

EUGENOL POLYMER MODIFIED TITANIUM ELECTRODE FOR THE ANALYSIS OF CARBOCYSTEINE

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Abstract: A eugenol polymer immobilized electrode was developed for the assay of the carbocysteine compound. The electrochemical sensor was made by *in situ* electropolymerization of eugenol at titanium electrode. Cyclic voltamperometry at prepared electrode permitted to point out a reversible pattern for carbocysteine electrooxidation.

Keywords: *carbocysteine, eugenol, modified electrode, polymerization, sensor*

INTRODUCTION

Cysteine (Cys) plays an important role in several biological processes [1]; Cys or compounds of Cys are widely used in many pharmaceutical products. Determination of Cys or compounds of Cys are commonly used in clinical investigation, pharmaceutical industry, and rederch.

Among the many methods for determination of Cys [2, 3] or compounds of Cys, chromatographic methods are widely used. In spite of HPLC [4 – 6], several disadvantages can be cited. In all chromatographic methods, the sample should pass through derivatization and extraction of the products of reaction before their microinjection into column. Those methods use expensive reagents and equipment, and a significant period of time for whole assay.

The present paper describes the utilization of the eugenol polymer modified titanium electrode for electrochemical determination of Cys.

The considerable current interest in conducting polymer has led to a number of important applications [7 – 9]. Special attention is currently being given to the preparation of new conducting electrode coatings based on composite polymers [10]. It is expected that this strategy will improve the behaviour of conducting polymers and will result in polymers designed for specific application. Diaz and co-workers [11] described the preparation of poly(vinyl chloride) (PVC)/polypyrrole (PP) composite membranes, by electropolymerizing PP inside a PVC film on the electrode surface.

Buttry and Hirai's groups [12, 13] prepared poly(aniline)(PA)/Nafion composites by electropolymerization within precast Nafion layers, while Penner and Martin [14] illustrated the advantage of Nafion-impregnated Gorotex membranes.

Chtaini *et al.* [15] described the preparation of titanium/polypyrrole composite, by electropolymerizing pyrrole in the electrode surface.

In this report we describe a new titanium/poly-eugenol composite coating, for the determination of cysteine and their derivatives compounds.

EXPERIMENTAL

Electrochemical experiments were performed using a Voltalab potentiostat (model PGSTAT 100, Eco Chemie B.V., Utrecht, The Netherlands) driven by the general purpose electrochemical systems data processing software (Voltalab master 4 software). A conventional three-electrode system consisting of the eugenol polymer modified electrode working, platinum counter and SCE reference electrodes was used.

Eugenol compound was extracted from nail cloves. All other regents used were of analytical grade. Bidistilled deionized water was used throughout the work.

RESULTS AND DISCUSSION

Electrochemical polymerization of the polymers can be carried out by potential step or potential sweep methods, using typical coating eugenol monomers in basic media. In the cyclic voltammetric curves for the polymerization (Figures 1 and 2) in titanium electrode. For the first cycle a broad peak well defined at -0.2 V was observed. This

peak disappears from the second cycle, this behavior indicates the rapid deposition of a non-conductive polymer to the electrode surface. However, when the potential scan is extended towards positive values is observed a second peak at about 1.3 V, Ciszewski *et al.* [16], in a study of the same molecule on a glass electrode, attributed the first peak in the deposition of a polymer on the electrode surface, the second peak is probably due to the phenomenon degradation / restriction of this polymer.

