Recovery of Tin from Wave Solder Slags generated from PCB Manufacturing

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Introduction

Sources for recycling tin:

➢ treatment of tin scrap, (tin soldering scrap), composed by a variety of metals beside tin.

➢ tin-alloys, used as solders in the manufacture of printed circuit boards (PCBs) by wave soldering, being the various solder scraps formed by reaction of the liquid solder with the atmospheric air, they also contained a variety of metals beside tin.

Introduction

❖The price of some of these metals, i.e., tin (13,826 €/Tm), silver (500 €/kg), copper (5,618 €/Tm), lead (1,753 €/Tm), etc., and their concentrations in the scrap make of interest to investigate a technology for the recovery and profit of such metals.

Introduction: treatment options

- Pyrometallurgical refining: in the case of these tin materials, the presence of accompanying metals make this option not fully advantageous due to its multi-stage characteristics, not high efficiency and high cost.

- Electrorefining technologies: save these disadvantages, primarily final purity of the electrorefined tin and the possibility of the recovery of valuable metals from the anodic slimes, and in one step.

Introduction: Electrorefining process

a) electrochemically dissolving tin from impure tin anodes into a tin(II)-suitable electrolyte, and

b) selectively electroplating pure tin from the electrolyte onto cathodes,

Purposes:

1) it produces tin essentially free of unwanted impurities, and

2) it is possible to separate valuable metals and recover them as byproducts.

Introduction: Electrorefining process

i) tin is electrochemically dissolved from the anode into the electrolyte producing dissolved tin and electrons:

$$Sn \rightarrow Sn^{2+} + 2e^{-} \qquad E^{0} = -0.136\ V$$

ii) the electrons produced by the above reaction are conducted towards the cathode through an external circuit and power supply,

iii) the dissolved tin in the electrolyte migrate to the cathode basically by diffusion,

iv) the electrons and the dissolved tin recombine at the cathode surface to produce tin metal which plates on the cathode, accordingly to:

$$Sn^{2+} + 2e^{-} \rightarrow Sn \qquad E^{0} = +0.136\ V$$

Objective

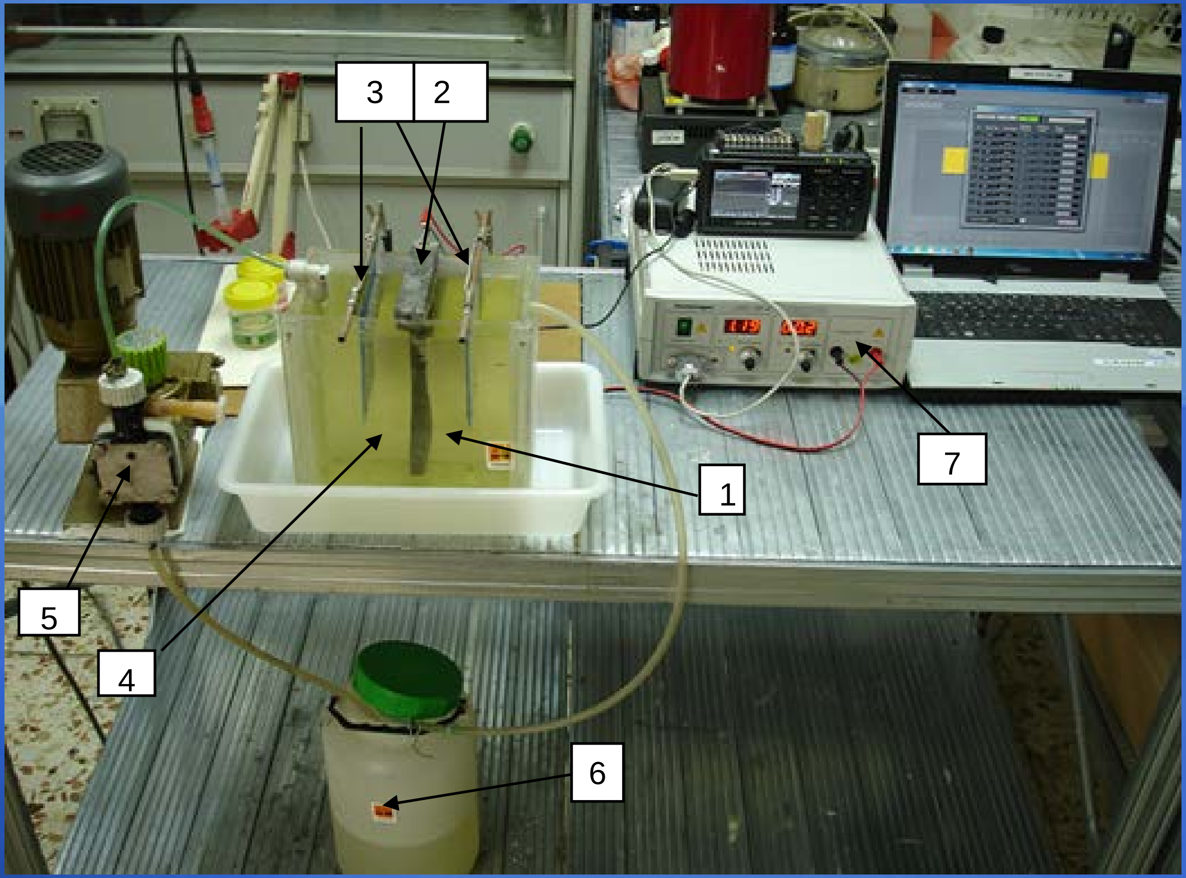
Purification of three tin alloys, with different compositions, using tin electrorefining in sulphuric acid medium.

