Production cross-section of the ^{nat}Sn(α, x)^{118}Te reaction up to 50 MeV

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Among positron-emitting isotopes, ^{118}Sb is a potential candidate for Positron Emission Tomography (PET) due to its short half-life ($T_{1/2} = 3.6$ min), high positron emission probability (75%), and low intensity of accompanying high-energy γ radiation (E_γ = 1229.33 keV, $I_\gamma = 2.5\%$). This makes it suitable for use in PET imaging.[1)] Another advantage of this isotope is that it can be obtained using a ^{118}Te/^{118}Sb generator with decay of ^{118}Te, which has a half-life of 6 d.[2,3)] Isotope ^{118}Te can be produced with accelerators by nuclear reactions of light-charged-particles on natural or isotopically enriched tin (Sn) or antimony (Sb).[4)] Only an experimental study measuring ^{nat}Sn(α, n)^{118}Te reaction cross-section[5)] determine its cross-section.

Thus, we aimed to measure the production cross-section of ^{nat}Sn(α, x)^{118}Te reaction.

The stacked-foil activation technique and γ-ray spectrometry were used to measure the cross-sections. The stacked target comprised metallic foils of ^{nat}Sn (thicknesses of 10 μm with a purity of 99.9%) and ^{nat}Ti (5 μm, 99.6%). The target was irradiated for 30 min with a 50.8-MeV α-particle beam from RIKEN AVF cyclotron. The incident beam energy was measured by the time-of-flight method. The energy degradation in the stacked target was calculated using SRIM code.[6)] The beam intensity measured using a Faraday cup was 201 nA and double-checked with ^{nat}Ti(d, x)^{51}Cr monitor reaction.[7)] The γ-ray spectra of the irradiated foils were measured by a high-resolution and high-purity germanium (HPGe) detector. The detector was calibrated by a mixed γ-ray point source. The dead time was maintained below 10% in the measurements.

The activation cross-sections of ^{110g,111g}In, ^{113,117}Sn, ^{116m,117,118m,120m,122g,124g,126g}Sb, and ^{116,117g,119m,119g,121m,121g,123m}Te were determined. ^{118}Te decays to ^{118}Sb ($T_{1/2} = 3.6$ min) through an electron capture (EC) process with a 100% branching ratio without any γ-ray emission. Thus, the measurements of 1229.33-keV γ line ($I_\gamma = 2.5\%$) from the ^{118}Sb decay were used to derive the cross-sections of ^{nat}Sn(α, n)^{118}Te reaction.

Our measured excitation function of ^{nat}Sn(α, n)^{118}Te reaction is shown in Fig. 1 when compared with previous experimental data[5)] and the theoretical estimation of the TENDL-2023 values.[8)] Our result in Fig. 1 is consistent with previous experimental data.[5)] The TENDL-2023 values show partial agreement with the experimental data sets.

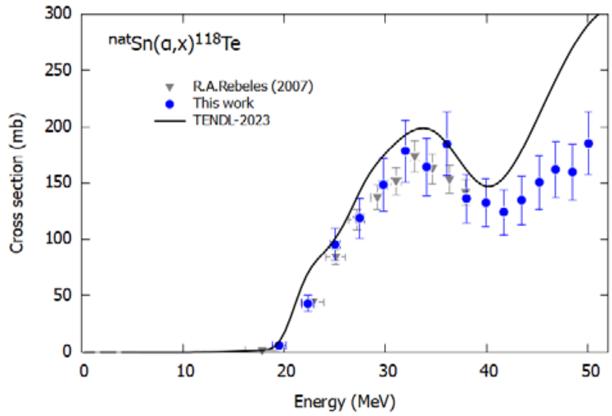

Fig. 1. Excitation function of ^{nat}Sn(α, x)^{118}Te reaction.

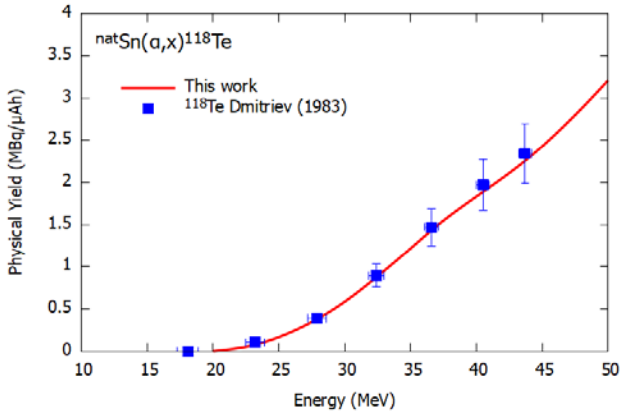

Fig. 2. Physical yield of ^{118}Te.

The physical yield of ^{118}Te was deduced based on the measured excitation function and shown in Fig. 2 when compared with the previous experimental data[9)] of up to 50 MeV. The deduced yield agrees with the measured values reported by Dmitriev (1983).[9)]

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