Production cross sections of ^{68}Ga via deuteron-induced reactions on natural zinc

Ts. Zolbadral,[*1,*2] M. Aikawa,[*1,*3,*2] D. Ichinkhorloo,[*3,*2] Kh. Tegshjargal,[*4] N. Javkhlantugs,[*4] Y. Komori,[*2] and H. Haba[*2]

^{68}Ga ($T_{1/2}$ = 68 min), a positron emitter, is a valuable medical isotope used for positron emission tomography (PET). One of the production routes of this radionuclide is the deuteron-induced reaction on zinc. In a literature survey, only two datasets of the experimental cross sections of the ^{nat}Zn$(d,x)^{68}$Ga reaction were found,[1,2] and these data show a remarkable discrepancy. It is necessary to obtain reliable cross sections to investigate the best production route for practical use. Therefore, we measured the production cross sections of ^{68}Ga via the deuteron-induced reaction on natural zinc.

The stacked-foil activation method and γ-ray spectrometry were used. The stacked target was composed of metallic foils of ^{nat}Zn (17.64 mg/cm^2, 99.9% purity) and ^{nat}Ti (9.13 mg/cm^2, 99.6% purity). The target was irradiated for 22 min by a 24-MeV deuteron beam from the RIKEN AVF cyclotron. The incident beam energy was measured using the time-of-flight method. The energy degradation in the stacked foils was calculated using SRIM code.[3] The beam intensity was measured using a Faraday cup and cross-checked using the ^{nat}Ti$(d,x)^{48}$V monitor reaction.[4] By referring to the cross sections of the monitor reaction, the beam intensity was increased 6.6% from the measured value and thereby corrected to 102.4 nA. The γ-ray spectra of the irradiated foils were measured using a high-resolution HPGe detector (ORTEC GMX30P4-70) without chemical separation. The detector was calibrated using a standard mixed multiple γ-ray-emitting point source. The distance between the detector and foils was chosen to keep the dead time less than 7%.

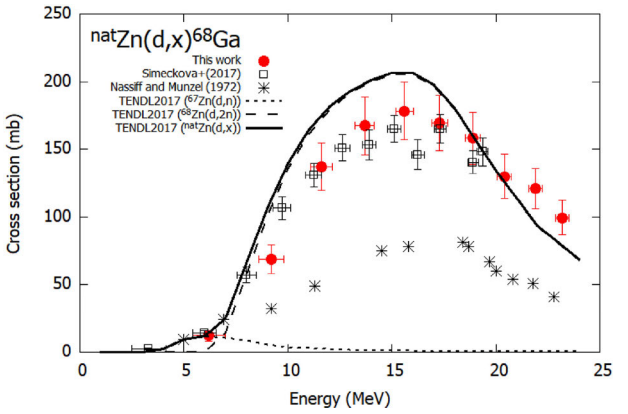

Fig. 1. Excitation function of the ^{nat}Zn$(d,x)^{68}$Ga reaction.

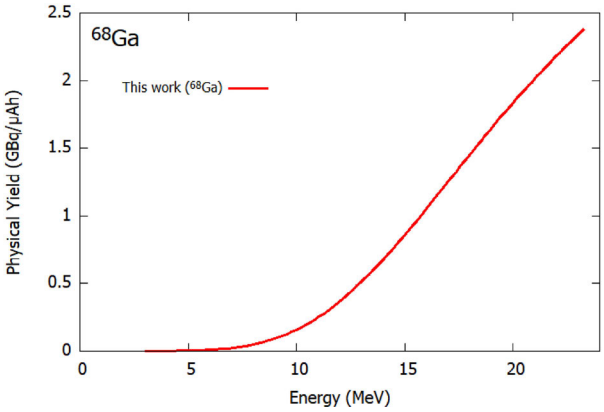

Fig. 2. Integral yield of ^{68}Ga.

The cross sections of the ^{nat}Zn$(d,x)^{68}$Ga reaction were derived from the measurements of the 1077.34-keV γ-line (I_γ = 3.22%) associated with the ^{68}Ga decay. The excitation function of the reaction is shown in Fig. 1 in comparison with previous data[1,2] and the theoretical estimation of TENDL-2017.[5] Our result is consistent with the data reported by Šimečková *et al.*[2] but inconsistent with those reported by Nassiff and Münzel[1] in the whole investigated energy region. The TENDL-2017 data overestimate the experimental data around the peak in the energy range of 8–18 MeV.

The physical yield of ^{68}Ga was deduced from the measured cross sections. The derived yield is shown in Fig. 2. The physical yield of ^{68}Ga via the deuteron-induced reaction on zinc is reported for the first time.

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*1 Graduate School of Biomedical Science and Engineering, Hokkaido University
*2 RIKEN Nishina Center
*3 Faculty of Science, Hokkaido University
*4 School of Engineering and Applied Sciences, National University of Mongolia

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