

Solid-liquid extraction of Mo and W by Aliquat 336 from HCl solutions toward extraction chromatography experiments of Sg[†]

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Chemical characterization of transactinide elements with atomic number ≥ 104 is an attractive and challenging subject in the field of radiochemistry. Two decades ago, Schädel *et al.* performed the pioneering cation-exchange experiment of seaborgium (Sg) in 5×10^{-4} M HF/0.1 M HNO₃¹⁾ and 0.1 M HNO₃²⁾ using an automated rapid chemistry apparatus (ARCA). In the literature, it was reported that the fluoride complexation of Sg was similar to that of its lighter homologs, Mo and W. In their experiment, however, Schädel *et al.* observed only four time-correlated events from the daughters and granddaughters of ²⁶⁵Sg^{a,b,1,2)} produced in the ²⁴⁸Cm(²²Ne, 5n)²⁶⁵Sg^{a,b} reaction because of the time-consuming α -sample preparation. One of the possible methods of unambiguous identification through detection of α -correlations from ²⁶⁵Sg^{a,b} and its descendants is to adopt liquid scintillation counting for the physically pre-separated ²⁶⁵Sg^{a,b} with GARIS.³⁾ This approach has high detection efficiency and the sample preparation time is short. In parallel with the development of the measurement apparatus, it is also necessary to search for experimental conditions applicable to ²⁶⁵Sg^{a,b}. In this study, we examined solid-liquid extraction of Mo and W in the Aliquat 336/HCl system as a model experiment for Sg.

⁹⁰Mo ($T_{1/2} = 5.7$ h) and ¹⁷³W ($T_{1/2} = 7.6$ min) were simultaneously produced via the ^{nat}Ge(²²Ne, xn)⁹⁰Mo and ^{nat}Gd(²²Ne, xn)¹⁷³W reactions, respectively, using Gd/Ge targets at the RIKEN K70 AVF cyclotron. Reaction products recoiling out of the targets were continuously transported to the chemistry laboratory using a He/KCl gas-jet method. The transported products were deposited on the ARCA collection site for 5 min. The products were then dissolved in HCl and subsequently fed into a microcolumn (1.0 mm i.d. and 3.5 mm) filled with 52-wt.% Aliquat 336/CHP20Y resin at a flow rate of 1 mL/min. The effluents were collected in polypropylene (PP) tubes for every 50- or 80- μ L fraction. Then, the remaining products in the column were stripped with 400–500 μ L of 6 M HNO₃/0.01 M HF and collected in another PP tube. These samples were assayed through γ -ray spectrometry with Ge detectors. We also performed batch experiments with ^{93m}Mo and ¹⁸¹W using the Aliquat 336/CHP20Y resin in HCl solutions.

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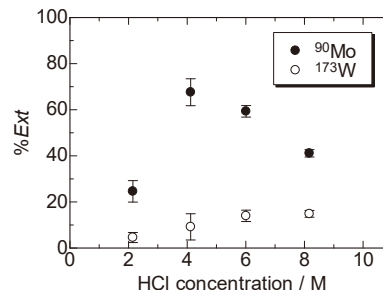


Fig. 1. Variation of %Ext values of ⁹⁰Mo and ¹⁷³W on 52-wt. % Aliquat 336/CHP20Y column (1.0 mm i.d. and 3.5 mm) as a function of HCl concentration.

In the experiments involving the transactinide elements and performed using the ARCA, chromatographic separation was conducted with approximately 200 μ L of the eluent (first fraction) and the remaining radioactivities in the column were eluted by a stripping solution as the second fraction.⁴⁾ To evaluate the extraction behaviors of Mo and W by this method, the percent extraction (%Ext) on the resin was defined as

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

where A_1 indicates the amount of radioactivity eluted with 200 μ L of the effluent and A_2 is that remaining in the column with the effluent. The variation of the %Ext values as a function of HCl concentration are shown in Fig. 1.

In the figure, the %Ext values of Mo increase to 70% in 2–4 M HCl and then decrease in 4–6 M, while those of W are less than 20% for all examined concentrations. The trend of the %Ext values, Mo > W, is qualitatively consistent with the results of the batch experiments performed with ^{93m}Mo and ¹⁸¹W. This indicates that the extraction behaviors of Mo and W obtained with ARCA reflect the chloride complex formation of these elements, *i.e.*, formation of the anionic oxochloro complexes $[\text{MO}_2\text{Cl}_3]^-$ (M = Mo and W) in 1–6 M HCl.^{5,6)} Under the present conditions, therefore, it is expected that information on the chloride complexation of Sg can be obtained by comparing its %Ext values with those of Mo and W using our developed systems.

References

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