

## Reversed-phase extraction behavior of the 105<sup>th</sup> element, Db, with tributyl phosphate

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Our group has investigated the extraction behavior of Nb and Ta, homologs of the 105<sup>th</sup> element Db, from HF solutions with tributyl phosphate (TBP) by the batchwise and on-line column chromatographic methods.<sup>1,2)</sup> In the on-line column experiment with a 62 wt% TBP resin,<sup>2)</sup> the obtained distribution coefficients ( $K_d$ ) of Ta were in agreement with those obtained by the batch experiment, indicating that the studied system can be applicable to the column chromatographic experiment with the short-lived <sup>262</sup>Db ( $T_{1/2} = 33.8$  s). In this work, the extraction behavior of Db was studied to discuss the chemical form of Db in HF media by comparing the behavior of Nb and Ta.

The isotopes <sup>262</sup>Db and <sup>170</sup>Ta ( $T_{1/2} = 6.76$  min) were simultaneously produced in the bombardment of a <sup>19</sup>F beam on the mixed <sup>248</sup>Cm/<sup>nat</sup>Gd target. The <sup>19</sup>F beam was delivered from the AVF cyclotron, and its energy was 105.3 MeV at the center of the target. The typical beam intensity was 700 particle-nA. The reaction products were transported with a He/KCl gas-jet system to a chemistry laboratory and were deposited on a collection site in Automated Rapid Chemistry Apparatus (ARCA<sup>3)</sup>) for 80 s. Then, the products were dissolved in 140  $\mu$ L of 1.0 M HF and were loaded onto a column (1.6 mm i.d.  $\times$  7.0 mm height) filled with the 62 wt% TBP resin. The flow rate of the eluent was 1.0 mL/min. The effluent was collected in a Ta dish as Fraction 1. The remaining products in the column were stripped with 140  $\mu$ L of 10 M HF at a flow rate of 1.0 mL/min, and the effluent was collected in another Ta dish as Fraction 2. Both effluent fractions in the Ta dishes were evaporated to dryness and subjected to  $\alpha$  spectrometry using an automated rapid  $\alpha$ /SF detection system.<sup>4)</sup> The  $\alpha$ -particle measurement was started at 43 s and 57 s after the collection of the products for Fractions 1 and 2, respectively. The counting duration was 259 s and 248 s for Fractions 1 and 2, respectively. After the  $\alpha$ -particle measurement, every third or fifth pair of Ta dishes was subjected to  $\gamma$ -ray spectrometry to monitor the behavior of <sup>170</sup>Ta and its chemical yield.

In total, 820 cycles of chromatographic separation were conducted. In the  $\alpha$  energy region ( $E_\alpha = 8.42$ –

8.74 MeV) for <sup>262</sup>Db and its  $\alpha$ -decay daughter <sup>258</sup>Lr ( $T_{1/2} = 3.9$  s), 16 and 2 events were observed in Fractions 1 and 2, respectively, including one time-correlated  $\alpha$  pair in Fraction 1. The chemical yield of <sup>170</sup>Ta, including deposition and dissolution efficiencies of the aerosols, was  $44 \pm 13\%$ .

Percent extraction (%Ext) values were evaluated using the equation

$$\%Ext = \frac{100A_2}{A_1 + A_2}, \quad (1)$$

where  $A_1$  and  $A_2$  are the radioactivities in Fractions 1 and 2, respectively. The correction for the radioactive decay was considered for  $A_1$  and  $A_2$ . In Fig. 1, the obtained %Ext values of <sup>262</sup>Db and <sup>170</sup>Ta are shown as closed symbols, together with those of <sup>909</sup>Nb and <sup>178a</sup>Ta (open symbols) obtained in the separate experiment,<sup>2)</sup> as a function of the initial HF concentration,  $[HF]_{ini}$ . Because of the small number of the <sup>262</sup>Db events in Fraction 2, an upper-limit %Ext value of  $\leq 25\%$  was evaluated for <sup>262</sup>Db. The evaluated %Ext value for <sup>170</sup>Ta was  $93 \pm 5\%$ , which was in agreement with the previous result for <sup>178a</sup>Ta (%Ext =  $94 \pm 4\%$ <sup>2)</sup>). This suggests that Db would not form a Ta-like fluoride complex  $[DbF_6]^-$  in 1.0 M HF, where Ta forms an extractable species,  $[HTaF_6(TBP)_3]$ .<sup>5)</sup>

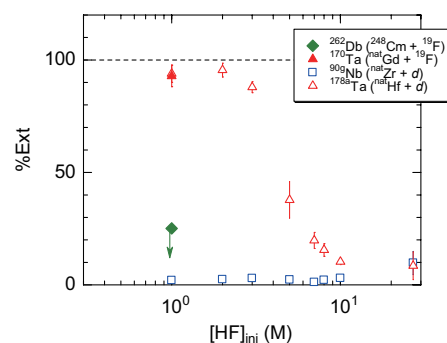


Fig. 1. Dependence of %Ext values of Nb, Ta, and Db on  $[HF]_{ini}$ .

### References

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