Excitation function of α-induced reaction on ^{nat}Pd for ^{103}Ag production

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Radioactive isotopes (RIs) are available in many application fields, such as engineering and medicine. Production of such RIs is possible through various reactions involving combinations of projectiles and targets. The best process to obtain RIs can be discussed based on the information of all the reactions. The production cross sections induced by neutrons and light charged-particles thus constitute fundamental information for the applications.

One such RI for medical applications is ^{103}Pd ($T_{1/2}$ = 16.991 d) for brachytherapy[1,2] and targeted radionuclide therapy as part of the ^{103}Pd/^{103m}Rh *in vivo* generator[3]. In addition to direct ^{103}Pd production, the production of its generator, ^{103}Ag, is worthly of investigation. ^{103}Ag has the isomeric state ^{103m}Ag at 134.4 keV ($T_{1/2}$ = 5.7 s, IT: 100%), which cumulatively contributes to ^{103g}Ag ($T_{1/2}$ = 65.7 min, $\epsilon + \beta^+$: 100%) production through IT decay. In the case of α-induced reactions on ^{nat}Pd, only experimental data are available only below 37 MeV[4]. Therefore, we performed an experiment to obtain the excitation function of ^{nat}Pd(α,x)^{103}Ag up to about 50 MeV. This experiment is promising as it would provide fundamental information for establishing the best process for ^{103}Ag/^{103}Pd production.

The experiment was performed at the RIKEN AVF cyclotron by using the stacked foil technique and the activation method. ^{nat}Pd foils (purity: 99.95%, Nilaco, Japan) were used with ^{nat}Ti monitor foils (purity: 99.9%, Goodfellow, UK). The thicknesses of the Pd and Ti foils were 9.80 mg/cm^2 and 4.95 mg/cm^2, respectively. The stacked target consisted of 12 sets of the Pd-Pd-Ti-Ti foils to reduce the possible recoil effect in every second foil. The target was irradiated for 2 h by the 51.2 MeV α beam with the average intensity of 55.7 pnA. This beam energy was measured by the time-of-flight method using a plastic scintillator monitor[5]. γ rays from the irradiated foils were measured by HPGe detectors.

According to the NuDat 2.6 database[6], there are many specific γ lines from ^{103g}Ag decays. We adopted the intense γ line at 118.74 keV (31.2%) to derive the production cross sections of ^{103g}Ag since the γ line at 148.20 keV (28.3%) overlaps with that of ^{111m}Cd ($T_{1/2}$ = 48.54 min, IT: 29.1%) at 150.824 keV. Our preliminary result is shown in Fig. 1 with the previous experimental data[4] and theoretical calculation of ^{102}Pd(α,x)^{103}Ag in TENDL-2014[7] with normalization of the ^{102}Pd abundance (1.02%). Our result shows slightly larger values than the previous data[4] below 37 MeV. The peak could be found at around 42 MeV in our result but at around 45 MeV in TENDL-2014[7]. Further analysis will be performed on the data and the Ti monitor reaction to finalize the result.

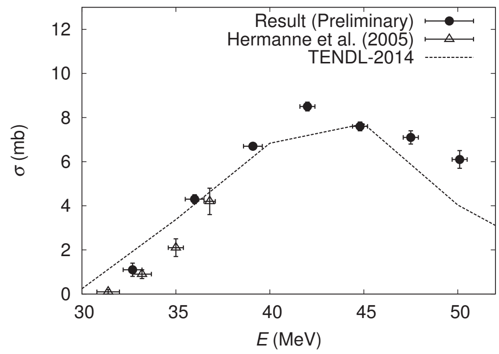

Fig. 1. Excitation function of the ^{nat}Pd(α,x)$^{103g+m}$Ag reaction. Our preliminary result (solid circles) with statistical errors is compared with the previous experimental data (open triangles)[4] and the theoretical calculation[7] of ^{102}Pd(α,x)^{103}Ag with normalization of the ^{102}Pd abundance.

In summary, we performed an experiment on ^{nat}Pd(α,x)$^{103g+m}$Ag by using the stacked foil technique and the activation method. The preliminary result of the excitation function of the reaction shows slightly different values from the previous experiment and theoretical calculation. The final result based on further analysis will be reported in a separate paper. We will also analyze the spectral data to derive production cross sections of other RIs.

This work is supported by the Japan - Hungary Research Cooperative Program, JSPS and HAS.

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