# New Energy Saving Copper Recovery Process by Using Ammoniacal Alkaline Solution Containing Cu(I)

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## 1. Introduction

The recovery of various metals from waste materials is an important issue to preserve the environment and metal resources. Copper is very important material for the industry. There are two ways to recover the copper, pyrometallurgical and hydrometallurgical. We have been studying on the hydrometallurgical copper recovery process. Our process is characterized by using ammoniacal alkaline solution containing cuprous ions. The process is schematically illustrated in Figure 1. The copper in waste materials is dissolved as cuprous ions. Metallic copper is then electrowon from the Cu(I)-ammine solution during the electrowinning process. Cu(I) ions are simultaneously oxidized to Cu(II) at the anode in the electrolytic cell. Cu(II) ions are used as the oxidizing agent in the leaching process. The advantages of this process are as follows.

a) Selectivity of copper leaching is high
   Fe, Al are not dissolved
b) Energy consumption is low
   Electrodeposition from Cu(I) at the cathode and electrolytic oxidation of Cu(I) at the anode

In this report, we studied the behaviors of leaching and electrowinning of copper.

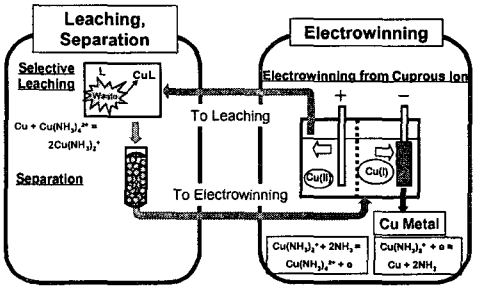


Figure 1 Copper recovery process using ammoniacal alkaline solution.

## 2. Experiments

Printed circuit board(PCB) in which copper content is 9.5wt% was used in the leaching experiments. Cupric sulfate was also used as an oxidizing agent. A rectangular vessel which was divided into two components by an anion exchange membrane was used in the electrowinning experiments. Both experiments were carried out under nitrogen atmosphere.

## 3. Results and Discussion

Copper in PCB was dissolved in the Cu(II)-$NH_3$-$(NH_4)_2SO_4$ solution. The oxidation-reduction potential rapidly decreased with time during the initial stage of leaching and then gradually after 30 minutes. This means that cuprous ions was produced during the leaching experiment.

Figure 2 depicts the effect of the current densities on the current efficiencies at a cathode in the electrowinning experiments. The current efficiencies of approximately 100% were obtained at the current densities less 1000 A $m^{-2}$. However, it slightly decreased due to the hydrogen evolution at 1500 A $m^{-2}$.

Copper was uniformly deposited when the current density was 500 A $m^{-2}$.

An energy consumption was also measured. It was 284kwh/t when the current density was 200 A $m^{-2}$ and 10mm x 10mm Pt was used as cathode. The energy consumption in the conventional electrowinning process is 2000-2500kwh/t. The energy consumption by this process was found to be much smaller than that by the conventional electrowinning process. This is due to the Cu(I) oxidation to Cu(II) at the anode as well as monovalent electrodeposition at the cathode.

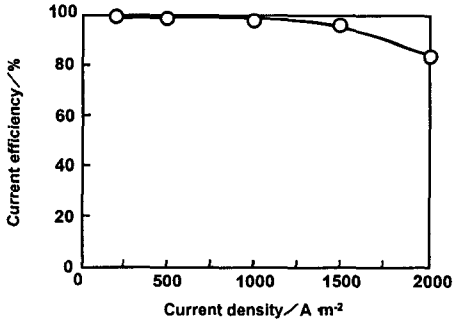


Figure 2 Effect of effect of current densities on the current efficiencies. (Cu(I): 0.5 kmol $m^{-3}$ , $NH_3$ : 5 kmol $m^{-3}$, $(NH_4)_2SO_4$:1 kmol $m^{-3}$)

## 4. Conclusion

This process using ammoniacal alkaline solution containing cuprous ions is characterized by energy saving in the electrowinning stage. We will give further research and development on this process.

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