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

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The radioisotope ^{117m}Sn ($T_{1/2}$ = 13.76 d) can be used as a theranostic radioisotope for both medical therapy and imaging. The production of ^{117m}Sn is of much concern, and the possible production reactions are studied. We focused on one of the reactions, namely the ^{115}In(α, x)^{117m}Sn reaction, in this paper. Three experimental literature[1–3] could be found in the EXFOR library.[4] The literature data, however, show a large discrepancy from each other. More reliable and accurate data are required for practical use. Therefore, we performed a new experiment to measure the cross sections of the ^{115}In(α, x)^{117m}Sn reaction. In addition, the cross sections of the by-products, ^{113}Sn and $^{116m, 117, 118m}$Sb, were measured.

The experiment was performed at the AVF cyclotron of the RIKEN RI Beam Factory. The stacked foil technique, activation method, and high resolution γ-ray spectrometry were used to derive the activation cross sections. Metallic foils of ^{nat}In (4.29% ^{113}In and 95.71% ^{115}In) and ^{nat}Ti were stacked as a target. The target was irradiated by a 51.6-MeV α beam for 2 h. The incident beam energy was determined using the time-of-flight method.[5] The beam energy degradation in the stacked target was calculated using the SRIM code.[6] The average intensity of the beam was 202.1 nA, which was measured by a Faraday cup. The irradiated foils were separated and subjected to γ-ray spectrometry with an HPGe detector.

The excitation function of the ^{nat}Ti(α, x)^{51}Cr monitor reaction was used to assess the beam parameters and the target thicknesses. The excitation function could be derived from measurements of the γ line at 320.08 keV (I_γ = 9.91%) from the decay of ^{51}Cr ($T_{1/2}$ = 27.7025 d). The result is in good agreement with the recommended values.[7] Therefore, we adopted the measured beam parameters and target thicknesses without any adjustments.

The measurement of the 156.02-keV γ line (I_γ = 2.113%) from the ^{117m}Sn decay was performed for the cross sections of the ^{115}In(α, x)^{117m}Sn reaction. The cooling time was longer than 45 h for the complete decay of the parent nuclei, ^{117g}In ($T_{1/2}$ = 43.2 min), ^{117m}In ($T_{1/2}$ = 116.2 min), and ^{117}Sb ($T_{1/2}$ = 2.80 h). The cumulative cross sections of ^{117m}Sn for ^{nat}In targets were obtained from the measurement. The cross sections were normalized to those for ^{115}In enriched targets, taking into account the negligibly small contribution of the α-capture reaction on ^{113}In. The result is shown in Fig. 1 in comparison with the previous experimental data[1–3] and the TENDL-2017 data.[8] The present result is almost consistent with the data obtained by Qaim and Döhler (1984).[2] The data obtained by Fukushima *et al.* (1963)[1] and TENDL-2017 show smaller amplitudes than the others. On the contrary, the data obtained by Bhardwaj *et al.* (1992)[3] are much larger than that obtained by the others.

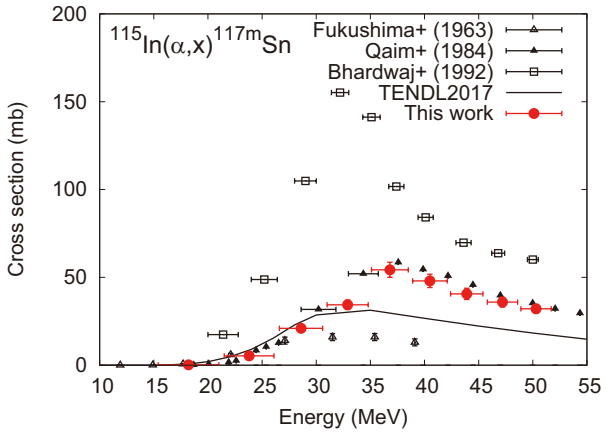

Fig. 1. Excitation function of the ^{115}In(α, x)^{117m}Sn reaction.

In this work, the cross sections of the ^{115}In(α, x)^{117m}Sn reaction up to 50 MeV were measured using the stacked foil activation technique and high resolution γ-ray spectrometry. The measured cross sections were compared with the earlier experimental data and the TENDL data. One of the three experimental datasets is in good agreement with our result. Our result can contribute to the estimation of ^{117m}Sn production.

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