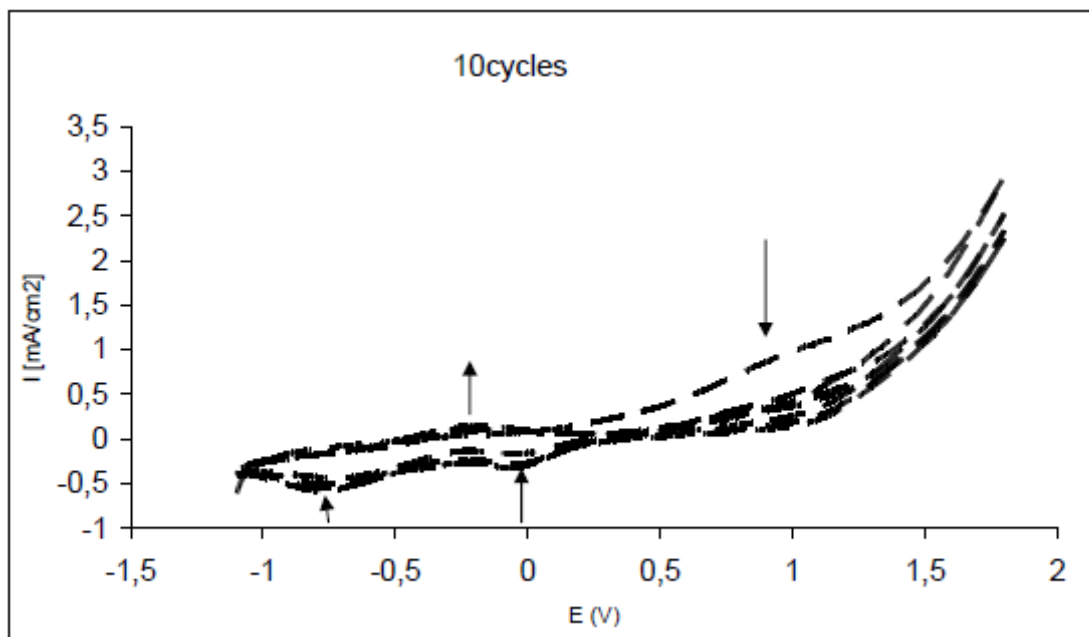


Figure 1. Cyclic voltammograms for electrochemical polymerization of eugenol in NaOH solution at titanium electrode, scan rate: 50 mV/s, 10 cycles

