

EFFECT OF IMPURITY IONS ON THE PRECIPITATION PROPERTY OF URANYL PEROXIDE

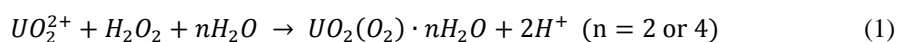
Keun-Young Lee, Maengkyo Oh, Jimin Kim, Eil-Hee Lee, Kwang-Wook Kim, Dong-Yong Chung, Jei-Kwon Moon, Jong-Won Choi

Decontamination and Decommissioning Research Division, KAERI, 989-111 Daedeok-daero, Yuseong-gu, Daejeon, Republic of Korea, 305-353, lky@kaeri.re.kr

This work studied the effects of impurity ions in a solution on the precipitation property of uranyl peroxide by comparing the conditions with pure uranium solution and uranium-metal impurity solution generated from actual uranium waste. In the comparative experiments, the precipitation rate of uranyl peroxide in the solution with the impurities was approximately three-times faster than that in the pure uranium solution. In addition, the aggregated particles with relatively large sizes and irregular shapes were mainly observed from the results of a particle analysis when the precipitates were obtained in the solution with metal impurities. Both the precipitation rate and morphology might be affected by the co-precipitation of uranium and other metal ions under the solution condition. It might be meaningful to understand the actual applications for a precipitation reaction in the uranium separation process, because impure ions can exist in the solution and affect the precipitation property under the most unideal cases.

I. Introduction

Various studies on the precipitation properties of uranyl peroxide ($UO_4 \cdot xH_2O$) have been performed in the fields of uranium chemistry, nuclear engineering, and uranium waste treatment. Uranium can be precipitated under acidic solution conditions by adding excess hydrogen peroxide (H_2O_2) according to Eq. (1) (Ref. 1, 2).



A precipitation reaction was used to recover uranium in solutions generated from the treatment process of uranium ore or uranium waste, because uranyl peroxide has a very low solubility of around 10^{-5} to 10^{-8} M under acidic conditions. Previous studies have focused on the precipitation characteristics of uranyl peroxide under different solution conditions (pH, initial uranium concentrations, hydrogen peroxide concentrations, storage pH, and temperatures). In this study, we investigated the effects of impurity ions in the solution on the precipitation property of uranyl peroxide by comparing the conditions with a pure uranium solution and uranium-metal impurity solution generated from an actual uranium waste.

II. Materials and Methods

For the precipitation experiments of uranyl peroxide from pure uranium solution, uranyl nitrate hexahydrate ($UO_2(NO_3)_2 \cdot 6H_2O$) was dissolved in the solution under different initial concentrations. Uranyl peroxide was precipitated by adding hydrogen peroxide to reach 1M and nitric acid to adjust the pH to 3.5. The precipitation efficiency was observed with the reaction time by measuring the uranium concentrations of the solution. In addition, the experimental results were compared with those of the uranium-metal impurity solution generated from the actual uranium waste. The uranium concentrations in the solutions were analyzed using a colorimetric method using Arsenazo III and ICP-MS, and the solid phase analyses were performed using XRD and TEM-EDS.

III. Results and Discussion

The analytical results showed that the solution from the actual uranium waste contains several ppm of Fe, Sb, and Si as impurities with around 100 ppm of uranium. In comparative experiments, the precipitation rate of uranyl peroxide in

the solution with the impurities was approximately three-times faster than that in the pure uranium solution. A uranium precipitation efficiency of 99% was achieved in the solution with and without impurities after 24 h and 72 h, respectively. From the results of a particle analysis using TEM, the aggregated particles with relatively large sizes and irregular shapes were mainly observed when the precipitates were obtained in the solution with metal impurities. This result is significantly different from the precipitation property of normal uranyl peroxide under pure conditions. The elemental analysis by EDS showed the co-existence of uranyl peroxide and metal oxides containing iron and antimony in the aggregated particles. This is the result of co-precipitation of these elements in the solution condition, and the precipitation rate might also be affected by the co-precipitation. The precipitated iron and antimony oxides can be a bridging part between the uranyl peroxide crystals, which might be the reason for the morphological difference with the pure uranyl peroxide.

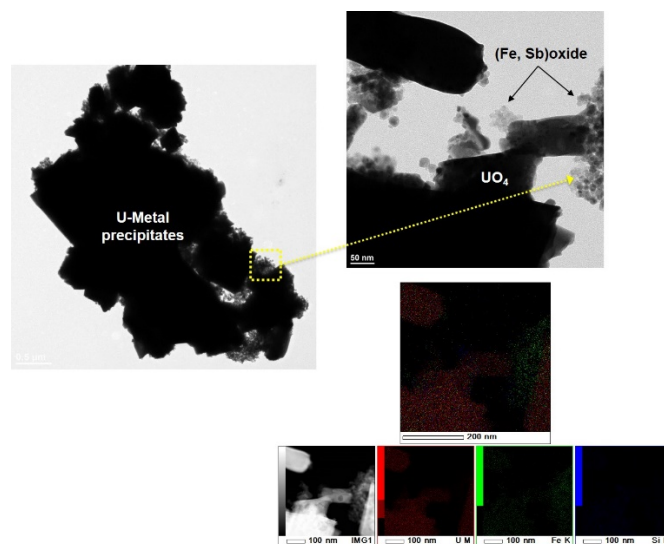


Fig.1. TEM images and elemental mapping by EDS of uranium-metal precipitates.

IV. CONCLUSIONS

This work studied the effects of impure ions on the precipitation property of uranyl peroxide by comparing the conditions with and without metal impurities in the solution condition. It should be meaningful to understand the actual application of a precipitation reaction on the uranium separation process because impure ions can exist in a solution and affect the precipitation property under the most unideal cases.

ACKNOWLEDGMENTS

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