Coprecipitation experiment of element 102, No, with $Sm(OH)_3$ using NH_3 and NaOH solution

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Heavy elements are expected to have the characteristic chemical properties in the periodic table owing to significant relativistic effects on their orbital electrons. From the previous cation-exchange studies on element 102, noberium (No) in HCl, the most stable ion valency of No in aqueous solution is reported to be +2, although that of other heavy actinide elements is +3.[1,2] However, it is difficult to investigate the chemical behavior of heavy elements. Heavy elements with $Z \geq 101$ are synthesized by heavy-ion-induced nuclear reactions with very low production rates and their half-lives are short.[3] Thus, the chemical experiments of these elements must be rapidly conducted on one-atom-at-a-time basis using nuclear reaction products transported from the target chamber by a He/KCl gas-jet system. Additionally, for unambiguous identification of a single atom, detection of α particle is required. Owing to these difficulties, there are a few reports on solution chemical experiments of No. In the tri-n-octylamine chloride extraction system and cation-exchange experiment in HCl, the elution behavior of No was reported to be similar to that of alkaline earth metals.[4] To deepen the understanding of the chemical properties of No, we aim at investigating a precipitation of nobelium hydroxide.

In previous studies, we newly developed coprecipitation method with samarium hydroxide to investigate the hydroxide and ammine complexation properties of heavy elements.[5] Then, we succeeded in conducting the coprecipitation experiment of element 104, Rf, in NH_3 and NaOH solutions using the developed suction filtration apparatus. In this study, by applying the coprecipitation method, we performed online coprecipitation experiment of ^{255}No to investigate the precipitation behavior of nobelium hydroxide.

We produced ^{255}No ($T_{1/2}$ = 186 s) and ^{162}Yb ($T_{1/2}$ = 18.9 min) by ^{248}Cm(^{12}C, 5n)^{255}No and ^{nat}Gd(^{12}C, xn)^{162}Yb reactions with AVF cyclotron at RIKEN. The reaction products were transported by the He/KCl gas-jet system to the chemistry room and dissolved in dilute HCl solution. In the case of making precipitated sample, 20 μg of Sm and 2 mL of the basic solution (dilute or concentrated aqueous NH_3 or 0.10 or 1.0 M NaOH solution) was added into the dissolved solution in the PP beaker and stirred for 5 min at room temperature. Then, the solution containing the precipitate was filtrated using the suction filtration apparatus controlled by PC. In the case of making standard sample, the reaction products were dissolved in dilute HCl solution and the solution was put on a Ta plate. Then, these precipitated and standard samples were dried and subjected to alpha particle measurement by the automated rapid α/SF detection system. After alpha particle measurement, γ-ray activities of ^{162}Yb in the samples were measured with Ge detectors.

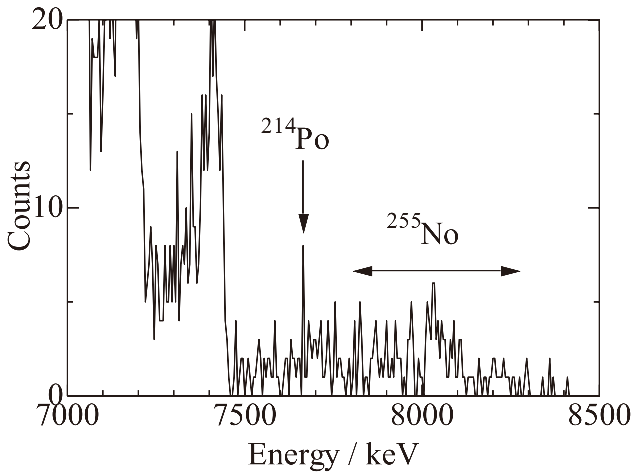

Fig. 1. α-spectra for ^{255}No standard samples.

We successfully prepared 51 coprecipitated samples and 48 standard samples. In the alpha-particle measurement (Fig. 1), we detected 243 events for ^{255}No. The cross-section of ^{255}No was estimated to be approximately 450 nb and the value was consistent with that obtained in the previous report.[6] High precipitation yields of No were obtained and the detailed evaluation is now under analysis.

In future, we will discuss the hydroxide complexation properties of ^{255}No based on the comparison of the coprecipitation behavior of ^{255}No with those of alkaline earth metal elements.

References

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