Extracting tin from simulated leaching solution of anode slime with cyclone electrowinning method

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KEYWORDS: Anode slime, Tin, Cyclone Electrowinning, Current efficiency

ABSTRACT: Simulated leaching solution of tin anode slime was prepared as electrolyte to investigate the performance of cyclone electrowinning on extraction of tin from solution in this work. The results showed that Sn(II) could be extracted as sponge tin with cyclone electrowinning. Sn(IV) could be extracted as tin plate. As the concentration of tin chloride solution was lower, the current efficiency was lower and the quality of electrolytic product was poorer. On the condition of Sn(IV) concentration of 50 g/L, operation time of 2h , flow flux of 200 L/h and current density of 400 A/m^2, the current efficiency was more than 90% and the electrolytic product was of high purity which contains 99.5% tin. Cyclone electrowinning was proved to be an effective way to extract Tin from simulated leaching solution.

INTRODUCTION

Tin is an important strategic resource and has a wide range of applications in industry. Tin recovery from by-product is meaningful for saving resource. Anode slime of tin is a kind of insolubility slime attached on the surface of the anode scrap or precipitated in the bottom of electrolytic bath. The anode slime has high content of tin. Pyrometallurgy process is the common way to recover tin from anode slime [1]. Hydrometallurgical processing is another way to extract tin using acid or alkali leaching [2-5]. But the further recovery of metals from leaching liquid is also a problem. Cyclone electrowinning is an effective way to recover heavy metals and precious metals from leaching liquid. Many scholars did works on the recovery of metals with cyclone electrowinning[6-10].

In this work, hydrochloric acid was used as leaching agent to extract tin from anode slime first. Tin is leached in the condition of 4mol/L HCl and 120 minutes using liquid to solid ratio of 6:1 at 80˚Cand 350rpm, the leaching rates of tin reaches 96.24%. After purification, cyclone electrowinning was applied to recover tin from solution.

MATERIALS AND METHOD

Materials

Simulated leaching solution contains Sn(II) or Sn(IV). The solution was prepared with $SnCl_2 \cdot 2H_2O$, $SnCl_4$, HCl and deionized water.

Table 1.Chemical composition of simulated leaching solution

Components	Sn	HCl
Content(g/L)	25	73

Method

A certain concentration of Sn(II) or Sn(IV) chloride solution was prepared as raw material. The opeartion time of cyclone electrowinning was 10 minutes. The product cyclone electrowinning can be collected and tested（the product was analyzed by SEM）.

RESULTS AND DISCUSSION

Sn(II) solution

Cyclone electrowinning were carried out with Sn(II) solution as feed in order to investigate the behaviors of cyclone electrowinning . The condition was set as follows: 25g/L Sn(II), flow flux of 500 L/h and current density of 400 A/m2. Figure1 shows the change of cell voltage with operation time. Figure 2. shows SEM image of electrolysis product.

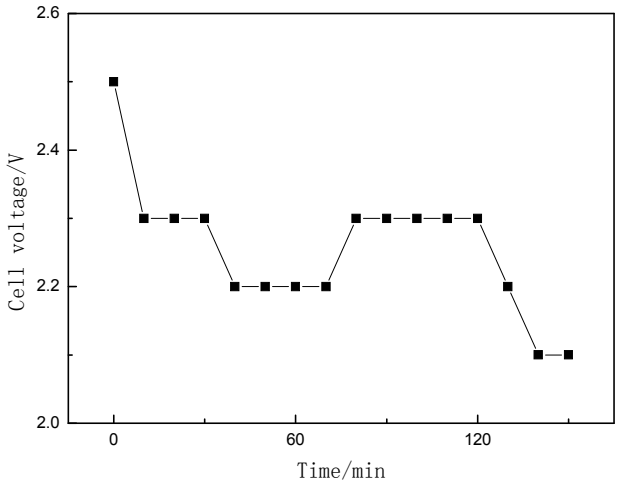

Figure 1. Change of cell voltages with operation time

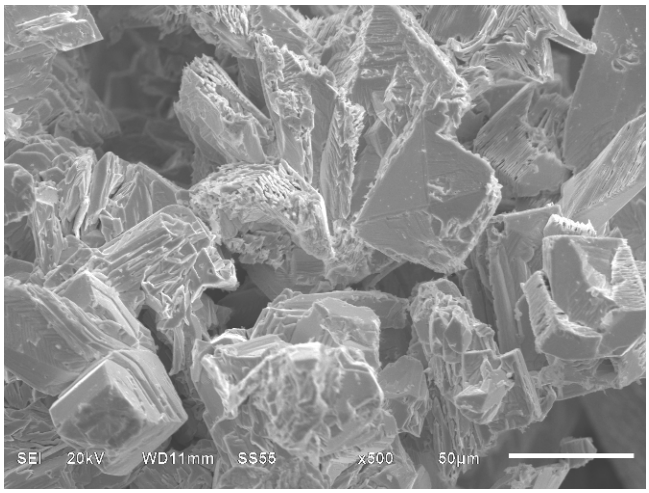

Figure 2. SEM image of electrolytic product

As shown in Figure 1 and Figure 2, cell voltages is lower and lower with the growth of operating time. The cell voltages is not stable so that the electrolytic product is sponge tin. The quality could not be improved through adjusting electrolytic condition. .

