

DSA Type Electrodes Characterisation by Cyclic Voltammetry in the Presence of Surfactants

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Abstract: The aim of this study was surface characterisation of Ti/SnO₂-Sb₂O₅ anode by cyclic voltammetry (CV) in the presence of nonylphenol ethoxylate with 6 ethoxy units (NP6EO). The anode was prepared by thermal decomposition of appropriate precursors. Cyclic voltammograms in 0.01 g/L NP6EO were recorded for a scan rate of 0.05 V/s and 0.1M Na₂SO₄ as the supporting electrolyte. The examination of the cyclic voltammograms showed that the oxidation of NP6EO could occur under conditions of simultaneous O₂ evolution.

Keywords: cyclic voltammetry, DSA, nonylphenol ethoxylates

1. Introduction

Surfactants related to nonylphenol but with additional groups of ethylene oxide units are nonylphenol ethoxylates. They belong to a class of surfactants called nonionic surfactants.

Nonylphenol and the related nonylphenol ethoxylates are used in pesticide products as "inert" ingredients and as adjuvants added by the pesticide user. Nonylphenol ethoxylates are also widely used as surfactants in industrial and institutional cleaning products

Nonylphenol and some of its ethoxylates are estrogenic; they mimic the action of the hormone estrogen. Nonylphenol ethoxylates have been shown to reduce fertility in laboratory animals.

Nonylphenol and some of its ethoxylates cause breast cancer cells to increase in number.

Nonylphenol and its ethoxylates are acutely toxic to a wide variety of animals: bees, spiders, fish, molluscs, and crustaceans [1].

Thus, the release of nonylphenol ethoxylates in the aquatic environment leads to toxic effects.

The nonionic surfactants can be degraded by anodic oxidation at Ti/SnO₂-Sb₂O₅ DSA type electrodes. The electrochemical characterization of electrodes provides precious information about the degradation process. CV is an important technique used to electrochemical characterization of thin films containing SnO₂ content [2-8].

The aim of this study was the Ti/SnO₂-Sb₂O₅ electrode characterization by CV to get information about its behaviour in presence of NP6EO.

2. Experimental

The cyclic voltammetric experiments were performed by using an EcoChemie Autolab-PGSTAT 302 computer-controlled potentiostat-galvanostat. A saturated calomel electrode was used as a reference electrode. DSA wires with active surface area of 1 cm² were used as working electrode and a platinum plate of 1 cm² as a counter electrode. Experiments were carried out at 50 mVs⁻¹ scan rates and at room temperature.

The supporting electrolyte was a solution of 0.1 M Na₂SO₄ (Chimopar București). The surfactants solutions of 0.01 g/L NP6EO were prepared by using the technical product.

The Ti/SnO₂-Sb₂O₅ anode was prepared by thermal decomposition of appropriate precursors: SnCl₄ · 5 H₂O (Aldrich) and SbCl₃ (Aldrich). The molar ratio Sb:Sn in precursor solution was 3:97.

3. Results and discussion

The cyclic voltammograms of Ti/SnO₂-Sb₂O₅ fresh anode recorded for a large potential range in the 0.1 M Na₂SO₄ supporting electrolyte for three scans are shown in Fig. 1.

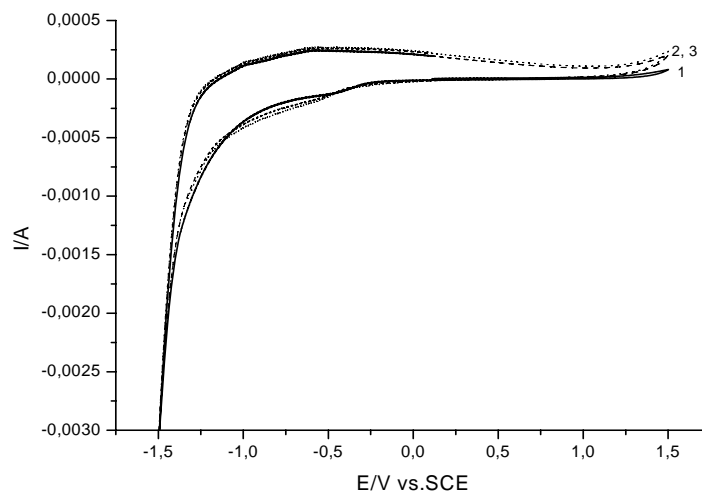


Fig. 1. Cyclic voltammogram of Ti/SnO₂-Sb₂O₅ in 0.1 M Na₂SO₄; scan rate 0.05 V/s; potential range: -1.5 V to 1.5 V vs. SCE; 1- first scan; 2-second scan; 3-third scan

It can be seen a slight increase of the current after the first scan that proves the electrode activation. The third scan overlaps the second one, therefore an advanced electrochemical preformation was not needed.

