Cross section measurement of the deuteron-induced reaction on ^{89}Y to produce ^{89}Zr

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Zirconium-89 ($T_{1/2}$ = 78.41 h) is a positron emitter, which can be used for the diagnostic imaging of Positron Emission Tomography (PET). There are many routes to produce ^{89}Zr. The ^{89}Y(p, n)^{89}Zr reaction and the ^{89}Y(d, 2n)^{89}Zr reaction can be quoted as their examples. The former is better known, as many experiments have been performed on this reaction during the last several decades. In contrast, only seven experiments with the latter[1–7] could be found in the literature. The behaviors of the excitation functions of the latter disagree with each other and there are only a few previous experiments that show cross sections over 20 MeV. These facts are obstacles to deciding the most efficient way to obtain this radionuclide. Therefore, we performed an experiment on the ^{89}Y(d, 2n)^{89}Zr reaction and measured the cross sections up to 24 MeV.

We adopted the standard stacked-foil activation method for this experiment. The target consisted of ^{89}Y foils (purity: 99.0%, thickness: 28.6 μm; Goodfellow Co., Ltd., UK) and ^{nat}Ti foils (purity: 99.6%, thickness: 20.3 μm; Nilaco Corp., Japan), which were used for the ^{nat}Ti(d,x)^{48}V monitor reaction. This stacked target was positioned in a target holder served as a Faraday cup and irradiated by a 23.6-MeV deuteron beam for 1 h at the RIKEN AVF cyclotron. The average beam intensity was 102.3 nA, which was measured by using the Faraday cup. The energies of the projectile going through each foil and their uncertainties were calculated by using the SRIM[8] code.

After a cooling time of approximately 1 h, we disassembled the stacked foils and measured the γ-ray spectra on each foil by using an HPGe detector. The 909.15-keV γ-line (I_γ = 99.04%) following the decay of ^{89}Zr and the 983.525-keV γ-line (I_γ = 99.98%) following the decay of ^{48}V were measured to derive the cross sections of the ^{89}Y(d, 2n)^{89}Zr and ^{nat}Ti(d, x)^{48}V reactions, respectively. Keeping the dead time less than 5%, the distance between the measured foils and the HPGe detector was adjusted in every γ-ray measurement.

The cross sections of the ^{nat}Ti(d,x)^{48}V reaction were derived, and it was confirmed that their values agree with the IAEA recommended values, which indicates the correctnesses of the thicknesses and beam parameters within the uncertainties.

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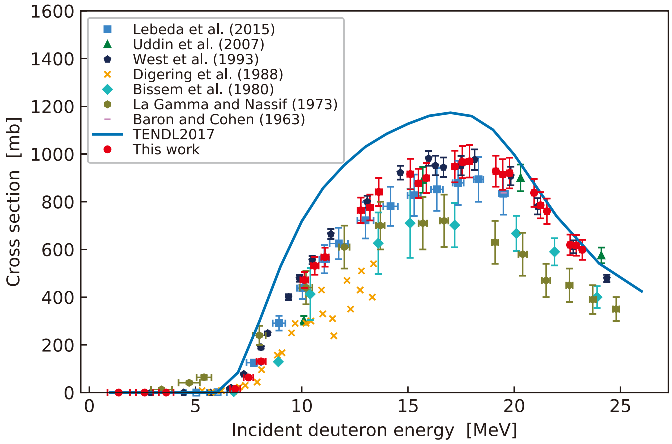

Fig. 1. Excitation function for the ^{89}Y(d, 2n)^{89}Zr reaction compared with the previous experimental data and the TENDL data.

Figure 1 shows the excitation function of the ^{89}Y(d, 2n)^{89}Zr reaction in this work in comparison with the previous data and the TENDL[9] data. Our result indicates that the peak of the excitation function is located at around 17.9 MeV and the corresponding cross section value is approximately 970 mb. These values are almost the same as that of some of the previous data. On the other hand, the cross section values of the TENDL data are higher than those of all the experimental data in the range between 10 and 20 MeV.

In this work, we performed an experiment on the ^{89}Y(d, 2n)^{89}Zr reaction at the RIKEN AVF cyclotron. The stacked foil activation method and γ-ray spectrometry were used for this experiment. The cross sections of this reaction were measured up to 24 MeV. Our result is consistent with some of the previous data. The production yield of ^{89}Zr in this reaction will be derived and compared with that in other reactions.

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