Production of ^{118}Te by the alpha-particle irradiation on enriched ^{116}Sn

Y. Kanayama,[*1] Y. Shigekawa,[*1] A. Nambu,[*1] X. Yin,[*1] and H. Haba[*1]

We are developing production methods for useful radioisotopes in various applications using the heavy-ion accelerators at RIBF. Tellurium-118 ($T_{1/2}$ = 6.0 d) decays through electron capture to ^{118g}Sb ($T_{1/2}$ = 3.6 min) soon decays by β^+-particle emission with a high intensity of 73.5%. Thus, ^{118}Te is expected to be used for PET imaging as a ^{118}Te-^{118}Sb generator.[1,2) In this study, we investigated the production of ^{118}Te *via* the ^{116}Sn$(\alpha, 2n)^{118}$Te reaction using the RIKEN AVF cyclotron.

A metallic ^{116}Sn foil (Trace Sciences International Inc.; 97.8%-enriched) with a 240.3-mg/cm^2 thickness was irradiated with a 28.92-MeV α-particle beam from AVF. The irradiation time was 59 min and the average beam current was 0.82 particle μA. After the irradiation, the produced radioisotopes were investigated *via* γ-ray spectrometry using a Ge detector. An example of γ-ray spectra is shown in Fig. 1, where the γ-ray peaks of ^{118m,g}Sb and ^{119m,g}Te are assigned. Owing to the absence of γ-ray emission from ^{118}Te, the production of ^{118}Te was confirmed with the γ rays of its daughter nuclide ^{118g}Sb in radioactive equilibrium. Figure 2 shows the decay curves for the 1229.3-, 644.0-, and 1136.7-keV γ lines of ^{118}Te, ^{119g}Te, and ^{119m}Te, respectively. Here, ^{118}Te and ^{119m}Te, the exponential decay curves with the literature half-lives of 6.00 ± 0.02 d and 4.70 ± 0.04 d,[3,4) respectively, fit the radioactivities well. However, ^{119g}Te with the literature half-life

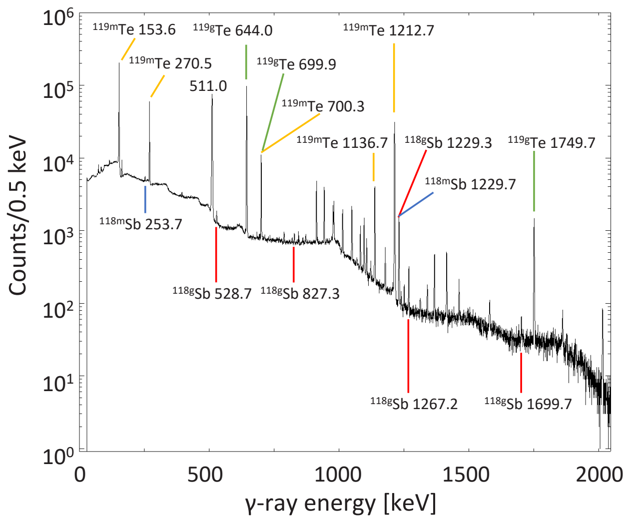

Fig. 1. γ-ray spectrum of the ^{116}Sn target irradiated with a 28.92-MeV α-particle beam.

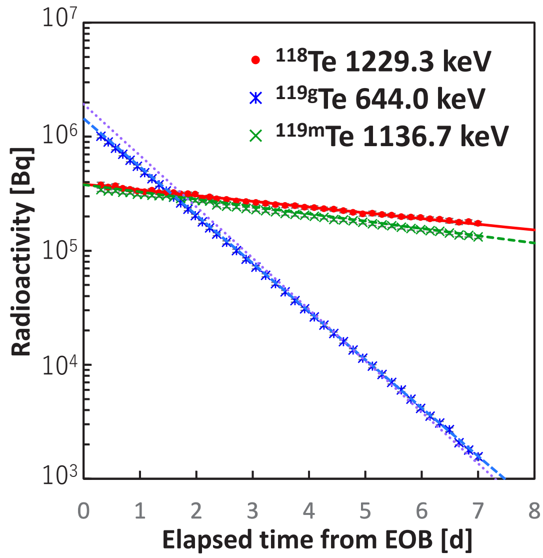

Fig. 2. Radioactive decay curves of ^{118}Te, ^{119g}Te, and ^{119m}Te.

of 16.05 ± 0.05 h[4) cannot reproduce the radioactivities as shown by the purple dotted curve. Thus, we reevaluated the half-life of ^{119g}Te to be 17.09 ± 0.03 h (blue dashed curve), which is 6% longer than the literature value.[4) This longer half-life was confirmed for other 699.9- and 1749.7-keV γ lines of ^{119g}Te. The radioactivities of ^{118}Te and the by-products ^{119g}Te and ^{119m}Te at the end of bombardment (EOB) were determined to be 0.372 ± 0.017, 1.390 ± 0.047, and 0.375 ± 0.007 MBq. These radioactivities were obtained as weighted averages of the radioactivities determined from the γ lines at 528.7, 827.3, 1229.3, 1267.2, and 1699.7 keV for ^{118}Te, 644.0, 699.9, and 1749.7 keV for ^{119g}Te, and 153.6, 270.5, 1136.7, and 1212.7 keV for ^{119m}Te.

The radionuclidic purity of ^{118}Te at EOB was approximately 17% among the Te isotopes. The purity can be increased with the cooling time by decay of the short-lived ^{119g}Te as shown in Fig. 2. It is reported that the excitation functions for the ^{116}Sn$(\alpha, 2n)^{118}$Te and ^{116}Sn$(\alpha, n)^{119m,g}$Te reactions show maxima at around 30 MeV and 21 MeV, respectively.[5,6) In this study, the thick ^{116}Sn target was irradiated to degrade the α-particle beam energy from 28.27 MeV to 0 MeV, fully covering the excitation function of the ^{116}Sn$(\alpha, n)^{119m,g}$Te reactions. As the next step, we plan to increase the radionuclidic purity of ^{118}Te by optimizing the α-particle energy and the target thickness for the ^{116}Sn$(\alpha, 2n)^{118}$Te reaction.

*1 RIKEN Nishina Center

DOI:10.34448/RIKEN.APR.57-187

References
1) P. McQuade *et al.*, in *Positron Emission Tomography: Basic Science and Clinical Practice*, edited by P. E. Valk *et al.*, (Springer-Verlag, London, 2003), p. 251.
2) A. Dash and R. Chakravarty, Am. J. Nucl. Med. Mol. Imaging **9**, 30 (2019).
3) K. Kitao, Nucl. Data Sheets **75**, 99 (1995).
4) D. M. Symochko *et al.*, Nucl. Data Sheets **110**, 2945 (2009).
5) Experimental Nuclear Reaction Data (EXFOR): `https://www-nds.iaea.org/exfor/`.
6) F. T. Tarkanyi *et al.*, J. Radioanal. Nucl. Chem. **319**, 533 (2019).