# Adsorption behavior of No with a TTA chelate extractant from HF/$HNO_3$ acidic solutions

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In a study on the fluoride complexation of a super-heavy element, rutherfordium (Rf), we focus on the extraction with an acidic chelate extractant, 2-thenoyltrifluoroacetone (TTA), which is sensitive to the valence of the metal complex. Recently, we developed a reversed-phase chromatography technique with TTA and performed Rf experiments with this technique in various HF/0.01 M $HNO_3$ concentrations.[1)]

The isotope $^{261}$Rf used in the experiments decays into its daughter $^{257}$No. The $\alpha$-particle energies of $^{257}$No ($E_\alpha$ = 8.22, 8.32 MeV) are close to that of $^{261}$Rf ($E_\alpha$ = 8.28 MeV). Therefore, these energies are difficult to distinguish from each other. In the Rf experiments, two types of $^{257}$No $\alpha$-events are expected to be observed. One is from $^{257}$No produced from the $\alpha$-decay of $^{261}$Rf after its chemical separation. It reflects the chemical behavior of Rf. The other is of $^{257}$No deposited during the collection of $^{261}$Rf, which reflects the chemical behavior of No. In order to correct the contribution of $^{257}$No, we observe the adsorption behavior of No in the same systems of the Rf experiments.

Similar to the Rf experiments, the isotope $^{255}$No ($T_{1/2}$ = 3.10 min) was produced in the $^{248}$Cm($^{12}$C, 5$n$) reaction with an 84 MeV $^{12}$C beam at the RIKEN K70 AVF cyclotron. The reaction products were rapidly transported with a KCl/He gas-jet system to a chemistry laboratory and were deposited on the collection site of the on-line Automated Rapid Chemistry Apparatus (ARCA) for 180 s. After deposition, the products were dissolved in 85 μL of various HF/0.01 M $HNO_3$ solutions and fed into a 1.6 mm i.d. × 7.0 mm TTA resin column at a flow rate of 0.1 mL/min. The effluent from the column was collected on a Ta disk as fraction 1. The remaining products in the column were then stripped with 250 μL of 0.1 M HF/0.1 M $HNO_3$ solution at a flow rate of 1.0 mL/min and then collected on another Ta disk as fraction 2. Both samples were evaporated to dryness using hot He gas and a halogen heating lamp. The samples were assayed with a rapid $\alpha$/SF detection system for the aqueous chemistry of super-heavy elements at RIKEN. In order to determine the chemical yield, $^{162}$Yb was simultaneously produced from the Gd content in the Cm target and was measured by a Ge detector after the measurement of $^{255}$No. The average chemical yield of $^{162}$Yb in all the experiments was approximately 17%.

From 195 cycles of the No experiments, a total of 1042 $\alpha$-events indicating the production of $^{255}$No were registered in the energy range of 7.60–8.20 MeV. The adsorption probability, %ads, of No with a fixed volume of the effluent was evaluated using the following equation:

$$\%ads = Fr2 / (Fr1 + Fr2) \times 100, \quad (1)$$

where Fr1 and Fr2 are the radioactivities observed in fraction 1 and 2, respectively. The decay of No was taken into account in the correction for the %ads values. The results for %ads of $^{255}$No as a function of $[F^-]_{eq}$ in the range of $1.93 \times 10^{-5}$ to $1.66 \times 10^{-3}$ M are shown in Fig. 1. In the Rf experiments, [1)] the %ads values of $^{261}$Rf were constant at approximately 60% in the $[F^-]_{eq}$ range up to $5 \times 10^{-4}$ M and then steeply decreased at $[F^-]_{eq} = 9 \times 10^{-4}$ M. On the other hand, in the No experiments, it was found that the %ads values of $^{255}$No were less than 10% in the entire range of $[F^-]_{eq}$.

In order to evaluate the %ads values of $^{261}$Rf, we assumed in the previous report[1)] that the adsorption of No was negligible. Based on the present work, it was confirmed that No was adsorbed to TTA to a small extent and the %ads values of $^{261}$Rf can be determined with greater precision.

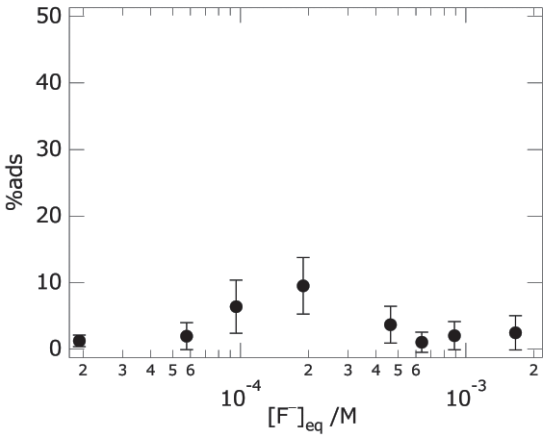


Fig. 1 Adsorption probability, %ads, of $^{255}$No plotted as a function of $[F^-]_{eq}$ in TTA column chromatography.

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Reference

1) Y. Kitayama, Y. Fukuda, H. Haba, K. Tsukada, A. Toyoshima, H. Kikunaga, M. Murakami, Y. Komori, M. H. Huang, T. Taniguchi, S. Ueno, K. Hayashi, Y. Yatsu, I. Chiyonishio, K. Murakami, A. Yokoyama: RIKEN Accel. Prog. Rep. **48**, 281 (2015).