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Mechanism and clean procedure to extract gold from printed circuit board

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Abstract

The recoveries of gold from printed circuit board are carried out in this work. Chemical analysis of waste printed circuit board was determined by ICP (Inductively Coupled Plasma) method. The dissolving mechanism of gold was elaborate. The thermodynamics for leaching process of gold was analyzed, the E-pH diagrams at 298K were drew by Factsage software. The stability of leaching process of gold in thiourea solution was investigated, the optimal experimental conditions were obtained. Moreover, orthogonal experiments were carried out based on single factor experiments, the most important factor for the gold leaching process was the concentration of thiourea solution.

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Keywords: Gold, Clean procedure, Thiourea, Printed circuit board;

1. Introduction

Metal pollution due to the huge electronic waste (E-waste) accumulation is widespread across the globe. Over the past several decades, electronic waste has become to be the fastest growing solid waste; which is increasing 3-5% a year. Printed circuit board (PCB) is one of the electronic waste which contain 28-32% metallic components and 68% non-metallic components which mainly include plastics, glass and ceramics[1-5]. Recycling of PCB is a difficult task due to the complexity of the materials and possible expulsion of toxic substances. It contains several types of metals, such as zinc, copper, silver and gold, which are quite valuable to be recovered[6-11]. Gold is a typical precious metal, it is reported that the gold content in printed circuit board is twice more than that in the nature gold ore, thus recovery of gold from the printed circuit board has drew more and more attention all over the word.

The conventional extracting of gold methods are subtotal toxic and are Easy to cause environmental pollution, such as cyanide process, aqua regia leaching method, and iodide process[8,10,11]. The leaching processes of gold in this

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work are carried out based on thiourea leaching method, compared with the aforementioned methods; the thiourea method has two advantages: (1) The leaching method is nontoxic, which is more environmental than other methods; (2) Thiourea leaching method has selectivity for extracting gold. Thus the thiourea leaching method is a feasible for extracting gold from the waste printed circuit board.The aim of this work is to analyze the the dissolving mechanism of gold in thiourea solution and thermodynamics of the leaching reactions in order to achieve an environmental way to recover of gold form waste printed circuit board.

2 Experimental

2.1. Pre-treatment of the materials

All the experimental materials are printed circuit boards which are used as mainboard in computer. The non-metal devices were teared down from the boards before the crushing process. The boards were cut into small pieces which are below 15 mm. Metal content in the original PCBs powder was determined by ICP (Inductively coupled plasma atomic emission spectrometry), the results is shown in table 1.

Talbe 1. Metals content in the printed circuit boards

Metals	Mass fraction (mg/g)
Au	0.0385
Pb	20.986
Zn	3.968
Fe	40.756
Ni	3.854
Mn	0.976
Pd	0.435
Cu	308.752
Ag	0.541

2.2. Leaching of gold from the waste printed circuit board

During the gold leaching process, the PCB materials were placed in a container, and then a certain concentration of thiourea solution was added into the container, then the system was heated to the experimental temperatures then open stirrer. In order to investigate the effect of leaching process, the reactions were carried out in the temperature range of 283-323K and the time range of 1-5 hours. In a typical leaching process, 10 g of PCBs sample and 50 ml of thiourea solution were added to a container before reaction. The hydrogen peroxide was used as oxygen source. In order to investigate the effect of SCWO pre-treatment conditions, the reactions were carried out in the temperature range of 283~323K and the time range of 15-150 min. Figure 1 is the leaching experimental facility used in this work.

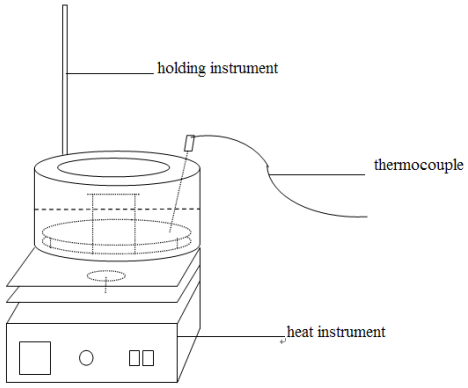

Fig.1. The leaching experimental facility used in this work