Activation cross sections of α-induced reactions on ^{nat}Zn for ^{68}Ge production

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Radioactive isotopes are used in nuclear medicine for therapy and diagnosis. A positron emitter, ^{68}Ga ($T_{1/2}$ = 67.71 min), is applied for positron emission tomography (PET).[1] In addition to ^{68}Ga, its long-lived parent, ^{68}Ge ($T_{1/2}$ = 270.95 d), is useful as a ^{68}Ga generator.[2] A possible reaction route to produce ^{68}Ge (Z = 32) comprises alpha-induced reactions on zinc isotopes (Z = 30), cross sections of which have been investigated previously.[3,4] However, the amplitudes of the previous data are slightly different from each other. We therefore measured cross sections of the alpha-induced reactions on natural zinc for ^{68}Ge production.

The experiment was performed at the AVF cyclotron of the RIKEN RI Beam Factory by using the stacked foil technique and the activation method. ^{nat}Zn foils (purity: 99.9%, Nilaco, Japan) were stacked with ^{nat}Ti monitor foils (purity: 99.6%, Nilaco, Japan). The thicknesses of the Zn and Ti foils were estimated from the measured area and weight of large foils (50 × 50 mm^2 and 50 × 100 mm^2) and found to be 18.64 mg/cm^2 and 2.25 mg/cm^2, respectively. The stacked target consisted of 14 sets of the Zn-Ti-Ti foils (8 × 8 mm^2) cut off from the large foils. The first Ti monitor foils at the downstream side of the beam were assumed to compensate for losses of recoil products. The target was irradiated for 2 h by a 51.5 MeV alpha beam with an average intensity of 41.0 pnA, which was measured by a Faraday cup. The beam energy was measured by the time-of-flight method using a plastic scintillator monitor.[5] The irradiated foils were subjected to γ-ray spectrometry by HPGe detectors.

The decay data[6] are summarized in Table 1. The measurement of the 1077.34 keV γ-line (3.22%) from the ^{68}Ga decay, which is in equilibrium with that of its parent ^{68}Ge, was performed after a long cooling time of about 80 days. Each Zn foil with its Ti catcher foil was simultaneously measured to collect the recoiled products. In the cooling time, all ^{68}Ga produced directly through the ^{nat}Zn(α,x) reaction during the irradiation could be considered to have decayed completely. The cross sections derived from the measurement are shown in Fig. 1 together with the previous experimental data (open squares and triangles)[3,4] and the TENDL-2015 data (dashed line).[7] The present result is slightly different from the previous experimental data, although the peak position of approximately 30 MeV is consistent with them. In contrast, the TENDL-2015 data shows a different tendency from the experimental data, probably because of underestimation of the contribution from the ^{nat}Zn(α,3n) reaction.

Table 1. Decay data of ^{68}Ge and ^{68}Ga

Nuclide	$T_{1/2}$	E_γ (keV)	I_γ (%)
^{68}Ge	270.95 d	-	-
^{68}Ga	67.71 min	1077.34	3.22

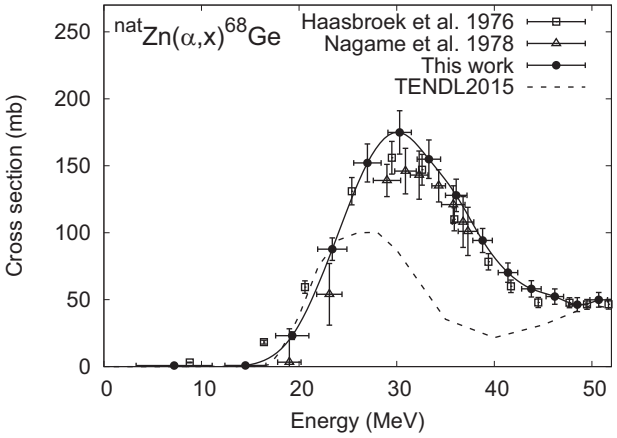

Fig. 1. Excitation function of the ^{nat}Zn(α,x)^{68}Ge reaction. The result is compared with the previous experimental data[3,4] and TENDL-2015.[7]

In summary, we performed an experiment on the alpha-induced reactions on natural zinc to produce ^{68}Ge, a generator of a positron emitter, ^{68}Ga. The excitation function of the ^{nat}Zn(α,x)^{68}Ge reaction was measured up to 51.5 MeV, and the peak position was found to be consistent with that of previous experiments.

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