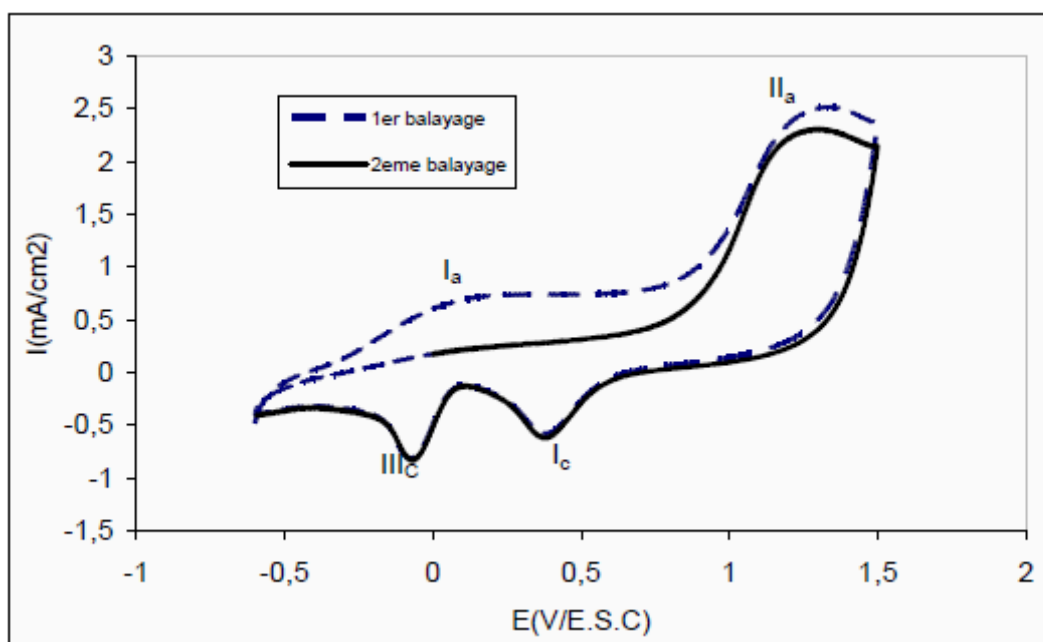
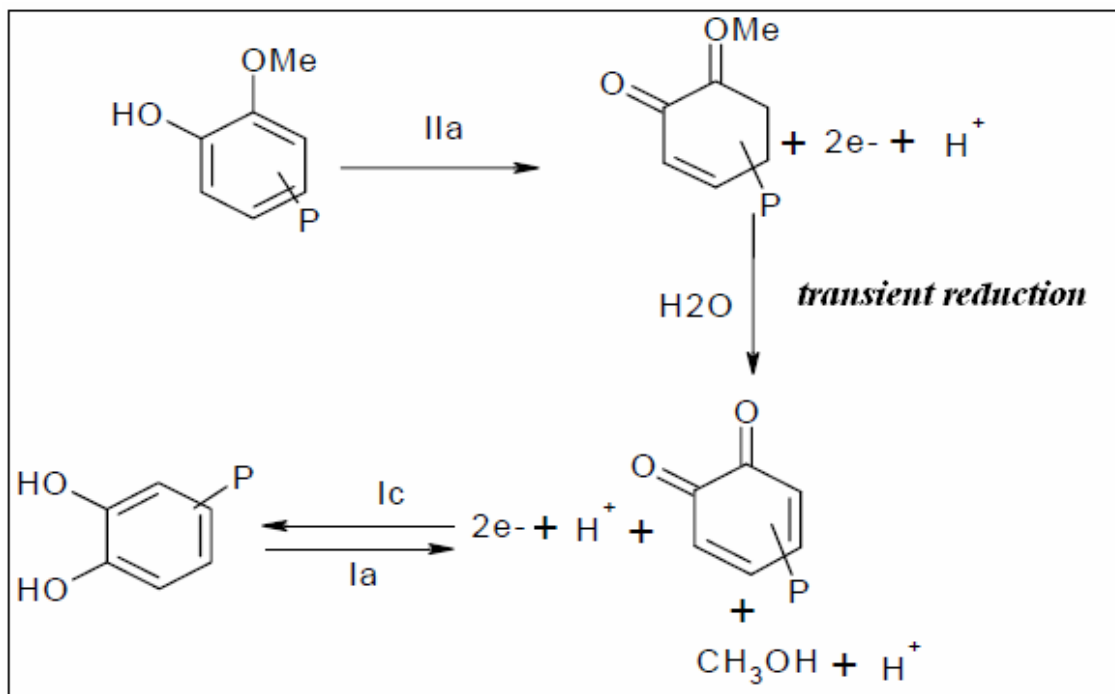
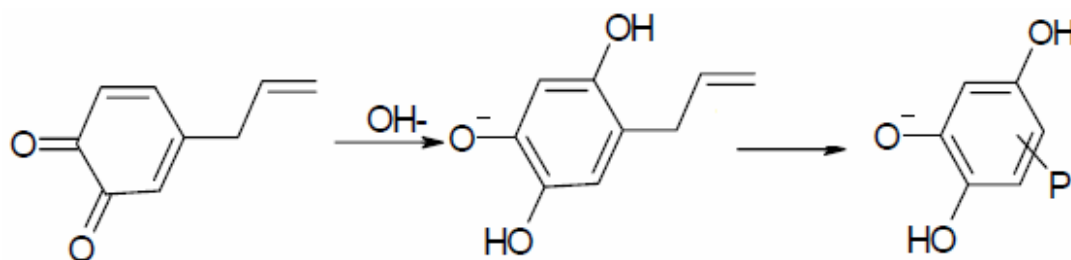


Figure 2. Cyclic voltammograms for electrochemical polymerization of eugenol in NaOH solution at titanium electrode, scan rate: 50 mV/s, first and second cycles

