

Recuperation of Silver from Wastewater of Miroiterie of Thenia (Algeria)

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Abstract. In Algeria, the nonexistence of silver mines makes it particularly rarer than its classification among the precious metals imposes its metal recuperation. The objective of this study is electrodeposition of silver ions of sludge from wastewater of miroiterie of SOMIVER Thenia. The process applied in this case is electrolysis of sludge formed in a glass cell containing two electrodes: a cathode made of aluminum and a graphite anode. An adjustable continue current source capable of delivering from 1 to 10 Amps, this causes the cathode reaction electrodeposition of silver. Therefore, we lead to precede by comparison determinations under the effect of weight of cathode. Its weighing before and after electrolysis, and weight difference, means that amount of silver accumulated. Second, we determined the characteristics of sludge by electrochemical aluminum interface (OCP linear voltammetry and electrochemical impedance spectroscopy) before and after electrolysis, this is made possible by Potentiostat PGZ 301. In the electrolysis of silvering solution it has proved that low currents from 0.5 to 4 A can get a good yield of deposit silver where Δm increases linearly with increasing intensity of electrolysis current for a period of 30 minutes. By against, for electrolysis currents higher than 4 A we recorded decrease in the amount of silver.

Keywords: Silver, Silvering solution, Electrolysis, OCP, Voltammetry, Electrochemical impedance spectroscopy .

1. Introduction

In nature, there are many metals, but in different quantities there are precious metals that have particularly high economic value, they are not many which it has gold, silver, platinum, rhodium and palladium [1]-[3]. With industrial development, discharges of waste electrical and electronic equipment (WEEE) are considered as a source of precious metals attendance in nature, these quantities of WEEE increase of 3 to 5% per year, cite us amongst connectors, hard disk drives, integrated circuits, transistors, relays and circuit resistance-inductance-capacitance and switches [4]. The precious metals are also included in the composition of special alloys. Waste highly sought after for their homogeneity and content of non-ferrous and precious metals switches (Co: 49% Fe: 48% V: 2% Au: 0.5%, Rh: 0.4%) materials widely used in the communications industry.

Waste of these metals is also other uses such as covering materials for the brightness, silvering mirrors ... etc... They exist in wastewater after their applications.

In this work, we treat water discharges society SOMIVER Thenia in Algeria to recover silver for economic and environmental reasons. These wastes are obtained when applying the glass silvering. Society SOMIVER applied to glass a silver layer for reflection 85% with a minimum quantity of silver is 0.7 g/m² and a copper layer to protect the silver layer.

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Environmental point of view, silver is a highly toxic metal necessarily low concentrations used in toxicity testing the absorption by algae is very fast and no non-metabolizable ligand keeps the concentration stable silver an operating environment. Silver is considered one of the most toxic trace metals to aquatic organisms [5]-[7]. Moreover, its high toxicity results from its high affinity for sulfur groups S_2 contained in enzymes and proteins many cases of accumulation of this metal have been observed in various species all through trophic chain [8].

2. Materials and Methods

2.1. Sampling

The chemical composition of water discharges SOMIVER was determined by atomic absorption spectroscopy AAS. Silvering and coppering solutions contents respectively 2.098 and 0.468 mg/l of silver.

2.2. The electrochemical cell used for electrolysis with direct current

An electrochemical cell with one glass wall was used to control the temperature at 20 °C for all tests. Its large volume (1000 ml) avoids concentrations variations during electrodeposition. The cell consisting of two electrodes. The cathode is an aluminum plate of 7.25 cm² surface and the anode is made of graphite of 0.45 cm diameter and 20 cm of length. Before starting the experiment, aluminum cathode is polished with abrasive paper SiC 1000. Following, it is placed in nitric acid at 25% HNO₃, in acetone for 10 minutes and in demineralized water. To reduce the oxide layer that forms in open air on aluminum surface, an electrochemical polishing is needed to make its more smooth and glossy surface. The procedure is described in [9], [10]. For this, the electrode is polarized at -2.5 V/SCE for 5 minutes (electrochemical degassing).

2.3. Electrochemical cell used for characterizing interface aluminum/ solutions

The different electrodes used in the study of electrochemical behavior of interface aluminum- silvering solution are the aluminum plate mentioned above as a working electrode, a saturated calomel electrode is used as reference electrode and platinum as a counter electrode. Electrochemical experiments were driven under potentiostatic conditions using Radiometre PGZ 301 interface (Potentiostat/Galvanostat). A computer provided with a Windows software application (Voltmaster 4) was used. Impedances were measured at -1.3 V/SCE, either in silvering solutions. The impedance recordings are realized in a frequency interval ranging from 100 kHz to 0.1 Hz with amplitude 10 mV.

3. Results and Discussion

3.1. Effect of continuous current on silver electrodeposition

After electrolysis continuous source of silvering water for 30 minutes, we observed the formation of silver deposit on the aluminum electrode.

After drying of electrode to air, we weighed the deposition of silver to evaluate the variation of deposition amount as a function of applied current. Table 1 shows that the mass of deposit is important for low currents.

Table 1: Variation in mass of silver deposit according to electrolysis current.

