Anion exchange experiments of tungsten for liquid phase chemistry of seaborgium (Sg, element 106)

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Seaborgium (Sg) may form anionic compounds in a 5×10^{-4} M HF/0.1 M HNO_3 aqueous solution, according to cation exchange experiment.[1] Our group has been planning an experiment using the multi-column technique to investigate the detailed anion exchange behavior of Sg. We expect that the anion exchange behavior of ^{265}Sg (half-life 8.5 s/14.4 s), which is produced in the ^{248}Cm(^{22}Ne, $5n$) reaction without the influence of decay products of Sg can be observed using a series of three ion exchange columns consisting of a cation exchange column, an anion exchange column, and another cation exchange column. In this study, anion exchange experiments of tungsten (W), as a lighter homolog of Sg, using ^{181}W (Half-life: $T_{1/2} = 121.2$ d) in an HF/HNO_3 aqueous solution, were performed for the future liquid-phase chemistry of Sg.

^{181}W was produced in the ^{181}Ta(p, n) or ^{181}Ta($d, 2n$) reactions at the JAEA tandem accelerator facility or supplied through the Supply Platform of Short-lived Radioisotopes from RIKEN. After the ion exchange purification, it was prepared in a 0.2 M HF aqueous solution as a carrier-free tracer. We measured the distribution coefficient (K_d) of ^{181}W in various anion-exchange conditions. In each anion-exchange procedure for the K_d-value evaluation, the ^{181}W solution, a dried anion exchange resin (MCI GEL CA08Y, MITSUBISHI CHEMICAL GROUP), and an HF/HNO_3 were mixed to be a desired HF/HNO_3 concentration. The mixture was shaken for a certain time. After centrifugation, the amount of ^{181}W was determined in the solution by counting the X-ray originating ^{181}W. The distribution coefficient (K_d) of W between an aqueous solution and an anion exchange resin was measured as a function of the HF and HNO_3 concentrations ([HF] and [HNO_3]).

We confirmed that the chemical equilibrium was reached in a few minutes regardless of the experimental conditions; therefore, the shaking time was fixed at 10 min. The dependence of the K_d values of W on [HF] was obtained as shown in Fig. 1. K_d decreased with increasing [HF] in the range 10^{-4} M < [HF] < 10^{-2} M, whereas K_d increased with [HF] in the range 10^{-2} M < [HF] < 1 M. The trends were consistent with those reported in the Refs. 2) and 3). The dependence of the K_d values of W on [HNO_3] determined the valence of anionic compounds of W in HF aqueous solution was 1.5 regardless [HF]. Because the theoretical
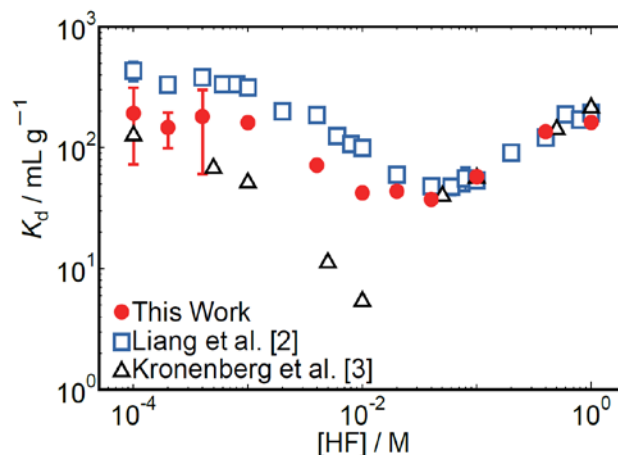

Fig. 1. Variations in the distribution coefficient (K_d) of ^{181}W on the anion-exchange resin as a function of the HF concentration ([HF]). The concentration of HNO_3 was constant (0.1 M).

calculations have suggested that W would form monovalent and divalent complexes in HF aqueous solution, we concluded that the amounts of molecules of each valence could be similar.

Short-lived ^{88}Zr and ^{175}Hf were also supplied from the Supply Platform of Short-lived Radioisotope project. We are planning the model experiment of the multi-column procedure using the isotopes based on the results obtained in this study.

References
1) M. Schädel *et al.*, Radiochim. Acta **77**, 149 (1997).
2) X. H. Liang *et al.*, J. Radioanal. Nucl. Chem. **292**, 917 (2012).
3) A. Kronenberg *et al.*, Radiochim. Acta **92**, 395 (2004).

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