

Extraction behaviors of chloride complexes of Nb and Ta with triisooctyl amine for chemical experiment of dubnium (Db)

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It has been reported that the anion-exchange behavior of the 105th element, Db, in HF/HNO₃ solution is similar to that of Nb rather than Ta.¹⁾ In our laboratory, the extraction behaviors of fluoride complexes of Nb and Ta with tributyl phosphate (TBP)²⁾ and Aliquat 336³⁾ have been investigated. The extraction yield of Ta is greater than that of Nb in these systems. For the extraction of Db with TBP from 1.0 M HF, the behavior of Db was significantly different from that of Ta.⁴⁾ To clarify the similarity of the extraction behavior between Db and Nb, systems where the extraction yield of Nb is greater than that of Ta should be studied. We investigated the extraction behaviors of Nb and Ta from HCl with triisooctyl amine (TiOA) on a tracer scale. It has been reported that the extraction yield of Nb is greater than that of Ta on a macro scale.⁵⁾

Radiotracers, ^{95g}Nb ($T_{1/2} = 34.991$ d) and ¹⁷⁹Ta ($T_{1/2} = 1.82$ y), were produced from ^{nat}Zr(d,xn) and ^{nat}Hf(d,xn) reactions, respectively, using the RIKEN AVF cyclotron. These radiotracers were chemically isolated from the target materials through an anion-exchange method and preserved in 1 M HF. An appropriate amount of this solution was evaporated to dryness and preserved in concentrated HCl (stock solution). An aliquot of the stock solution was evaporated to dryness and dissolved in an appropriate concentration of HCl. In a 1.5 mL polypropylene tube, 600 μ L of 8–10 M HCl containing the tracers was mixed with an equal volume of 0.12 M TiOA in xylene, and the mixture was shaken for a fixed time. After centrifugation, 420 μ L aliquots of each phase were separated into sample tubes. The radioactivity of each phase was measured with a Ge detector. We calculated the distribution ratios (D) of ^{95g}Nb and ¹⁷⁹Ta using the following equation:

$$D = (A_{\text{org}} / V_{\text{org}}) / (A_{\text{aq}} / V_{\text{aq}}),$$

where A_{org} and A_{aq} are the radioactivities in organic and aqueous phases, respectively, and V_{org} and V_{aq} are the volumes of the organic and aqueous phases, respectively.

The extraction kinetics from 10 M HCl into 0.12 M TiOA in xylene were investigated by changing the shaking time from 1 min to 60 min. It was found that the D values of ^{95g}Nb and ¹⁷⁹Ta were almost constant in the examined range of shaking time. This result shows that the extraction equilibrium is achieved quickly.

The dependence of the D values of ^{95g}Nb and ¹⁷⁹Ta extracted into 0.12 M TiOA in xylene is shown in Fig.1 as a function of the HCl concentration (8–10 M). The D values

of ^{95g}Nb are approximately 10² times greater than those of ¹⁷⁹Ta. The D values of ¹⁷⁹Ta are greater than the values in the literature, although those of ^{95g}Nb are in agreement with those in the literature. In the course of the investigation, the D values of ¹⁷⁹Ta decreased with time lapsed from the preparation of the stock solution, while those of ^{95g}Nb stayed constant (Fig. 2). The decreasing trend of the D values of ¹⁷⁹Ta may be caused by hydrolysis of the Ta species or an effect of residual fluoride ions in the stock solution. The preparation methods of the Ta tracer may be considered for the study of the extraction behavior of a chloride complex of Ta. A detailed investigation is necessary to solve the problem.

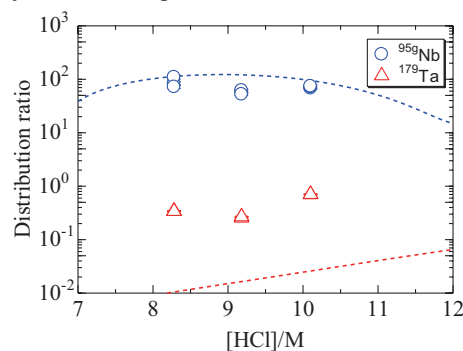


Fig. 1. The distribution ratios of ^{95g}Nb and ¹⁷⁹Ta extracted into 0.12 M TiOA in xylene as a function of the HCl concentration. Dashed lines indicate the literature values of Nb and Ta.⁵⁾

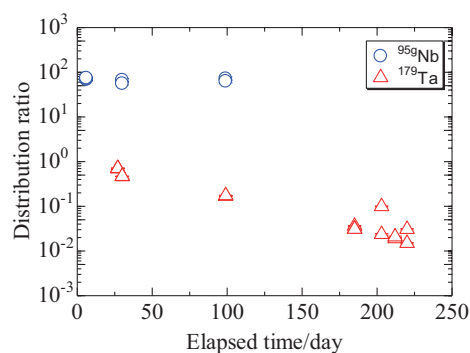


Fig. 2. Variation of the distribution ratios of ^{95g}Nb and ¹⁷⁹Ta from 10 M HCl extracted into 0.12 M TiOA in xylene as a function of time lapsed from the preparation of the stock solution.

References

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