For scanning back there are two reduction peaks, respectively, at -0.07 V and 0.37V, based on the results of Peter *et al.* [17], the major reversible couple (I_a / I_c), followed by an irreversible peak II_a can be attributed to the following steps:



where P indicates the polymeric structure in which a groups 2-methoxy-phenol are stationary, the second peak III_c is probably associated to the transition of trihydroxybenzene derivative formed during the polymerization from 4-allyl-1,2-quinone according to the reaction:



An impedance spectroscopy study was performed in order to confirm the results obtained by the cyclic voltammetric tests. Figures 3 and 4 shown the impedance diagrams recorded respectively, for titanium with and without polymers. In the both samples, the impedance curves are in the form of half-circle which can be attributed to the electron transfer step. The diameter of the circles increased considerably in Ti/polymer electrode, probably because the polymer over oxidized at such positive potentials it becomes electrochemically inactive and lead the increase of the electron transfer resistance.

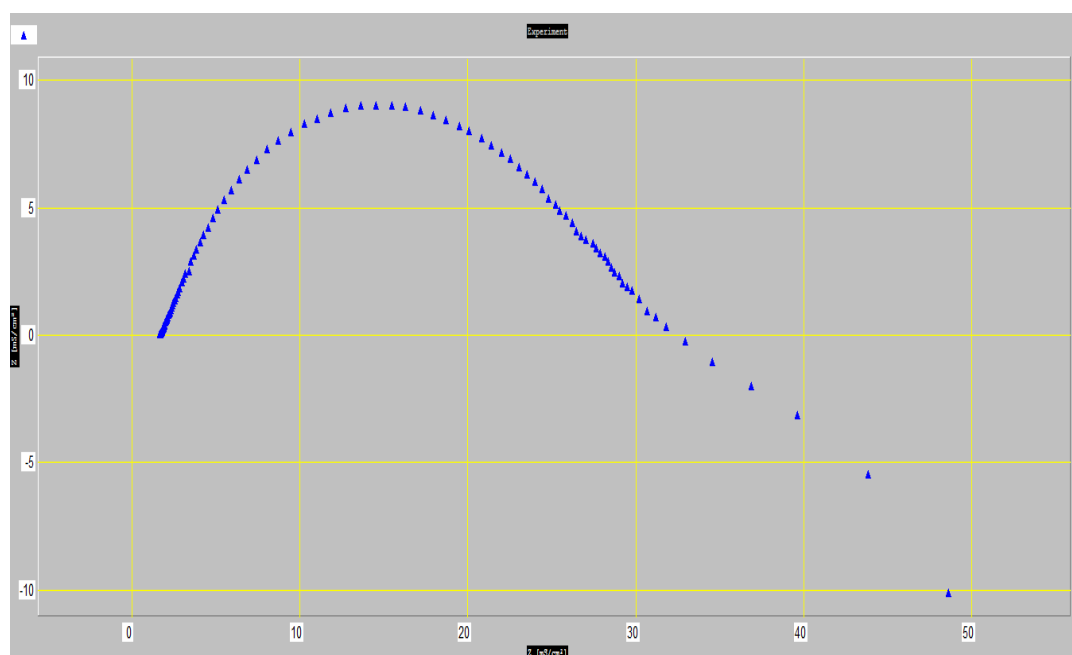


Figure 3. Electrochemical impedance spectroscopy for Ti electrode in 0.1M Na_2SO_4 solution

