Production of no-carrier-added Cr radiotracers in α-particle-induced reactions on Ti target

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^{48}Cr is a promising radioisotope for a double photon emission computed tomography.[1] The proposed method can achieve high spatial resolution and high signal-to-noise ratio.[2] As ^{48}Cr, a pair of 112- and 308-keV photons can be used for coincidence imaging.[1] We plan to produce ^{48}Cr in the ^{46}Ti$(\alpha, 2n)^{48}$Cr reaction. In nuclear medicine, ^{48}Cr must be chemically separated from the target material and byproducts. In this study, we investigated a production method of no-carrier-added Cr radiotracers from an α-particle-irradiated ^{nat}Ti (nat = natural isotopic abundance) target using ^{51}Cr ($T_{1/2}$ = 27.7 d) produced in the ^{nat}Ti$(\alpha, xn)^{51}$Cr reaction. In the future, ^{48}Cr can be produced using expensive enriched $^{46}TiO_2$ as the target material. Therefore, we also investigated the recovery of the target material after the production of the Cr radiotracers.

^{48,51}Cr were produced in the ^{nat}Ti$(\alpha, xn)^{48,51}$Cr reactions using the RIKEN AVF cyclotron. A metallic ^{nat}Ti plate of thickness 45 mg/cm^2 was irradiated for 1.69 h with a 28.9-MeV α beam of intensity 3.1 particle μA. Upon irradiating the target, ^{48}V ($T_{1/2}$ = 16.0 d) was also produced in the ^{nat}Ti$(\alpha, x)^{48}$V reaction and as the electron-capture and β^+-decay daughter of ^{48}Cr ($T_{1/2}$ = 21.6 h). It is desirable to remove the long-lived ^{48}V just before the imaging experiment with ^{48}Cr to increase the signal-to-noise ratio.

The irradiated ^{nat}Ti plate (63.4 mg) was dissolved in a mixture of 1 mL of concentrated HF (c. HF) and 0.3 mL of c. HNO_3 by heating, and the solution was evaporated to dryness. The residue was dissolved with 1 mL of c. HF by heating, and the solution was evaporated to dryness. The residue was dissolved in 6 mL of 4.5 M HF by heating. Subsequently, the solution was fed into an anion-exchange column (Muromac 1X8, 100–200 mesh, 10 mm *i.d.* × 110 mm height). The resin was washed with 9 mL (1 mL × 9) of 4.5 M HF and 35 mL (5 mL × 7) of c. HF. The 4.5 M HF fractions were combined, and 3 mL of it was used for the ICP-MS measurement to confirm the contamination of ^{nat}Ti.

The remainder of the 4.5 M HF was evaporated to dryness and further purified to remove ^{48}V using cation-exchange chromatography. The residue was dissolved in 3 mL of 0.5 M HNO_3. The solution (1 mL × 3) was fed into a cation-exchange column (Muromac 50WX8, 100–200 mesh, 5 mm *i.d.* × 50 mm height). The resin was washed with 3 mL (1 mL × 3) of 0.5 M HNO_3 and 5 mL (1 mL × 5) of 6 M HNO_3.

Each eluent from the anion- and cation-exchange columns were subjected to γ-ray spectrometry with a Ge detector to obtain the elution curves of ^{51}Cr and ^{48}V. To evaluate the elution curve of ^{nat}Ti, each c. HF fraction was evaporated to dryness, and the residue was weighted.

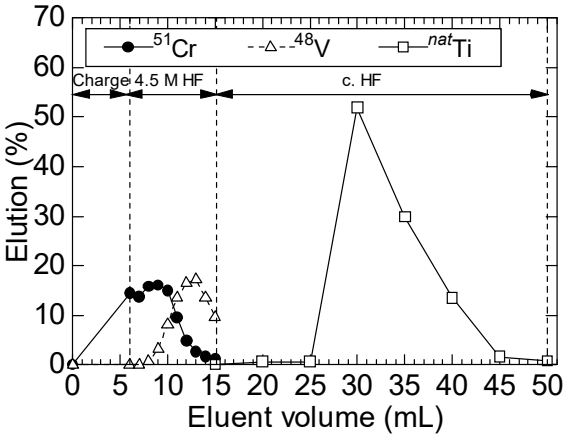

Fig. 1. Elution curves of ^{51}Cr, ^{48}V, and ^{nat}Ti for the anion-exchange chromatography.

The elution curves for the anion-exchange chromatography of ^{51}Cr, ^{48}V, and ^{nat}Ti are shown in Fig. 1. 95% of ^{51}Cr were eluted with 15 mL of 4.5 M HF. The decontamination factor of the ^{nat}Ti for ^{51}Cr was 4.9×10^{-4}, indicating that the anion-exchange separation was useful in the separation of the Cr radiotracers from the target material Ti. However, the decontamination factor of ^{48}V for ^{51}Cr was not satisfied (0.83). In regards to ^{nat}Ti, 99% was eluted with 35 mL of c. HF. This high recovery yield of ^{nat}Ti is promising for recycling of the enriched ^{46}Ti target material.

The elution curves in the cation-exchange chromatography of ^{51}Cr and ^{48}V are shown in Fig. 2. 94% of ^{51}Cr

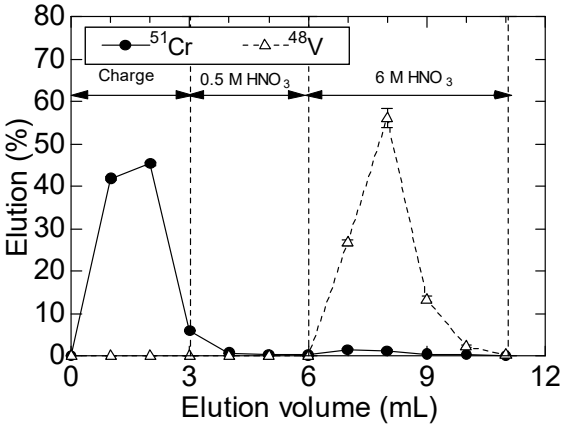

Fig. 2. Elution curves of ^{51}Cr and ^{48}V for the cation-exchange chromatography.

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was eluted with 6 mL of 0.5 M HNO_3. The decontamination factor of ^{48}V for ^{51}Cr was improved from 0.83 to 1.1×10^{-3}. The chemical yield of ^{51}Cr was 90% after both the anion- and cation-exchange separations.

We propose a method for the production no-carrier-added Cr radiotracers from an α-particle-irradiated Ti target. The ^{48}Cr produced using the proposed method using enriched $^{46}TiO_2$ as the target material can be used for double photon coincidence imaging experiments.

References

1) M. A. Choghadi *et al.*, Radioisotopes **70**, 271 (2021).
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