To check the electrode stability in the anodic potential range that is appropriate for oxidation, repetitive scans were performed. Thus, for each measurement three

consecutive scans were carried out. The results recorded for the third scan of each repetition are reproduced in figure 2. The voltammograms overlaps and this shows the electrode stability in the experimental conditions.

These voltammograms showed that for more positive potentials than 1.4 V vs. ESC, the anodic current increased exponentially, in this range O₂ evolution occurring.

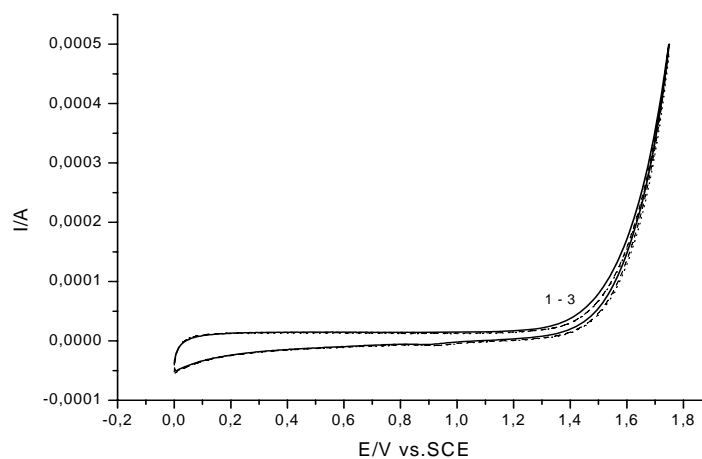


Fig. 2. Cyclic voltammogram of Ti/SnO₂-Sb₂O₅ in 0.1 M Na₂SO₄; three repeated scans; scan rate 0.05 V/s; potential range: 0 V to 1.75 V vs. SCE; 1- first repeated scan; 2-second repeated scan; 3-third repeated scan

In these experiments the behaviour of Ti/SnO₂-Sb₂O₅ electrode in the presence of NP6EO was also investigated. The voltammograms were recorded by consecutive and repetitive scans in the presence of the pollutants in 0.1 M

Na₂SO₄ supporting electrolyte. Fig. 3 shows the cyclic voltammograms recorded for the third scan of each repeated scan.

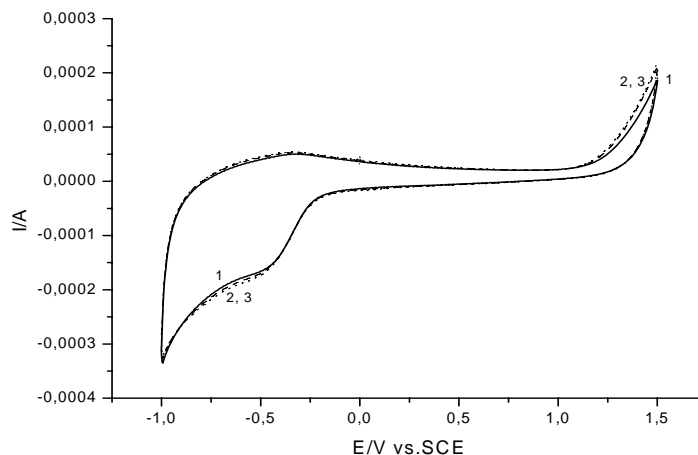


Fig. 3. Cyclic voltammogram of Ti/SnO₂-Sb₂O₅ in 0.1 M NP6EO 0.01 g/L in 0.1 M Na₂SO₄; three repeated scans; scan rate 0.05 V/s; potential range: -1.0 V to 1.5 V vs. SCE; 1- scan in the presence of Na₂SO₄; 2-scan in the presence of NP6EO 0.01 g/L in 0.1 M Na₂SO₄; 3- repeated scan in the presence of NP6EO 0.01 g/L in 0.1 M Na₂SO₄

It can be easily noticed that the voltammograms recorded without and in the presence of NP6EO overlap that suggests the oxidation of the pollutant could occur in the O₂ evolution potential range.

The voltammograms recorded in the presence of NP6EO for the two repeated scans overlap, therefore the electrode is stable in the above working conditions in presence of the pollutant.

4. Conclusions

The aim of this paper was the electrochemical characterisation of the DSA type electrode, Ti/SnO₂-Sb₂O₅, by cyclic voltammetry in the presence of NP6EO, a nonionic surfactant.

The electrode was prepared by thermal decomposition of the appropriate precursors.

The voltammograms were recorded in 0.01 mg/L NP6EO using as a supporting electrolyte 0.1 M Na₂SO₄ and a scan rate of 0.05 V/s.

The examination of the voltammograms showed the stability of the electrode both in the supporting electrolyte and in the presence of NP6EO.

Also, the recorded voltammograms suggest that the oxidation of the NP6EO can occur in conditions of simultaneous discharge of oxygen.

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