Electrochemical Investigation of CeF$_3$ in Molten FLiNaK Salt on W, Cu, and Ni electrodes

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Introduction

Electrochemical studies of CeF$_3$ in molten FLiNaK salt were carried out on W, Cu, and Ni electrodes at 973K. The redox reaction of Ce (III) + e$^-\rightarrow$ Ce (II) was identified to occur prior to that of K/I/K on all of these three electrodes. Ni electrode was turned out to be feasible for the separation of Ce from FLiNaK molten salt and the formed intermediate compound between Ce and Ni was determined to be CeNi$_3$.

Experimental Set-up

![Experimental Set-up Diagram]

- **Furnace**: Benchtop Muffle Furnace
- **Electrodes**: W/Cu/Ni working electrode; graphite counter electrode; platinum reference electrode
- **Salt**: 50g FLiNaK (LiF 14.6-NaF 5.85-KF 29.55, purity> 99%), CeF$_3$ (purity>99.9%).
- **Crucible**: Nickel crucible
- **Temperature**: 973 K
- **Potentiostat**: Gamry Interface 1000

Experimental Results

Cyclic voltammetry test was carried out W working electrode. A pair of redox peaks can be observed at the right of the electrochemical window. To identify what redox reaction this redox peaks correspond to, potentiostatic electrolysis was performed on W working electrode.

The W working electrode after potentiostatic electrolysis was taken out to do XRD and SEM tests. The results obtained from XRD and SEM tests show the product produced after potentiostatic electrolysis is CeF$_3$. Thus the redox reaction happens prior to K/I/K can be recognized as: Ce (III) + e$^-\rightarrow$ Ce (II).

To separate Ce out from FLiNaK molten salt, same electrochemical test procedure was performed on Cu working electrode. However, only the redox reaction of Ce (III) + e$^-\rightarrow$ Ce (II) was found.

Ni electrode was also tried to separate Ce out from FLiNaK molten salt. In addition to the redox reaction of Ce (III) + e$^-\rightarrow$ Ce (II) as observed on W and Cu electrodes, a reaction related to the intermediate compound formation was also identified. To confirm the redox reaction occurs, chronopotentiometry electrolysis by applying a current of -30 mA for 1 hour was performed on Ni electrode and then to do XRD and SEM tests.

Conclusions

This study explored the electrochemical behavior of CeF$_3$ in FLiNaK melt at 973 K on W (inert), Cu and Ni (reactive) working electrodes. It is found the reaction: Ce (III) + e$^-\rightarrow$ Ce (II) happens prior to the redox reaction of K/I/K. Intermediate compound electrodeposition only occurs on nickel working electrode at the current test condition.

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