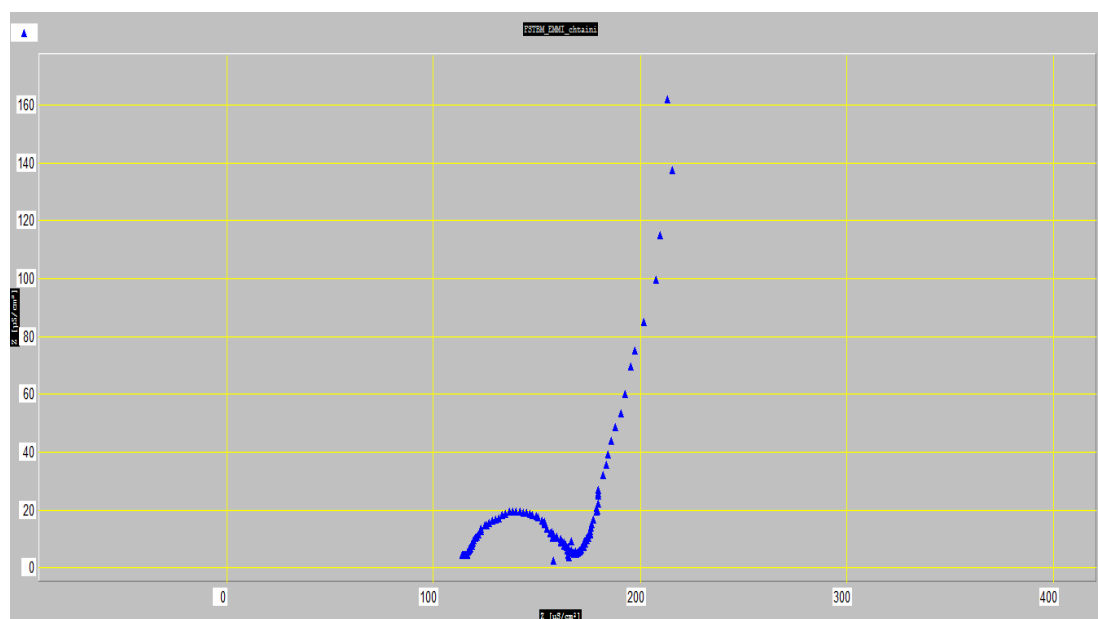


Figure 4. Electrochemical impedance spectroscopy for Ti/polymer electrode in 0.1M Na_2SO_4 solution

Figure 5 shows some of typical cyclic voltammetry curves recorded at Ti/polymer electrode after being in contact with different carbocysteine concentrations for 15 min of accumulation time. The oxidation of carbocysteine showed, in the investigated buffer media (pH = 6), a well known electrochemical behavior with removal of one electron to the corresponding cation radical $\text{RS}^{\cdot+}$ (peak).

