Activation cross sections of α-induced reactions on ^{nat}In for ^{117m}Sn production

M. Aikawa,[*1,*2] M. Saito,[*1,*2] Y. Komori,[*2] and H. Haba[*2]

The radioisotope (RI) ^{117m}Sn ($T_{1/2}$ = 13.76 d) decays with emission of both conversion electrons (126.82, 129.369, and 151.56 keV) and γ rays (158.56 keV). Further, this RI can be used as a bone pain palliation agent, because the electrons and γ rays are appropriate for therapy and imaging, respectively. The production reactions of this RI have previously been investigated and discussed; however, their production in adequate quantities remains of much concern.[1] In this study, we focused on one of the reactions, *i.e.*, the ^{115}In(α,x)^{117m}Sn reaction, the cross sections of which have exhibited large discrepancies in previous studies.[2–4] Another experiment measuring the cross sections of the reactions is, therefore, valuable.

The experiment was performed at the Azimuthally Varying Field cyclotron of the RIKEN RI Beam Factory using well-established methods, *e.g.*, the stacked foil technique, activation method, and high-resolution γ-ray spectrometry. Natural In foils (purity: 99.99%; Nilaco, Japan) were stacked with natural Ti monitor foils (purity: 99.6%; Nilaco, Japan). The thicknesses of the In and Ti foils were estimated from the measured areas and weights of large foils (50 × 50 mm^2) and found to be 16.60 and 2.44 mg/cm^2, respectively. The stacked target consisted of 11 sets of In-In-Ti-Ti foils (8 × 8 mm^2) cut from the large foils. The first foils on the downstream side of the beam were measured to compensate for the losses of the recoil products. However, the In foils were melted because of their low melting point at 156.6°C and could not be separated after α beam irradiation. Each set of In foils was therefore considered as one foil of 33.3 mg/cm^2. Irradiation with a 51.6-MeV α beam with an average intensity of 202.1 nA was performed for 2 h. The intensity and beam energy were measured by a Faraday-cup-like target holder and the time-of-flight method using a plastic scintillator monitor.[5] The γ rays emitted from the irradiated foils were measured by a high-resolution high-purity Germanium detector.

The decay data[6,7] are summarized in Table 1. Measurement of the 156.02-keV γ-line (I_γ = 2.113%) from the ^{117m}Sn decay was performed after a cooling time of approximately 45 h. The cooling time was set to be sufficiently long for decay of the parent nuclei, ^{117}Sb ($T_{1/2}$ = 2.80 h), ^{117g}In ($T_{1/2}$ = 43.2 min), and ^{117m}In ($T_{1/2}$ = 116.2 min). The γ-line at 158.56 keV (I_γ = 86.4%) was not selected to avoid the overlapped contribution of the 159.377-keV γ-line (I_γ = 68.3%) from the ^{47}Sc ($T_{1/2}$ = 3.3492 d) in the Ti catcher foils. The ^{115}In(α,x)^{117m}Sn reaction cross sections estimated from the ^{115}In abundance (95.71%) are shown in Fig. 1, together with the previous experimental data (open symbols)[2–4] and the TENDL-2015 data (dashed line).[8] Among the three sets of experimental data, the present result (filled symbols) is consistent with Qaim et al. (1984).[3] More detailed analysis regarding ^{117m}Sn and other RIs is currently being performed.

Table 1. Decay data for ^{117m}Sn and related nuclei

Nuclide	$T_{1/2}$	E_γ (keV)	I_γ (%)
^{117m}Sn	13.76 d	156.02	2.113
		158.56	86.4
^{47}Sc	3.3492 d	159.381	68.3

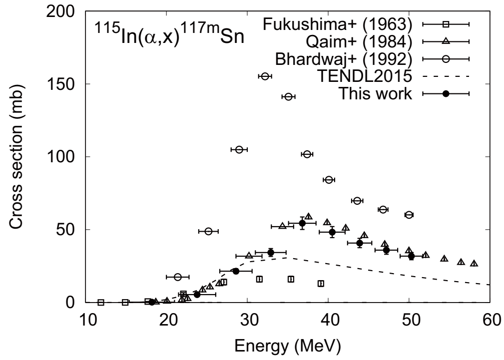

Fig. 1. Excitation function of ^{115}In(α,x)^{117m}Sn reaction. The result is compared with previous experimental data[2–4] and TENDL-2015.[8]

[*1] Graduate School of Biomedical Science and Engineering, Hokkaido University
[*2] RIKEN Nishina Center

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