

Liquid-liquid extraction of Nb and Ta with Aliquat 336 from 0.27 M HF solution

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The elements with atomic numbers ≥ 104 are called transactinide elements. Their chemical properties are greatly interesting because it is expected that chemical behavior of these elements would deviate from that of lighter homologs by strong relativistic effects on valence electrons¹⁾. Therefore, it is very important to study the chemical behavior of transactinide elements comparing with that of lighter homologs.

Among the transactinide elements, we are interested in the chemical properties of 105th element Db, especially, for complex formation with a fluoride ion which is a strong complexing reagent for group 5 elements. Anionic fluoride complex formation of Db has been investigated through anion exchange study from HF solution²⁾. The result of this experiment showed that the K_d value of Db in 13.9 M HF was smaller than that of Nb and Ta, which are lighter homologs of Db. However, the chemical form of Db was not yet determined in this condition. Therefore, for investigation of fluoride complex formation of Db in detail, we have been studying the liquid-liquid extraction behavior of Nb and Ta from HF solutions with quaternary ammonium salt, Aliquat 336. So far, a clear difference of the extraction behavior between Nb and Ta in 10⁻²-27 M HF was observed. While distribution ratios (D) of Nb were decreased with increasing HF concentration, those of Ta were a maximum at around 0.3 M HF³⁾. Since linear relations with slope ≈ 1 for both elements were observed from $\log D$ vs. \log [Aliquat 336] plots, it was suggested that univalent anionic fluoride complex of NbOF₄⁻ and TaF₆⁻ were extracted by Aliquat 336 in 2.7 M and 10 M HF. However, in previous study, we have not obtained information of chemical species in 0.27 M which those of Ta are most extracted. Therefore, in the present work, variation of D values of ^{95g}Nb and ¹⁷⁹Ta vs. concentration of Aliquat 336 in 0.27 M HF was studied.

Long-lived radiotracers, ^{95g}Nb ($T_{1/2} = 34.97$ d) and ¹⁷⁹Ta ($T_{1/2} = 665$ d), were produced during deuteron irradiation of Zr and Hf metallic foil targets with natural isotopic abundances, respectively, using the RIKEN K70 AVF Cyclotron. These radiotracers in the targets were chemically isolated by ion-exchange separation. The tracers were dissolved in 600 μ L of 0.27 M HF and then mixed with the same volume of 10⁻⁸-10⁻¹ M Aliquat 336/1,2-dichloroethane solutions in a polypropylene tube. After shaking of the solutions for 5 min, followed by centrifugation, the two phases were separately pipetted into sample tubes. The

radioactivities of the two samples were measured with a Ge detector. D values of Nb and Ta were obtained from the ratio of the radioactivities of the two phases.

The dependences of the distribution ratios of ^{95g}Nb and ¹⁷⁹Ta in 0.27 M HF on the concentrations of Aliquat 336 are shown in Fig. 1. The results show a linear relation with a slope of ≈ 1 for both Nb ([Aliquat 336] = 10⁻⁵-10⁻¹ M) and Ta ([Aliquat 336] = 10⁻⁸-10⁻⁷ M), which indicates that univalent anionic fluoride complexes are extracted by Aliquat 336. Therefore, it is suggested that NbOF₄⁻ and TaF₆⁻ were also extracted by Aliquat 336 in 0.27 M HF along with 2.7M and 10 M HF.

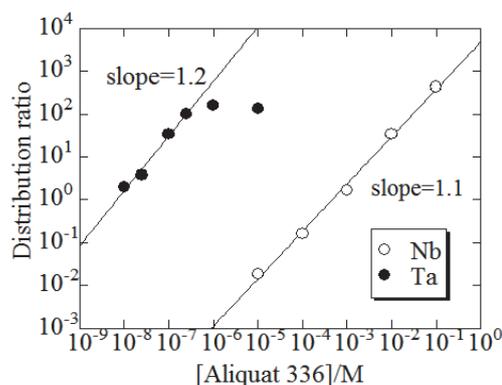
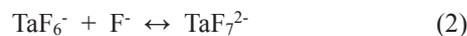


Fig. 1: Variation of the distribution ratio D of ^{95g}Nb and ¹⁷⁹Ta vs. concentration of Aliquat 336 in 0.27 M HF.

From the obtained results and reference [4-5], it is assumed that the chemical species of Nb and Ta change from NbOF₄⁻ to NbOF₅²⁻ and from TaF₆⁻ to TaF₇²⁻, respectively, with increasing HF concentration in the range of 0.27-10 M, expressed as following equations:



In the near future, dependence of D values of ^{95g}Nb and ¹⁷⁹Ta on concentration of Aliquat 336 in HF solution lower than 0.27 M will be investigated for further study of fluoride complex formation of group 5 elements.

References

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