Results

Table 1. Composition of the tin alloys used in the investigation.

Element (%)	Alloy 1	Alloy 2	Alloy 3
Sn	95.9	89.9	64.4
Ag	2.9	2.3	<0.05
Pb	0.32	7.4	35.5
Cu	0.79	0.47	0.13
Ni	0.036	0.021	<0.001
Sb	<0.05	<0.05	<0.05
Bi, Fe	<0.01	<0.01	<0.01
Zn	<0.002	<0.002	<0.002
Cd, In, Ge	<0.005	<0.005	<0.005

Results



(1) electrolytic cell (2) anode (3) cathodes (4) electrolyte (5) pump (6) electrolyte storage tank (7) power station.

Results

The electrolyte was made up by dissolving tin(II) sulphate in sulphuric acid. After near 70 hours of mixing, the mixture was filtered and a solution containing 0.22 g/L tin in 85 g/L sulphuric acid and 1 g/L thiourea (to control the crystalline growth) was used as electrolyte in further experiments.

Results: electrorefining of Alloy 1

Conditions of experiment: current intensity: 109.1 A/cm^2; electrolyte flow: 5 l/h

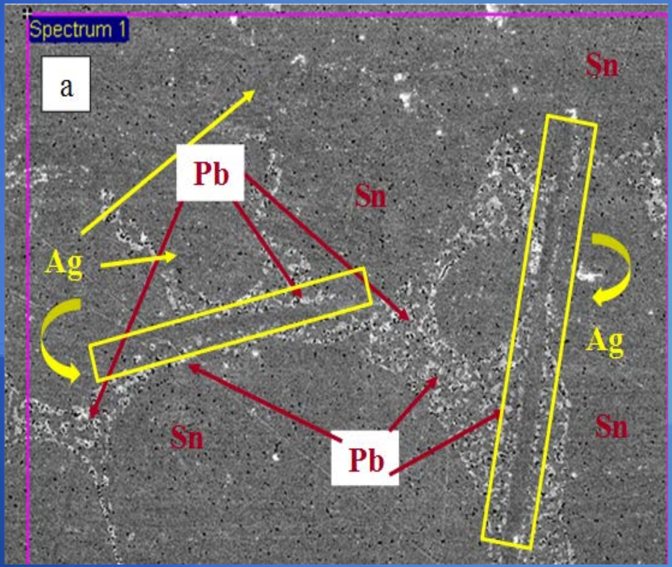
Test	time (h)	Tin purity (%)	Tin deposition (g/h)
1	144	99.96	2.33
2	149	99.96	2.39
3	192	99.96	2.23

Anodic slimes: 0.10 kg of slimes for every kg of purified tin.

Element	Content (%)
Sn	41.1
Ag	**34.2**
Cu	9.1
Pb	0.9

recovered from the slimes by a leaching-cementation operation

Results: electrorefining of Alloy 2



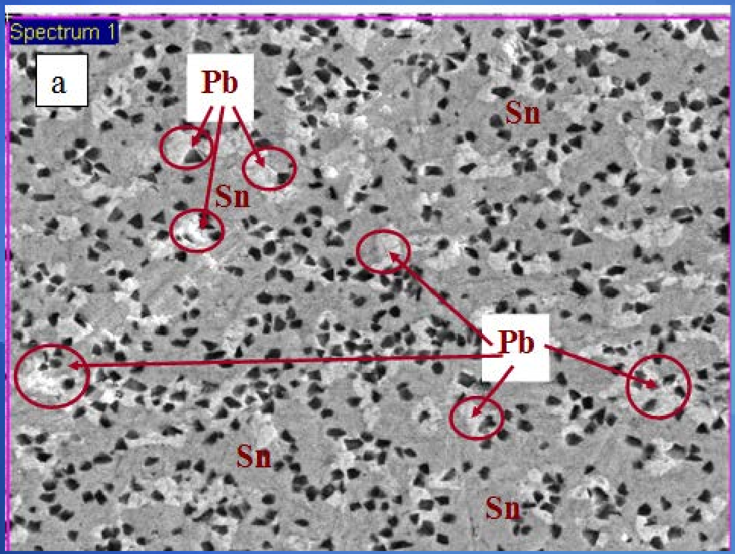
time (h)	860
Tin purity (%)	99.93
Tin deposition (g/h)	2.89
Current intensity (A/cm^2)	109.1
Electrolyte flow (l/h)	5

Anodic slimes: 0.19 kg of slimes for every kg of purified tin.

