Development of Np standard material for accelerator mass spectrometry

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Recently, there has been a rapid development in the techniques of highly sensitive mass spectrometry. Several elements or nuclides that were not supposed to be applicable in that technique are now quantitatively analyzed. Especially for long-lived actinide elements, the techniques are becoming more and more important as a promising alternative for radioactivity measurements. The tracer nuclide for chemical recovery determination, which has to be non-existent in nature and should not be contained in target samples, is absolutely necessary for that purpose. Tracers for several elements are available now; however, the tracer for neptunium has not been developed, yet. We are searching for an appropriate method for the production of Np-236 in the ground state with a half life of 1.54×10^5 y as a candidate of the tracer nuclide, from the viewpoints of both purity and production rate.

In the present study, we perform Np tracer production through the reaction of ^{232}Th + ^{7}Li and aim to apply Np contamination in environmental samples.

For the irradiation of ^{7}Li beam, two types of target stacks were prepared. One includes several targets of electrodeposited Th of ca. 1 mg/cm^2 on Al foils, as shown in Fig. 1. The other includes a thick target disc of 100 mg/cm^2 Th as shown at the bottom of the same figure. The former stack was utilized to check the production rate and interfering products depending on the projectile energy dumped in the stacking targets, and the latter was used to conduct a trial for the thick target production. Silver foils of natural abundance were also used to monitor the beam intensity calculated from the produced radioactivity of ^{111}In during the irradiation of ^{7}Li as well as for monitoring the current with a Faraday cup in the beam course.

We performed irradiation with ^{7}Li ions of 42 MeV from the RIKEN AVF cyclotron on the stack of thin targets for 8.5 h at 0.6 pμA and on the thick target for 14 h 21 min at 0.2 pμA on average. In order to isolate Np atoms from the irradiated targets, the chemical procedures were performed as follows. The target material was dissolved in 3M HNO_3 with Np-237 tracer for checking the chemical recoveries and was dried by heating. Then, the process of dissolving the residue in conc. HNO_3 and drying up was repeated three times. Finally, the sample was dissolved again in conc. HCl,

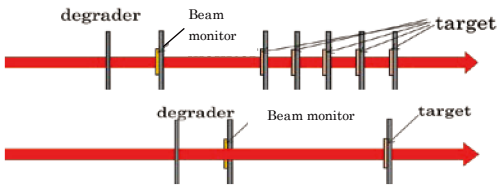

Fig. 1. Schematic illustration of target stacks for the reaction of ^{232}Th with ^{7}Li ions.

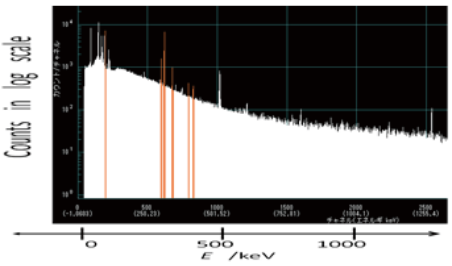

Fig. 2. An example of γ spectrum of isolated Np solution sample. Colored regions correspond to the most prominent emission of U-X ray and γ emissions from Pa-233.

and adjusted to the 10 M HCl solution of 4 mL. The solution was subjected to the separation procedure using a TEVA resin column and treated with 10 M HCl, followed by 3 M HNO_3, for purification, and finally 0.1 M HCl for elution of Np.

The purified samples of Np were subjected to γ spectrometry and α spectrometry to check the radiation emitted from the by-products.

As a preliminary result, an example of γ spectrum of the purified solution from one of the stacked targets is shown in Fig. 2. Li ions were projected onto the target at 17.3 MeV. The spectrum shows that the final solution from the sample was still contaminated by protactinium products. The intensities of uranium X-rays following decay of Np-236m with a half life of 22.5 h suggest that the production rate of Np-236g is greater than 5×10^9 atoms/g-Th/h/pμA, assuming an isomeric ratio of products, m/g, of ca. 5. The ratio was estimated from the production data of the same nuclides in the proton induced reaction of ^{238}U.[1] Analysis of the results is still in progress and additional experiments are under planning at present.

Reference

1) J. Aaltonen *et al.*, Phys. Rev. C **41**, 513 (1990).

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