Measurement of production cross sections of medical isotope ^{110m}In in alpha-particle-induced reaction on natural silver up to 50 MeV

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The metastable state of indium-110 (^{110m}In) has a half-life of 69.1 min and emits positrons ($E_{\beta+}$ = 1011 keV, $I_{\beta+}$ = 61.3%). This radionuclide can be used to label proteins and peptides for application in positron emission tomography (PET) imaging.[1,2] Furthermore, ^{110m}In emits a medium-energy and high-intensity γ line that is useful for $\beta + \gamma$ coincidence PET.[3]

A suitable route for direct production of ^{110m}In is the α-particle-induced reaction on a silver target (^{107}Ag 51.839%, ^{109}Ag 48.161%). ^{110m}In can be produced by the (α, n) reaction ($E_{\rm thr}$ = 7.87 MeV) on ^{107}Ag and the $(\alpha, 3n)$ reaction ($E_{\rm thr}$ = 24.92 MeV) on ^{109}Ag. Because most radioactive impurities can be eliminated, the ^{107}Ag$(\alpha, n)^{110m}$In reaction is a promising candidate for the production of ^{110m}In;[4] however an isotopically enriched ^{107}Ag target is required for the reaction. The longer-lived ground state, ^{110g}In ($T_{1/2}$ = 4.92 h), is co-produced in the energy region in addition to ^{110m}In. To investigate the production route of ^{110m}In, reliable data on the cross sections of the α-induced reaction on a natural silver target are required.

Thus, the main aim of this study is to measure the cross sections of the $^{\rm nat}$Ag$(\alpha, x)^{110m}$In reaction and to investigate a route for ^{110m}In production.

The cross sections were determined using the stacked-foil activation technique and γ-ray spectrometry. Pure metallic foils of $^{\rm nat}$Ag (thickness of 10.1 mg/cm^2 with a purity of 99.9%) and $^{\rm nat}$Ti (thickness of 2.2 mg/cm^2 with a purity of 99.5%) were stacked to form the target.

The stacked target was irradiated for 30 min with a 50.2-MeV α-particle beam from the RIKEN AVF cyclotron. The energy of the incident beam was measured using the time-of-flight method. The SRIM code[5] was used to calculate the energy degradation in the stacked target. The beam intensity was 213 nA measured with a Faraday cup.

A high-resolution high-purity germanium (HPGe) detector was used to measure the γ-ray spectra of the irradiated foils. The detector was calibrated by a mixed γ-ray point source. In the measurements, the dead time was less than 10%.

The cross sections of the $^{\rm nat}$Ag$(\alpha, x)^{110m}$In reaction were derived from the measurements of the 657.75-keV γ line (I_γ = 97.74%) from the ^{110m}In decay.

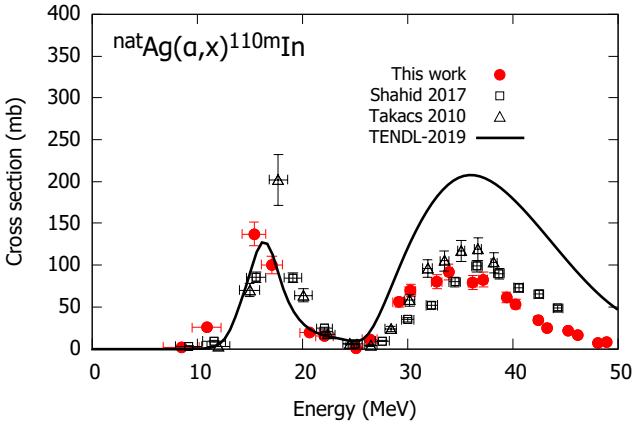

Fig. 1. Excitation function of the $^{\rm nat}$Ag$(\alpha, x)^{110m}$In reaction with previous experimental data[6,7] and the TENDL-2019 values.[8]

Figure 1 shows the preliminary results of the measured excitation function of the $^{\rm nat}$Ag$(\alpha, x)^{110m}$In reaction in comparison with recent experimental data reported by Shahid *et al.*,[6] Takács *et al.*,[7] and the theoretical estimation from TENDL-2019.[8]

Our measured excitation function of the $^{\rm nat}$Ag$(\alpha, x)^{110m}$In reaction is consistent with those of the previous experimental data sets[6,7] within uncertainties, however, the peak position of our result shifts slightly to lower energy.

The TENDL-2019 data show partial agreement with the experimental data sets. The second peak in the higher-energy region is much larger than the experimental data.

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