

## STUDIES ON THE POSSIBILITY OF USING EXPIRED CEFTRIAXONE DRUG AS ADDITIVE IN ACID ELECTROPLATING BATHS

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### Abstract

In this paper, preliminary data obtained using ceftriaxone (CEFTR) as additive in copper and nickel electrodeposition from acid baths are presented. Electrochemical behaviour of ceftriaxone and introductory information about the way its presence in the metalselectrodeposition bath influences the electrode processes have been obtained by cyclic voltammetry on platinum electrode. Inhibitory effect of ceftriaxone in the electrolyte solutions used in copper and nickel deposition processes was studied by linear voltammetry.

### Introduction

Considering the appreciable amount of unused and expired medical products available worldwide and the non-environmental friendly storage and neutralization techniques currently practiced, researchers seek for new ways of using non-compliant drugs [1-3].

Currently, the active substances from drugs are successfully used as corrosion inhibitors [4]. They act similar to the levelling agents added in the galvanic baths. Due to increasing coverage with organic substance because of adsorption onto metal surface, additives increase the metal deposition overpotential. Regarding the morphology of cathodic deposits, blocking active sites on the surface during electrodeposition results in nucleation rate enhancement. As it is known, this leads to more smooth cathodic deposits [5].

Research purpose is to harness CEFTR, the active substance from expired cefort, as additive in copper and nickel deposition from acid baths. Copper coatings are used for galvanotechnics purposes in manufacturing printed circuit boards, pattern and photogravures and very often as interlayer for nickel deposition [6]. Watts type bath is the most commonly used for nickel deposition. Nickel coatings are often used in decorative purposes and for their anticorrosive properties [7-9].

Coating properties are improved by additives. These are in general organic molecules which influence the physical and mechanical properties of cathodic deposits [10,11]. Similar compounds are found in active substances from drugs.

According to its structure, ceftriaxone sodium, a cephalosporin antibiotic, is a promising additive. It is the active substance found in cefort. Its systematic (IUPAC) name is: (Z)-7-[2-(2-aminothiazol-4-yl)-2-methoxyiminoacetamido]-3-[(2,5-dihydro-6-hydroxy-2-methyl-5-oxo-1,2,4-triazin-3-yl)thiomethyl]-3-cephem-4-carboxylic acid, disodium salt, sesquaterhydrate [12].

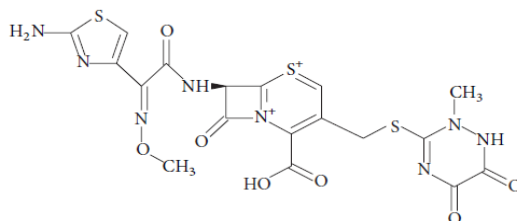
### Experimental

To characterize ceftriaxone voltametric behaviour in acid media (0.5 mol L<sup>-1</sup> H<sub>2</sub>SO<sub>4</sub> and 30 g L<sup>-1</sup> H<sub>3</sub>BO<sub>3</sub> + 0.5 mol L<sup>-1</sup> Na<sub>2</sub>SO<sub>4</sub> solutions), cyclic voltammetry (CV) on platinum electrode was performed. CVs were recorded at 50 mV s<sup>-1</sup>.

In order to determine ceftriaxone influence on copper and nickel deposition processes, linear voltammograms (LVs) were drawn on copper and nickel electrodes in electrolyte solutions containing 5 g L<sup>-1</sup> M<sup>2+</sup> ions, in 25 – 65°C temperature range.

In experimental studies, ceftriaxone sodium (Figure 1), the active substance from commercial

drugcefort was used.



**Figure 1.** Ceftriaxone sodium chemical structure [13].

All reagents used in experimental studies were of analytical grade. Copper and nickel working electrodes were polished with different grit emery papers, ultrasonic cleaned, washed with distilled water and dried.

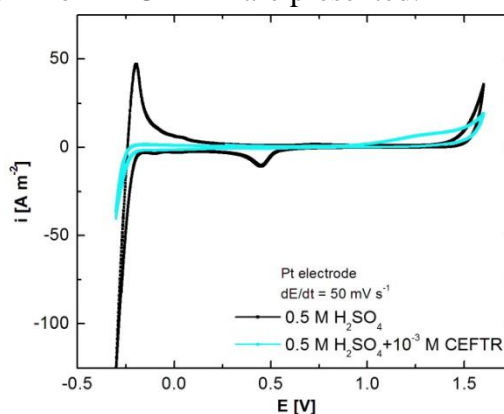
Electrochemical measurements were performed using a PARSTAT 2273 potentiostat/galvanostat in a thermostatic three-electrode glass cell equipped with: Pt/Cu/Ni working electrodes with 1 cm<sup>2</sup> exposed area, Ag/AgCl reference electrode and two graphite counter electrodes. All further potential values given in this paper are versus the reference electrode ( $E_{\text{Ag/AgCl}} = 0.197 \text{ V}$ ).

### Results and discussion

In order to determine CEFTR electrochemical behavior, CVs were recorded with different scan rates, on platinum electrode, in blank solution and solutions with different concentrations of CEFTR, between  $10^{-6} - 10^{-3} \text{ mol L}^{-1}$ .

