Decontamination of Po in the ^{211}Rn/^{211}At generator system

K. Aoi,[*1,*2] K. Kawasaki,[*1,*2] S. Maruyama,[*1,*2] M. Higashi,[*1,*3] K. Washiyama,[*4] A. Yokoyama,[*1,*3] I. Nishinaka,[*5] D. Mori,[*1] Y. Wang,[*1] and H. Haba[*1]

The short path length and high linear energy transfer of α particles are expected to enable targeted alpha therapy for the treatment of tumor. A promising nuclide among various α emitters is ^{211}At with a half-life of 7.21 h, which has gained popularity owing to its appropriate life and potential to synthesize labeled compounds as a halogen element. This has been the motivation behind several preclinical studies on At chemistry.[1] To improve the availability of ^{211}At, the development of a ^{211}Rn/^{211}At generator would be useful for expanding nuclide production away from accelerator facilities because ^{211}Rn, which has a half-life of 14.6 h, is the parent nuclide of ^{211}At.[2] However, Po isotopes such as ^{207}Po and ^{206}Po, which are known to be harmful to the human body, may contaminate the At sample owing to decay from the Rn products. We aim to study the wet chemistry processes by using adsorption chromatography resins for an At solution free from Po contamination.

In this study, ^{211}At was produced via the ^{209}Bi$(\alpha, 2n)$ reaction at the RIKEN AVF cyclotron and delivered to Kanazawa University. The irradiated Bi target was dissolved in 2 mL of 6 M HNO_3 and mixed with 10 mL of H_2O to prepare a 1 M HNO_3 solution, 2 mL of which was used to extract the ^{211}At nuclide into 18 mL of dodecane solvent.

Aliquots of the dodecane solution were subjected to back extractions into several solutions of various HCl concentrations. 2 mL of each solution was fed to adsorption chromatography columns filled with either a cation-exchange resin, DGA resin, or TEVA resin through a conditioning process in advance. The eluted solution from the column and the eluent due to additional washing with 2 mL of two solutions with the same HCl concentration were subjected to liquid scintillation counter (LSC) measurement to determine the ^{211}At radioactivity.

The results of the measurement of ^{211}At radioactivity after purification with adsorption chromatography columns demonstrate that the recoveries for DGA resin and cation-exchange resin were ca. 50% at most at 0.01 M HCl and were better than that for TEVA resin. This suggests that the species of At may have a variety of oxidation states that affect adsorption in columns. Therefore, another experiment was performed to change their oxidation states by using a reductant agent and to confirm the effect of reduction with cation-exchange resin.

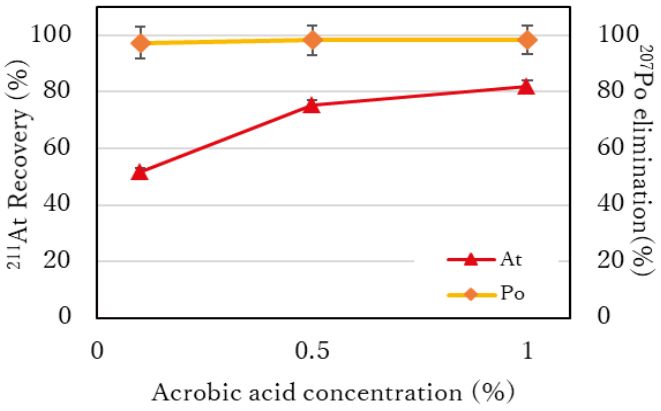

Fig. 1. Recovery of ^{211}At radioactivity and elimination of Po depending on the ascorbic-acid concentration.

Similarly to the experiment described above, aliquots of the dodecane solution were subjected to back extractions into 0.01 M HCl solution, which had been adjusted to the solutions with 0.01, 0.1, and 1% ascorbic acid. The HCl solutions were fed to a column filled with cation-exchange resin that was conditioned well in advance. The eluent from the column was collected and subjected to the LSC measurement in the same manner as above.

The recovery of ^{211}At radioactivity with ascorbic acid as a reductant agent is shown in Fig. 1 together with Po elimination data taken with the Po activity produced in the JAEA tandem accelerator. It was found that the ^{211}At recoveries are improved to 80%, and the elimination of Po was successful under the same condition.

*1 Graduate School of Natural Science and Technology, Kanazawa University
*2 Institute and College of Science and Engineering, Kanazawa University
*3 Fukushima Global Medical Science Center, Fukushima Medical University
*4 Quantum Beam Science Research Directorate, National Institutes for Quantum and Radiological Science and Technology
*5 RIKEN Nishina Center

References

1) F. Guérard, J. -F. Gestin, M. W. Brechbiel, Cancer Biother. Radiopharm. **28**, 1 (2013).
2) E. Maeda *et al.*, J. Radioanal. Nucl. Chem. **303**, 1465 (2015).