Sn(IV) solution

The cyclone electrowinning tests of *Sn*(IV) solution were carried out in order to investigate the cyclone electrowinning behaviors. Figure 3 shows the cell voltage change with the operation time. Figure4~6 show the effect of current density variation, time variation and Sn(IV) concentration on the current efficiency.

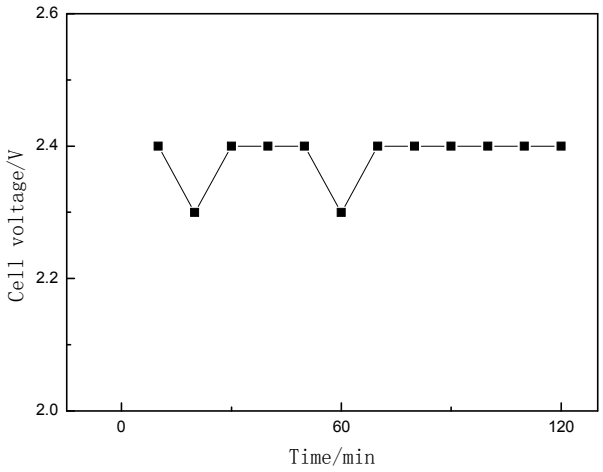

Figure 3. Change of cell voltages with operation time

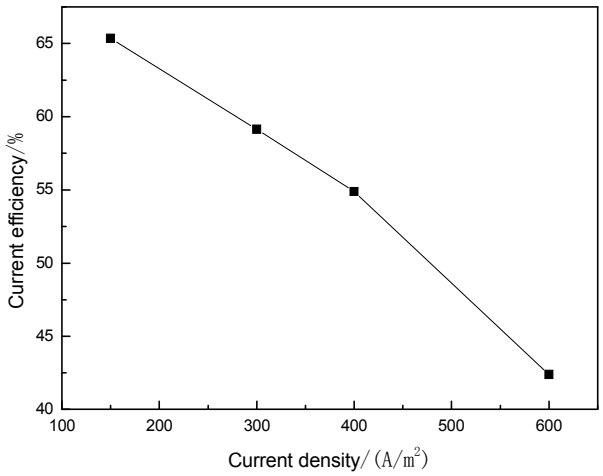

Figure 4. Effect of current density variation on the current efficiency (Sn(IV) concentration 25 g/L , operation time 2h and flow flux 200 L/h)

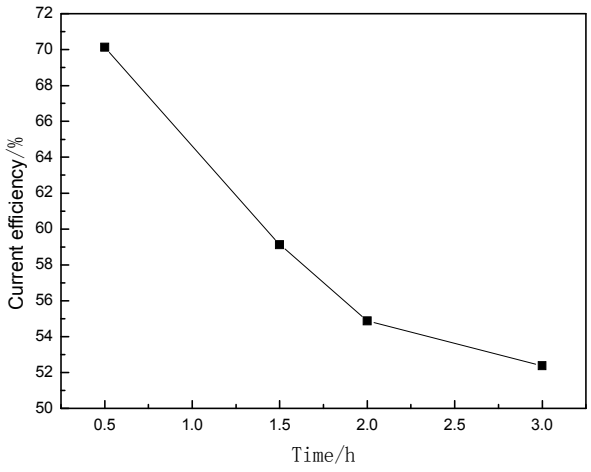

Figure 5. Effect of time variation in 25 g/L Sn(IV) with flow flux 200 L/h by using current density 400 A/m^2

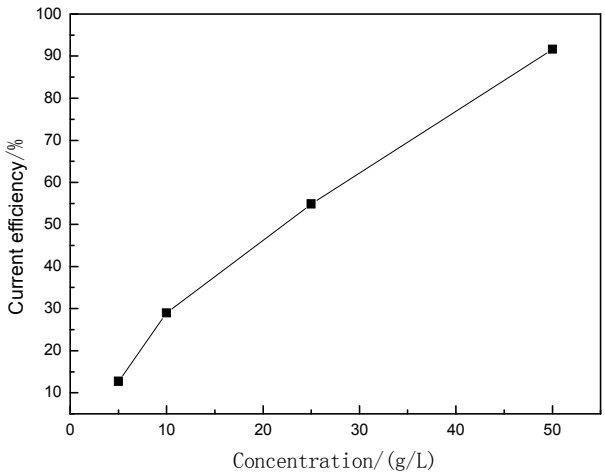

Figure 6. Effect of Sn(IV) concentration variation in 2h with flow flux 200 L/h by using current density 400 A/m2.