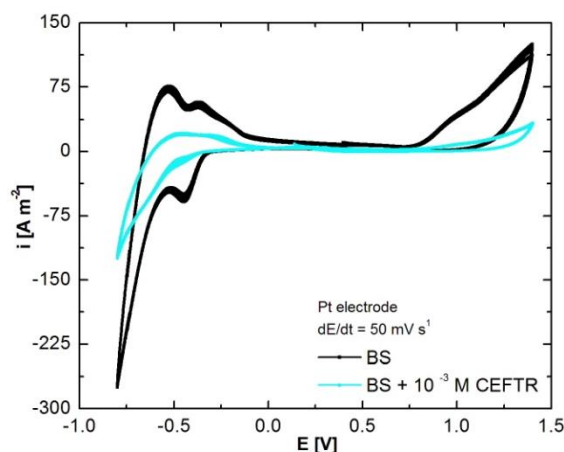
To simulate the pH values from industrial deposition baths, as blank solutions,  $0.5 \text{ mol L}^{-1} \text{ H}_2\text{SO}_4$  have been used for copper deposition, and  $30 \text{ g L}^{-1} \text{ H}_3\text{BO}_3 + 0.5 \text{ mol L}^{-1} \text{ Na}_2\text{SO}_4$  solution (BS) for nickel deposition.

In figure 2, CVs recorded at  $50 \text{ mV s}^{-1}$  scan rate on Pt electrode, in  $0.5 \text{ mol L}^{-1} \text{ H}_2\text{SO}_4$  in the absence and presence of  $10^{-3} \text{ mol L}^{-1}$  CEFTR are presented.



**Figure 2.** CVs on Pt electrode, in  $0.5 \text{ mol L}^{-1} \text{ H}_2\text{SO}_4$  without/with  $10^{-3} \text{ mol L}^{-1}$  CEFTR,  $50 \text{ mV s}^{-1}$  scan rate.

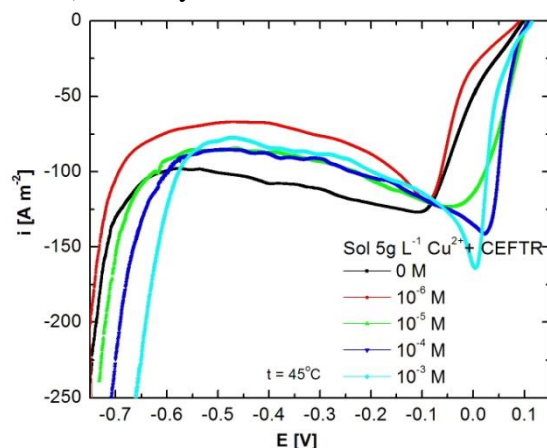
Figure 3 presents CVs recorded at scan rate of  $50 \text{ mV s}^{-1}$  on Pt electrode, in BS in absence and presence of  $10^{-3} \text{ mol L}^{-1}$  CEFTR.



**Figure 3.** CVs on Pt electrode, in BS without/with  $10^{-3}$  mol L $^{-1}$  CEFTR,  $50$  mV s $^{-1}$  scan rate.

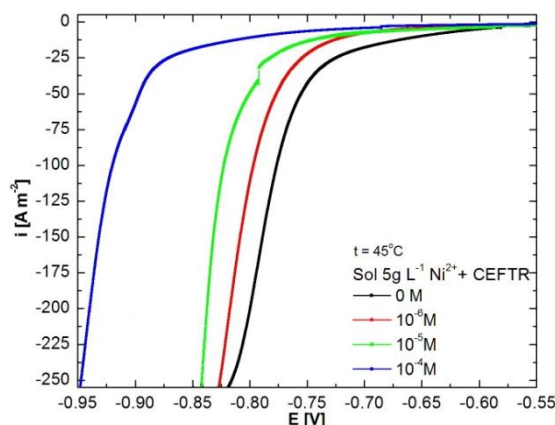
Comparing voltammograms drawn in the same potential range, from both figures 2 and 3 it can be observed a decrease of current density associated to characteristic processes when using CEFTR as against blank solution. Also, a shift of cathodic peaks to more negative potentials and of anodic peaks to more positive potentials can be seen.

CEFTR effect on copper and nickel deposition processes was studied at temperatures between  $25$  and  $65^{\circ}\text{C}$  by linear voltammetry. LVs were drawn at  $5$  mV s $^{-1}$  scan rate on Cu (Figure 4) and Ni electrode (Figure 5) in  $5$  g L $^{-1}$  Cu $^{2+}$  (from H $_2$ SO $_4$  + CuSO $_4$ ), respectively Ni $^{2+}$  ions (from H $_3$ BO $_3$  + NiSO $_4$  + NiCl $_2$ ) electrolyte solutions.



**Figure 4.** LVs in  $5$  g L $^{-1}$  Cu $^{2+}$  in the absence and presence of different CEFTR concentrations,  $5$  mV s $^{-1}$  scan rate.

Analysing above LVs, ceftriaxone addition in the electrolyte solution leads to a shift of copper and nickel deposition potential values because of the organic molecule absorption onto the metal surface.



**Figure 5.** LVs in  $5\text{ g L}^{-1}\text{ Ni}^{2+}$  in the absence and presence of different CEFTR concentrations,  $5\text{ mV s}^{-1}$  scan rate.

### Conclusion

Preliminary studies show that ceftriaxone from expired cefort can be recycled as an additive in copper and nickel electrodeposition from acid baths.

Ceftriaxone addition in the electrolyte solution inhibits both anodic and cathodic studied processes.

### Acknowledgements

This work was partially supported by University Politehnica Timisoara in the frame of PhD studies.

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