Element	Content (%)
Pb	49.9
Sn	15.1
Ag	**13.5**
Cu	3.8

recovered from the slimes by a leaching-cementation operation

Results: electrorefining of Alloy 3



time (h)	264
Tin purity (%)	99.93
Tin deposition (g/h)	3.86
Current intensity (A/cm^2)	109.1
Electrolyte flow (l/h)	5

Anodic slimes: 0.84 kg of slimes for every kg of purified tin.

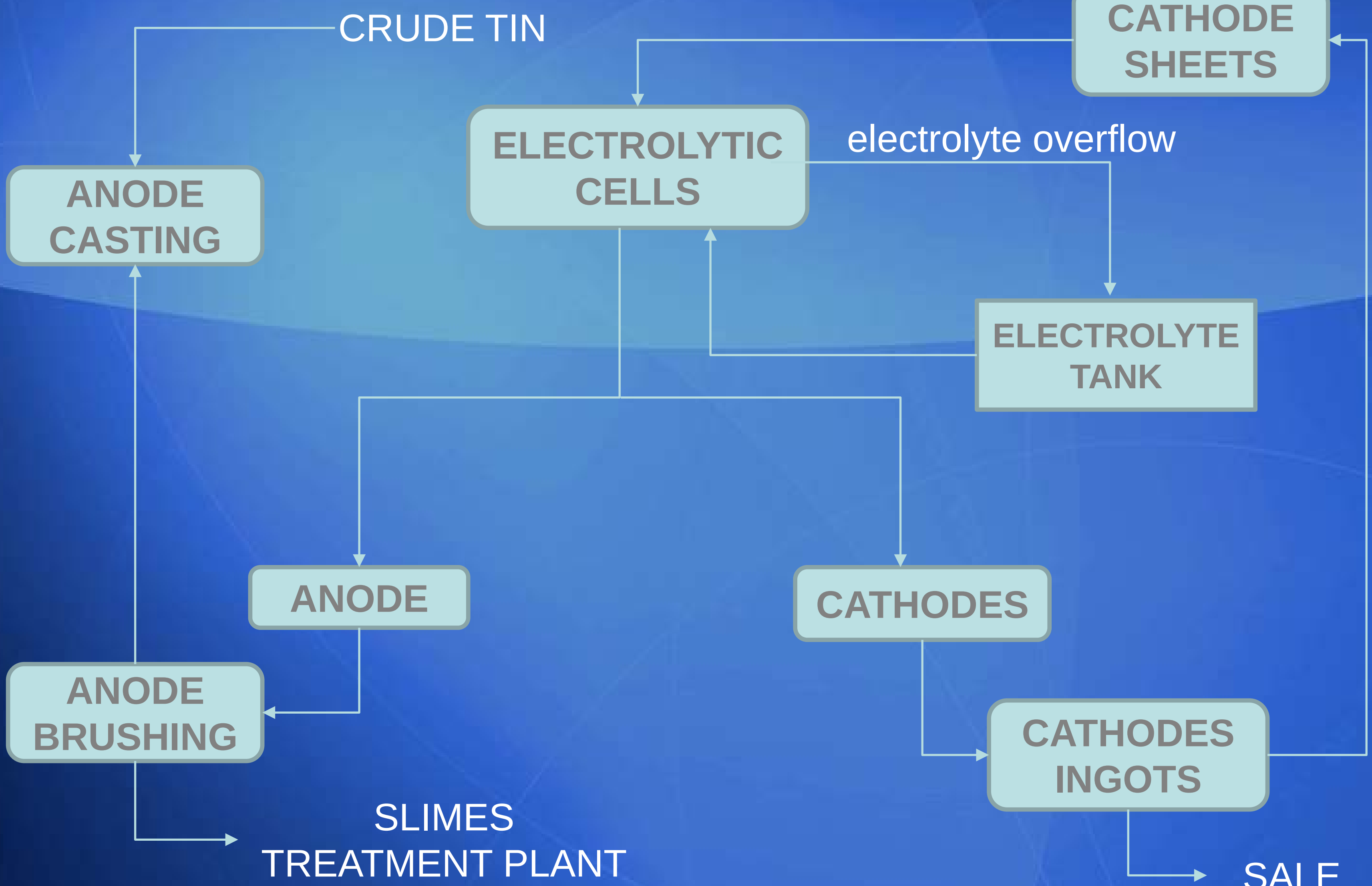
Element	Content (%)
Pb	84.6
Sn	15.4

recovered from the slimes using a pyrometallurgical operation

Summary

Alloy	Initial Tin purity (%)	Deposited Tin purity (%)
1	95.9	99.96
2	89.8	99.93
3	64.4	99.93

Demonstration plant



Thank you for your attention!