

Solid-liquid extraction of Nb and Ta with Aliquat 336 resin from HF solutions for chemical experiment of element 105, Db

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The elements with atomic number ≥ 104 are called super-heavy elements. Aqueous chemistry experiments with these elements have been performed often by a column chromatographic method. In particular, an anion-exchange experiment of element 105, Db was successfully performed in 13.9 M hydrofluoric acid solution using Automated Rapid Chemical Apparatus, ARCA.¹⁾ Chemical species of Db in HF solution were, however, still not identified. We have, therefore, studied liquid-liquid extraction behavior of Nb and Ta, which are lighter homologues of Db, with Aliquat 336 for investigating the charge of extracted complexes of these elements from HF solution. From these results, it was found that, although the extraction behavior of Nb was different from that of Ta, univalent anionic fluoride complexes were extracted for both Nb and Ta by Aliquat 336.²⁾ Based on these results, it is expected that information on the chemical species of Db in HF solution would be obtained by applying this extraction system to the solid-liquid extraction experiment with ARCA. The solid-liquid extraction experiments of Nb and Ta with an Aliquat 336 resin from HF solutions were conducted by a batch method for the column experiment with ARCA in this work.

Long-lived radiotracers, ^{95}gNb ($T_{1/2} = 34.97$ d) and ^{179}Ta ($T_{1/2} = 665$ d), were produced by deuteron irradiation on Zr and Hf metallic foil targets with natural isotopic abundance, respectively, using the RIKEN K70 AVF Cyclotron. These radiotracers in the targets were chemically isolated by an ion-exchange. A 32 wt% Aliquat 336 resin was prepared by mixing MCI GEL CHP20/P30 with Aliquat 336 dissolved in methanol for about 1 day, which was followed by drying in an oven at 80 °C.³⁾ The ^{95}gNb and ^{179}Ta tracers were dissolved in 400 μL of 1-27 M HF, and then mixed with 10-15 mg of the 32 wt% Aliquat 336 resin in a syringeless filter tube. After shaking for 5 min, the solution was separated from the resin by filtration, and 250 μL of the solution in each sample was pipetted into another sample tube. For measurement of initial radioactivity, A_{ini} , in the aqueous solutions, control experiments without the Aliquat 336 resin were also conducted. The radioactivities of these samples were measured with a Ge detector. The distribution coefficients, K_d of ^{95}gNb and ^{179}Ta were obtained by the following equation:

$$K_d = \frac{(A_{\text{ini}} - A_s)/m_r}{A_s/V_s} \quad (1)$$

Here, A_s is the radioactivity of solution, m_r is the weight of the resin used and V_s is the volume of a liquid phase.

The dependences of K_d values of ^{95}gNb and ^{179}Ta on the initial HF concentration, $[\text{HF}]_{\text{ini}}$ were investigated with the 32 wt% Aliquat 336 resin from 1-27 M HF solutions. The obtained results were shown in Fig.1. It is revealed that the K_d values of ^{179}Ta are decreased with increasing $[\text{HF}]_{\text{ini}}$, while those of ^{95}gNb show a minimum at 10 M HF. The decreases of the K_d values of both the elements are due to an increase of HF_2^- ion.¹⁾ Comparing with our earlier results on liquid-liquid extraction of these elements,²⁾ this solid-liquid extraction behavior of ^{179}Ta is found to be very similar to that in liquid-liquid extraction. Thus, the same complex, TaF_6^- ion as that in liquid-liquid extraction is probably extracted by the Aliquat 336 resin. However, the solid-liquid extraction behavior of ^{95}gNb was partly different from that in Ref. [2]. While distribution ratios of ^{95}gNb in Ref. [2] decreased gradually with increasing $[\text{HF}]_{\text{ini}}$, a gradual increase of K_d values is observed above 10 M HF in the present solid-liquid extraction. This suggests that the extracted complexes of ^{95}gNb in solid-liquid extraction might be different from those in liquid-liquid extraction. Further investigation of the extracted species of ^{95}gNb in solid-liquid extraction is needed for identification of the Nb species.

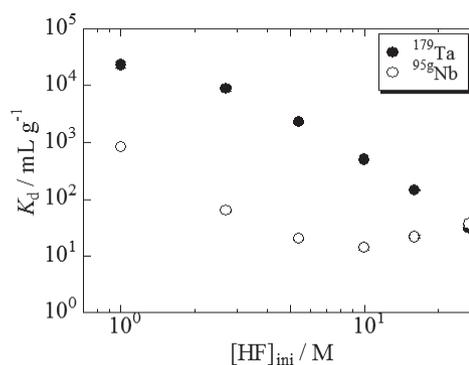


Fig.1 The adsorption behavior ^{95}gNb and ^{179}Ta on Aliquat 336 resin as a function of $[\text{HF}]_{\text{ini}}$

References

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