Continuous current (A)	0.5	1.5	2.5	4	6.5	7.5	8.5
Δm (g)	0.015	0.0157	0.0183	0.02	0.0146	0.0026	0.0017

From 0.5 to 4 A: Δm increases linearly with increasing current intensity of electrolysis. The current favors metal deposition, which gives a good yield for a period of 30 min.

From 4 to 8.5 A: recovered mass of silver decreases with increasing applied current. This is explained by fact that silver particles in the solution are dynamic because of their high speeds and are disturbed to deposit on cathode surface from which they return to solution.

3.2. Characterization of interface aluminum / silver

3.2.1. Evolution of potential abandonment

Determination of potential abandonment (E_{corr}) is essential to achieve stability of system. Fig. 1 shows ennoblement of corrosion potential when current intensity of electrolysis increases. From the results we can assume that the mechanism of corrosion (E_{corr}) depends on nature of solution and solution concentration [11], [12].

3.2.2. Polarization curves

Fig. 2 shows presence and displacement of limiting diffusion of silver ions according to electrolysis current. Indeed, important electrolytic current values lead more cathode tensions. This is explained by silver deposition on aluminum surface that prevents diffusion of species through the pores of deposit. On an anodic area, we obtained oxidation peak around 0.5854 V/SCE, attributed to formation of AlO_2^- [13], [14].

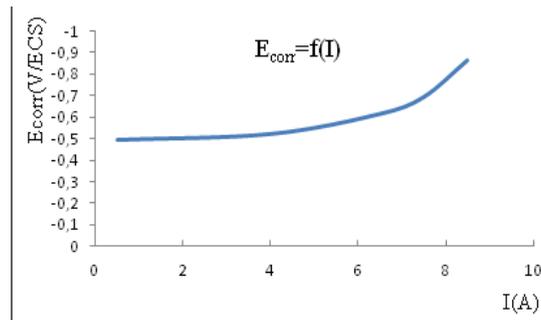


Fig. 1: E_{corr} evolution of Aluminum electrode according to currents electrolysis.

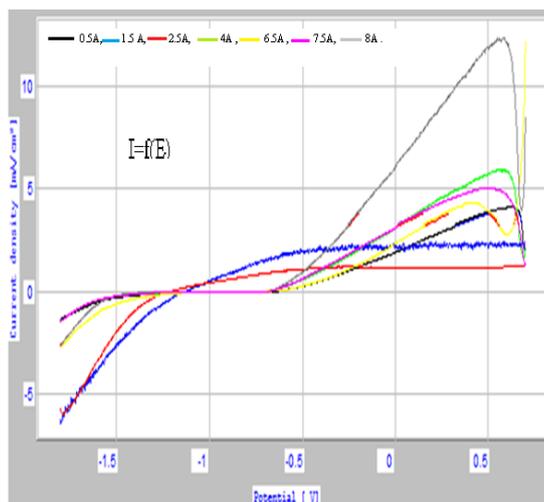


Fig. 2: Polarisation curves obtained for different currents electrolysis at ambient temperature.

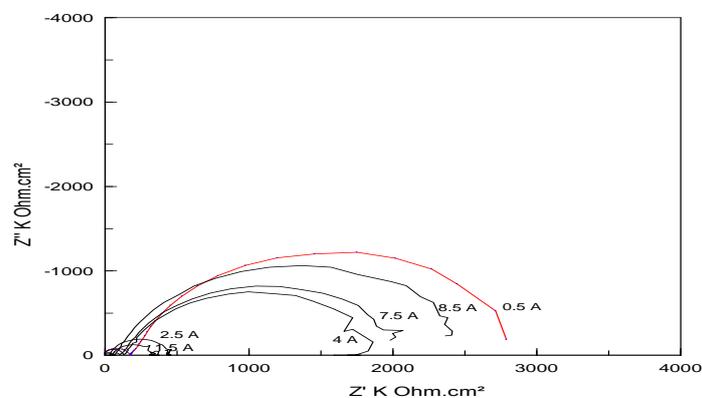


Fig. 3: Evolution of impedance diagrams according to various currents electrolysis.

3.2.3. Impedance spectra analysis

Electrochemical impedance spectroscopy (EIS) measurements were performed in situ. The same conditions than that observed for chronoamperometric experiments were applied: electrodes were polarized at -1.3 V/SCE. Electrochemical impedance diagrams were traced for different current electrolysis. We found for all diagrams (see Fig. 3), the presence at a high-frequency a capacitive loop due to phenomenon of charge transfer and another loop at low frequency relative to formation of silver deposit. This phenomenon has already been observed by authors [15], [16]. We also noted that polarization resistance R_p increases with increasing current intensity of electrolysis. Except for 0.5 A, R_p is greater than other current. This is explained by the prior, this phenomenon is due to significant transfer of silver ions.

4. Conclusion

During electrolysis of the silvering solution, we noted that low currents allowed us to obtain a good yield deposit for a period of 30 minutes.

The polarization curves show the presence and the displacement of limiting diffusion of silver ions according to electrolysis currents. Indeed, significant electrolysis current values favor more cathode tensions. This is explained by deposition of silver on aluminum surface that prevents diffusion of species through pores of deposit.

We found from impedance diagrams the presence of a loop at capacitive high-frequency due to the phenomenon of charge transfer and another at low frequency relative to the formation of silver deposit. We also note that polarization resistance R_p relative to the formation of silver deposit increases with increasing current density electrolysis.

5. References

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