As shown in Figure 3, cell voltages is stable as the operating time growing. It may be the reason why the quality of the electrolytic product is good.
Figure 4 shows that the current density for extracting tin is found to be 400 A/m^2. However, the highest current efficency appears at the lowest current density. The reason why we chooses 400 A/m^2 is to keep the balance between current density and time.
As shown in Figure 5, the optimum time is 2 h. In this conditon, more electrolytic product can be gotten. .
As presented in Figure 6, Sn(IV) concentration variation is an important issue to extract tin. high current efficency can be reached at a high Sn(IV) concentration. When the Sn(IV) concentration is more than 50g/L, the current efficiency is more than 90%. The electrolytic product was of high purity which contains 99.5% tin.
Figure7~9 show the photo and SEM images of electrolytic product.

Figure 7. Photo of electrolytic product in the condition of 50 g/L Sn(IV) ion and 2h with flow flux 200 L/h by using current density 400 A/m^2

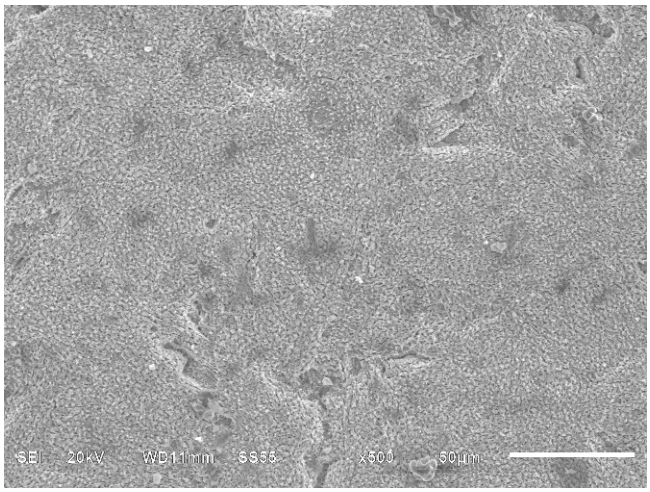

Figure 8. SEM images of electrolytic product in the condition of 50 g/L Sn(IV) ion and 2h with flow flux 200 L/h by using current density 400 A/m^2(front of electrolytic product)

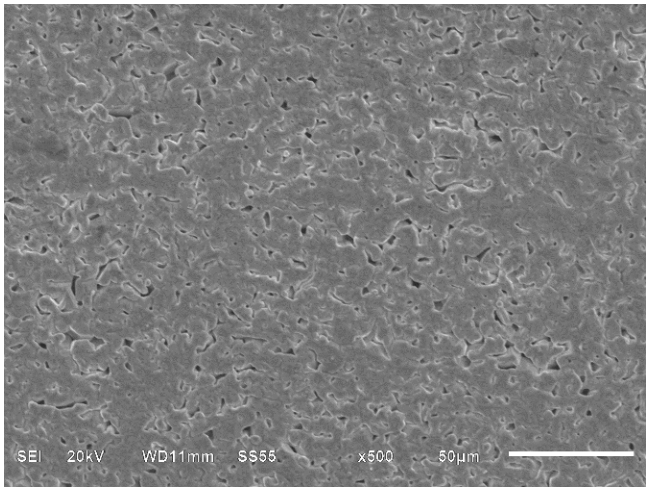

Figure 9. SEM images of electrolytic product in the condition of 50 g/L Sn(IV) ion and 2h with flow flux 200 L/h by using current density 400 A/m^2(the other side of electrolytic product).

As shown in Figure7, the photo shows the surface of the electrolytic product. The electrolytic product's surface is smooth, brilliant and luster. That means the electrolytic product may have a good quality.

As shown in Figure8~9, SEM results illustrate that the surface microstructure is very compact, and the surface is smooth. The results also illustrate that the electrolytic product is of good quality. The cyclone electrowinning is a good metehod to recover tin from simulated leaching solution.

CONCLUSIONS

In this work, the performance of cyclone electrowinning on extraction of tin from simulated leaching solution was investigated. The results showed that Sn(II) could be extracted as sponge tin with cyclone electrowinning. Sn(IV) could be extracted as tin plate. As the concentration of tin chloride solution is lower, the current efficiency is lower and the quality of electrolytic product is poorer. On the condition of Sn(IV) concentration of 50 g/L, operation time of 2h , flow flux of 200 L/h and current density of 400 A/m^2, the current efficiency was more than 90% and the electrolytic

product was of high purity which contains 99.5% tin. Cyclone electrowinning was proved to be an effective way to extract tin from simulated leaching solution

Cyclone electrowinning is a new method to recover tin from leaching solution. However, both of how to get higher qulity of electrolytic product and how to improve current efficiency constantly should be further studied.

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