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Electrochemical behavior on Ho and Bi ion in LiCl-KCl Eutectic Salt Using W Electrode

Beom-Kyu Kim, Hwa-Jeong Han, Ji-Hye Park, Won-Ki Kim and Byung Gi Park*
Department of Energy & Environmental Engineering, Soonchunhyang University, Soonchunghyangro 22, Asan, Chungnam 336-745, Republic of Korea
**Corresponding author: byunggi@sch.ac.kr*

1. Introduction

Pyroprocess developed to improve the sustainability of nuclear energy is under study in many countries. To reduce radioactive toxicity, Pyroprocess recovers most uranium and TRU from LiCl-KCl to liquid metal.[1] However, molten salts still contain trace amounts of actinide and are likely to be considered high-level wastes (HLW). We have introduced the PyroRedSox process concept using Liquid Bi for additional recovery of residual actinides. PyroGreen's main step of PyroRedSox process is a two-step process that involves electrochemical and chemical separation processes.[2] First, electrolytic reduction is using Liquid Metal Bi to recover both actinide and lanthanide to Liquid Metal Bi. Second, selective oxidation is a process of separating and extracting Ln using an oxidizing agent (Bi ions or $BiCl_3$) from liquid Bi to salt. It is well known that lanthanides and residual actinides reduced to liquid metal through electrochemical reductive extraction process form liquid metal and intermetallic compound. In particular, it is necessary to study the effect of liquid metal ions on the reduction of lanthanide and residual actinide ions in an electrochemical reductive extraction process when the liquid metal is oxidized and is present in the molten salt as an ion. This phenomenon is presumed to occur also in electrochemical reductive extraction process, which is the first step of the PyroRedSox process. In order to investigate this phenomenon, Holmium element was selected from lanthanide group and electrochemical reduction behavior was studied in the presence of Bi ion.

2. Methods and Results

2.1 experiments

An electrochemical cell was prepared with a one-end closed quartz tube (OD: 13 mm, ID: 10 mm), in which high purity LiCl-KCl eutectic salt (Alfa-Aesar, 99.99%) containing 1 wt% high purity $HoCl_3$ (Sigma-Aldrich, 99.99%) was placed.

Working Electrode (WE) and Counter Electrode (CE) were Tungsten wire (1mm diameter), the Pyrex guide tube was used to prevent contact between electrodes.

The reference electrode was consisted of an one-end closed Pyrex tube, in which LiCl-KCl eutectic salt containing 1wt% AgCl was placed and a silver wire (Alfa-Aesar, 99%, OD: 1 mm) was immersed in the salt. A W wire (Alfa-Aesar, 99%, OD: 1mm) was used as a counter electrode. The atmosphere of the electrochemical cell was controlled with glove box (H_2O < 1 ppm, O_2 < 1ppm). All electrochemical measurements were performed using PAR Versastat3 potentiostat with Versastudio software. Temperature of the salt was measured with Chromel-Alumel thermocouple. The temperature was always 773K.

2.2 Results

The cyclic voltammetry (CV) method is an electrochemical method that is generally used to obtain information about reactions occurring in an electrochemical environment. CV is induced oxidation and reduction reaction of metal species present in molten salt electrolyte by applying potential. Figure 1 shows the results of the experiment using a tungsten working electrode at 773K with a scan rate of 0.1 V / s. Except for the cathode/anode signal of Li2+/Li, the cathode/anode signal corresponding to Bi3+/Bi is the potential at which the metal Bi is formed 0.3V, which can be known by the oxidation/reduction behavior of the previously identified Bi metal. In addition, the Ho3+/Ho potential at which Ho reacts with three electrons are -2V. As addition to Bi ion increased, Bi-Ho intermetallic compounds gradually appeared. In particular, the Redox potential of -1.7 and -1.3 V increased sharply, and the reduction peak of Ho gradually decreased from about 1 wt%.

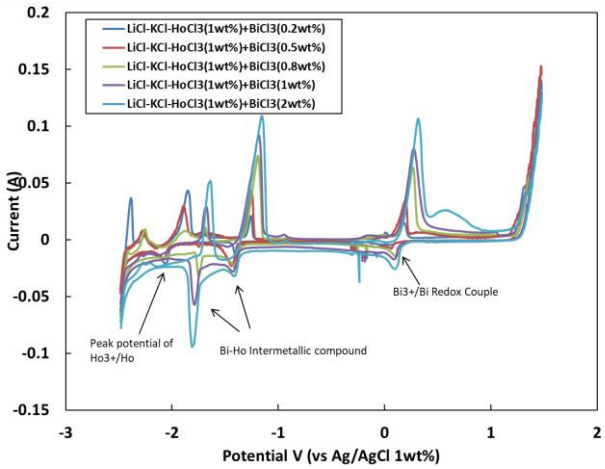

Fig. 1 Cyclic voltammograms of LiCl-KCl-$HoCl_3$(2wt%) at with $BiCl_3$(0.2~2wt%) using tungsten electrode and scan rate 100mV/s

3. Conclusions

This study, electrolytic behavior of Holmium and Ho-Bi ion system was studied. The electrochemical behavior of Ho was studied in LiCl-KCl-HoCl3 molten salts using electrochemical techniques Cyclic Voltammetry on tungsten electrodes at 773K. And during the process of CV, intermetallic compounds were observed as Bi-Tm due to the influence of Bi ions. Further study, in order to determine clarity of diffusion coefficient in this experiment, we will compare result of electrochemistry method and we also need to quantitative research.

REFERENCES

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