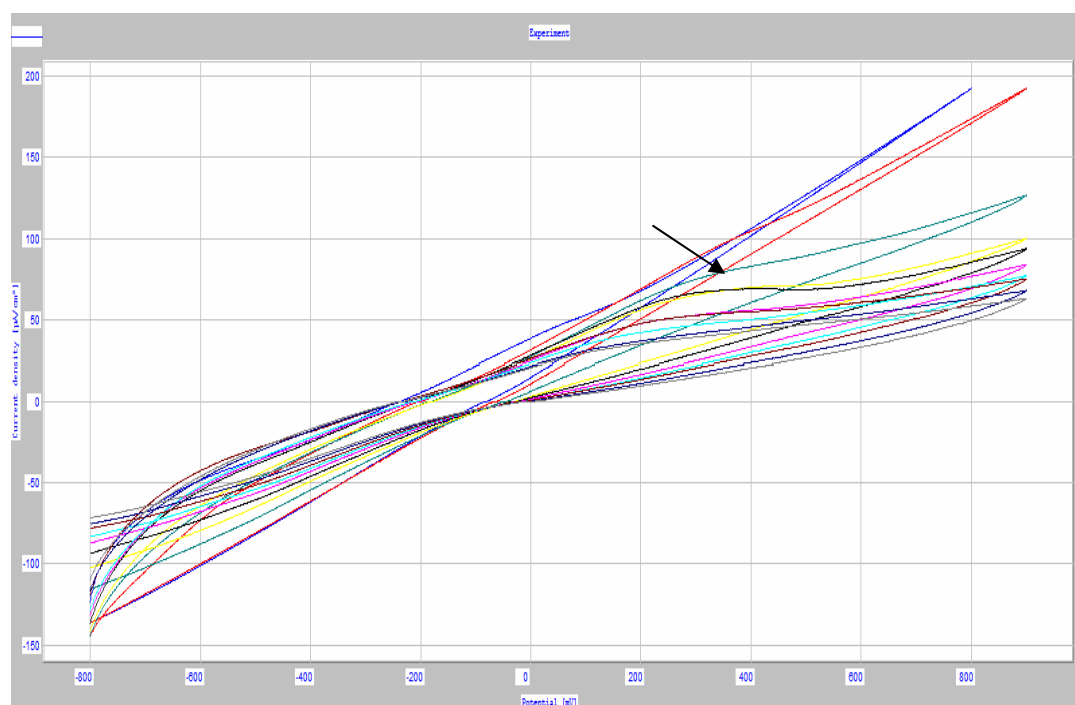


Figure 5. Cyclic voltammograms of different concentrations of carbocysteine in buffer media, pH = 6

Figure 6 shows the behavior of eugenol polymer modified titanium electrode in buffer solution, in the presence of different concentrations of carbocysteine compound. We constat that the modified electrode prepared reacts positively with the studied compound.

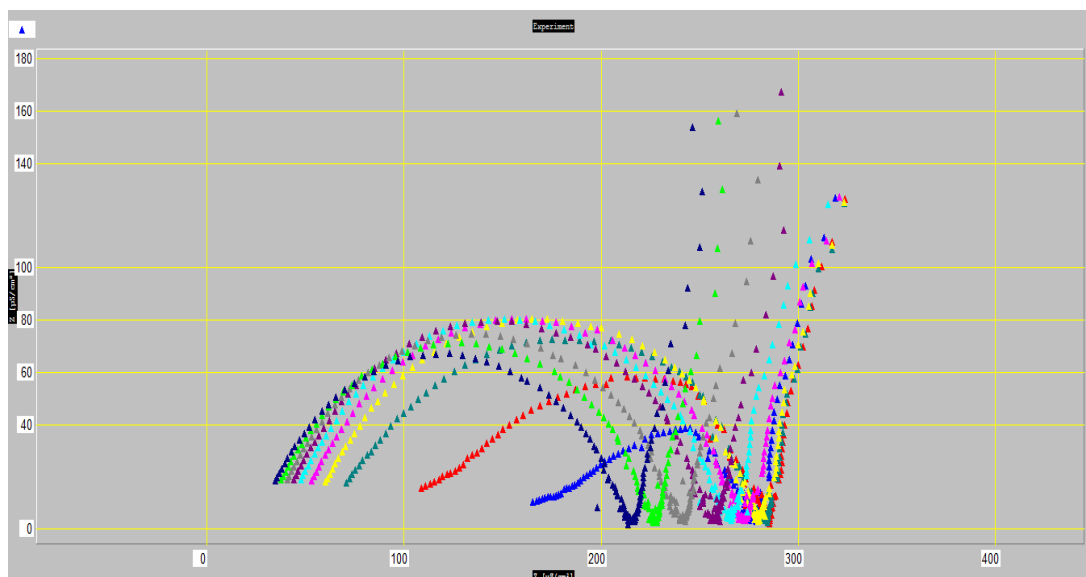


Figure 7. Nyquist diagrams of polymer modified titanium electrode, in presence of different concentration of carbocysteine

CONCLUSION

It was demonstrated here that eugenol is suitable for the preparation of an operating chemically modified electrode based on in situ polymerization of eugenol at titanium electrode for the the detection of carbocysteine.

Initially, the results presented in this article clearly demonstrate how the polymerization conditions influence the properties of electrochemically prepared polymer modified electrode.

The electrochemical behavior of carbocysteine was evaluated using the voltammetric results. The cyclic voltammetry showed one anodic pic associated to the oxidation of carbocysteine. The use of the polymer/Ti electrode makes the direct analysis of the samples possible without any necessity of pre-treatments or chemical preparation stages.

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