Investigation of Thermodynamic Behaviors of SrO in LiCl Molten Salt at 923 K

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1. Introduction

After burning U fuel in the nuclear power plant, wide range of fission products are produced from light alkali, alkaline earth elements to heavy transuranic metals. Among them, Sr and Cs emit high radiation and heat and threaten safety of researchers and workers dealing with spent nuclear fuels. Therefore, it is important to understand the behaviors of the fission products during the reprocessing process [1].

Especially in South Korea, pyroprocessing have been developed and the highly radioactive fission products are separated by reacting with LiCl molten salt during electrolytic reduction process which is a subprocess of pyroprocessing. However, the behavior of Sr is still not clearly identified, because of its little positive Gibbs reaction free energy with LiCl molten salt [2].

Therefore, experimental methods to investigate thermodynamic behaviors of SrO in LiCl molten salt at 923 K were designed in this paper.

2. Method

2.1 Experimental setup

All experiment will be conducted in an electrochemical system which consists of a glovebox, a furnace, a potentiostat as shown in Fig. 1. The glovebox maintains oxygen and moisture concentration below 1 ppm. The furnace consists of kanthal heating elements, heat controller, and heat insulator, which controls temperature from 25℃ to 900℃. The electrochemical techniques will be conducted with PARSTAT 4000 A which is a high performance potentiostat. It can apply current and potential in a wide range (±4 A, ±10 V).

Fig. 2. shows the experimental cell configuration and experimental configuration of the experiment. The experimental cell consist of quartz cell containing 5 g of LiCl molten salt and various concentration of SrO, tungsten working electrode and counter electrode, and an Ag/Ag^{+} reference electrode with mullite membrane.

Fig. 1. Electrochemical system.

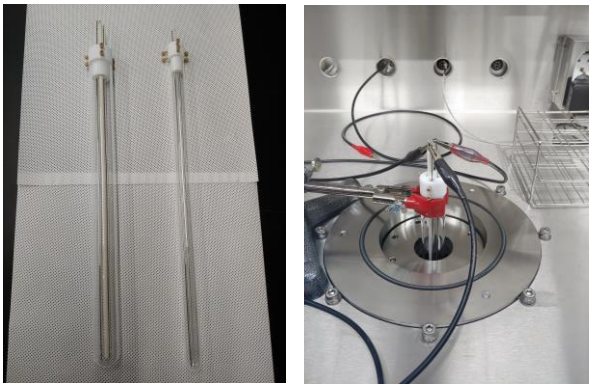

Fig. 2. (a) Cell configuration, (b) Experimental configuration.

2.2 Experimental procedures

The series of experimental procedures are described in Fig. 3. Initially, 5 g of LiCl powder and various concentration of SrO powder are added into the quartz cell and the quartz cell is heated up to 923 K in the furnace. The quartz cell is maintained for 2 hours until the composition of molten salt reaches the thermodynamic equilibrium.

After equilibrium, potentiometric titration is conducted. The potentiometric titration is a method to measure the O^{2-} concentration as the amount of metal oxide increases [3]. At point where the measured potential reaches to a plateau, the solubility limit of metal oxide can be determined as shown in Fig. 4.

Next, the surface of the molten salt is sampled by

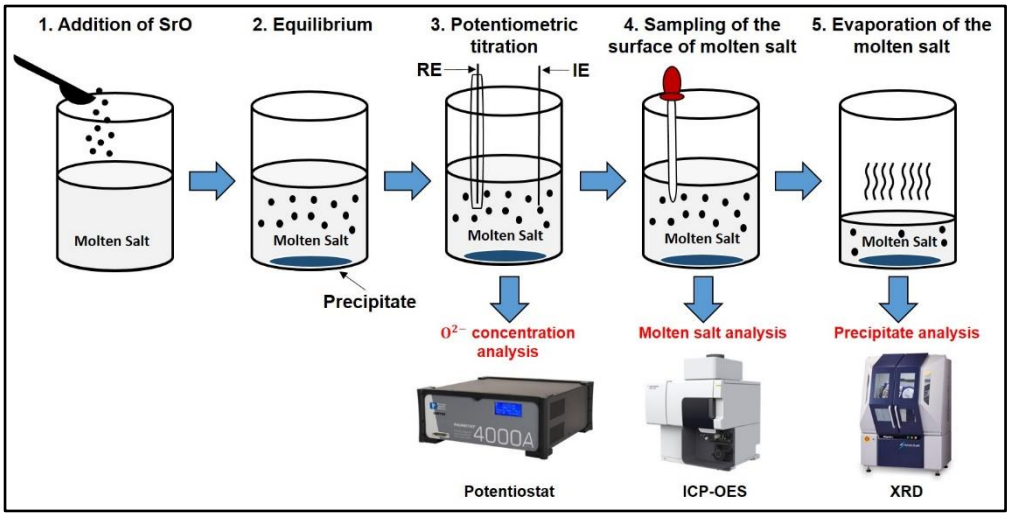

Fig. 3. Schematic of experimental procedures.

an aspirator with glass fiber filter to prevent absorption of precipitates. The sample is dissolved into water and the composition of molten salt is analyzed by inductively coupled plasma optical emission spectrometry (ICP-OES).

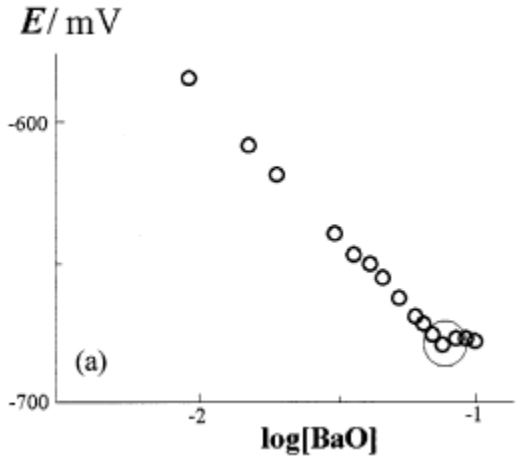

Fig. 4. (a) Plots of E Vs. initial oxide molality in KCl-NaCl-BaO systems at 727℃ [3].

Finally, the molten salt is vaporized by vacuum distillation method [4] and the remaining precipitates are analyzed by X-ray diffraction (XRD).

The above procedures are repeated with increasing concentration of SrO from 10^{-4}wt.% to 10^{-1}wt.% in LiCl molten salt to determine the solubility limit and their thermodynamic behavior or SrO in LiCl molten salt.

3. Conclusion

In this paper, a method to investigate thermodynamic behaviors of SrO in LiCl molten salt at 923 K is designed with potentiometric titration method, ICP-OES, and XRD analysis.

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