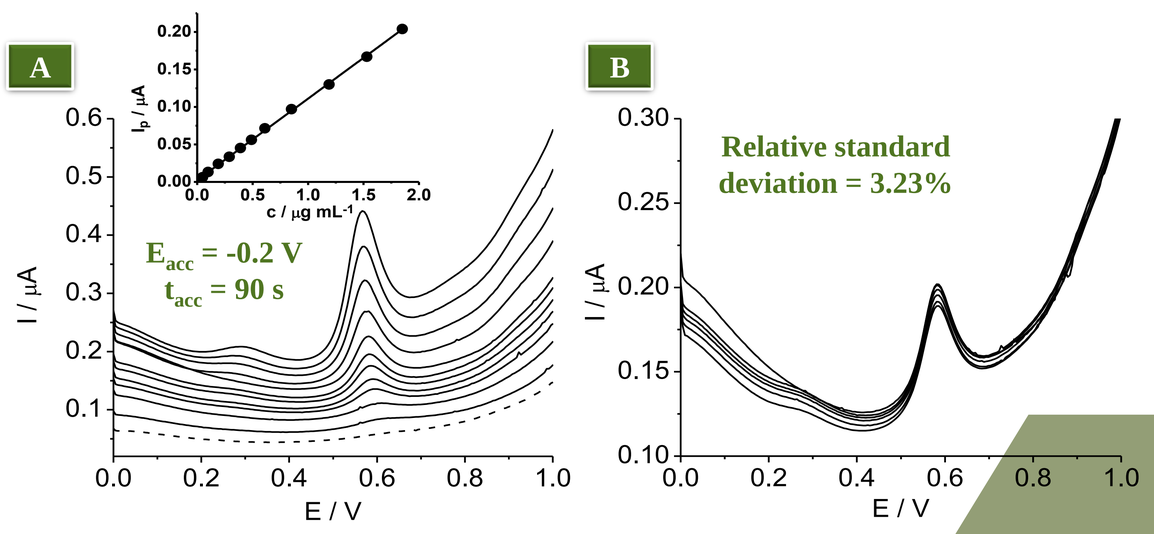


Fig. 5. DP-AdSV signals of different concentrations of MAN (from 0.049 to 1.84 µg mL^{-1}) at BC700-CPE in B-R buffer pH 7.0. Inset: Corresponding calibration curve (A). DP-AdSV responses of 0.49 µg mL^{-1} MAN (n = 6) (B)

REFERENCES

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