Production of 167Tm

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I. 7. Production of ^{167}Tm

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Knowledge of radioisotope formation cross-section is an essential prerequisite for development work on radionuclide production by means of charge-particle bombardment. Their understanding is also very useful for working in charge-particle activation analysis in order to predict both expected sensitivity and possible interference.

Thulium-167 decays by electron capture to ^{167m}Er with the half-life of 9.24 days, and the daughter also decays by isomeric transition to ^{167}Er with the short half-life of only 2.3 seconds. The gamma-ray due to ^{167m}Er, 208 keV, is in the optimum range of detectable energy for commercially available detecting devices and the gamma-ray emission provides 41.7 photons in every 100 disintegrations. Hence, it can be said that the carrier-free ^{167}Tm is well suited as a tracer in radiochemistry. However, its production has not yet been carried out.

Materials and Methods

In order to elucidate the reactions of holmium with alphas, in the present study, the excitation functions for the ^{165}Ho(α,n)^{168}Tm ($t_{1/2}$ = 93.1 d) and ^{165}Ho(α,2n)^{167}Tm reactions have been determined by bombarding alpha particles on holmium stacked target.[1) Further, the thick target yield of ^{167}Tm was estimated on the basis of the resulted excitation function.

The cross-sections were experimentally determined by means of activation method. The holmium targets were prepared by electrolysis[2) as holmium oxides on 25 μm aluminum foils. The thickness of each target was found to be about 100 μg/cm^2. The target weighted out accurately was placed between two aluminum foils of known thickness (10 or 25 μm), and 7 targets were stacked for bombardment. Then, two stacks were bombarded by 25 and 30 MeV alphas for 4 and 12 hours with average beam currents of

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600 and 900 nA, respectively. In order to determine the excitation functions, the alpha energy at the midpoint of each target thickness was calculated from the range-energy tables. After bombardment, the stack was allowed to stand for about 100 hours to eliminate short half-life radioactivities. The gamma-ray spectrum of each target was measured directly with a pure germanium detector connected to a 4000 channel pulse-height analyzer. Such measurements were carried out at time interval suitable for radionuclide identification. The number of counts in the relevant photopeak area was corrected by means of the counting efficiency of the detector and the gamma-ray branching ratio. Loses of the radioisotopes into the aluminum foil due to recoil were also examined in a similar manner.

Results and Discussion

In order to determine accurately the absolute production yields of ^{167}Tm and ^{168}Tm, 208 and 198 keV gamma-rays were measured for ^{167}Tm and ^{168}Tm, respectively. The above two radioisotopes found in the aluminum foil due to recoil were shown in Fig. 1, as recoil yields depending on the alpha energy. In calculations of the excitation functions, these radioisotopes were corrected as the radioactivities produced in each target. The excitation function curves for the ^{165}Ho(α,n)^{168}Tm and ^{165}Ho(α,2n)^{167}Tm were shown in Fig. 2. As can be seen in Fig. 2, the cross-section value in the peak for the ^{165}Ho(α,2n)^{167}Tm reaction is evidently higher than that for ^{165}Ho(α,n)^{168}Tm reaction, and the yield of ^{167}Tm increases sharply in the energy range from 20 to 27 MeV. The thick target yields of ^{167}Tm and ^{168}Tm which are obtained by integration of the corresponding yield curves are shown in Fig. 3 as a function of alpha energy. They are given in terms of μCi of the radioactivities produced by an hour irradiation of holmium target with the beam current of 1 μA. In Fig. 3, it indicates that the yields of ^{167}Tm and ^{168}Tm increases sharply in the energy range from 15 to 20 MeV and then increase gradually at energies above 20 MeV.

When production of carrier-free ^{167}Tm is performed by bombarding the holmium target with alphas, contamination of ^{168}Tm is always unavoidable, although its yields are lower than that of ^{167}Tm over the almost whole energy range of alpha. On the basis of the thick target yield curves in Fig. 3, however, it is expected that ^{167}Tm in higher quality is obtainable by bombarding the holmium target with alphas in the energy range from 20 to 29 MeV. In such a case, the yield of ^{167}Tm is found to be 60 μCi/μA·hr, while that of ^{168}Tm is 0.4 μCi/μA·hr.

References

1) Satoh I., Tomiyama H., Mitsugashira T., Nomura A. and Suzuki S., CYRIC Annual Report (1984) 55.
2) Satoh I., Morii N., Mitsugashira T., Nomura A. and Suzuki S., CYRIC Annual Report (1986) 124.

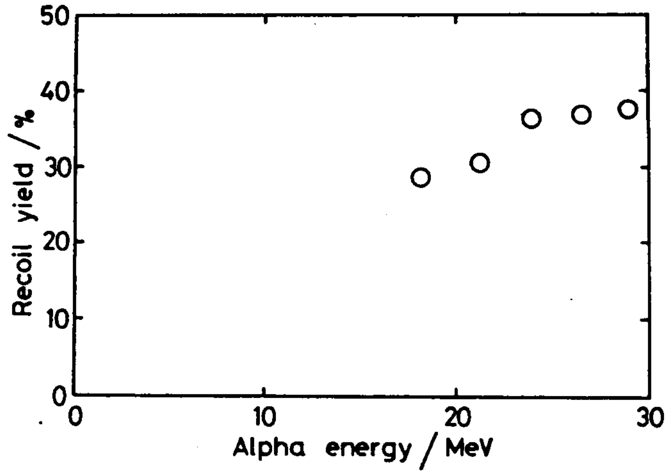

Fig. 1. Recoil yield of ^{165}Ho+α.

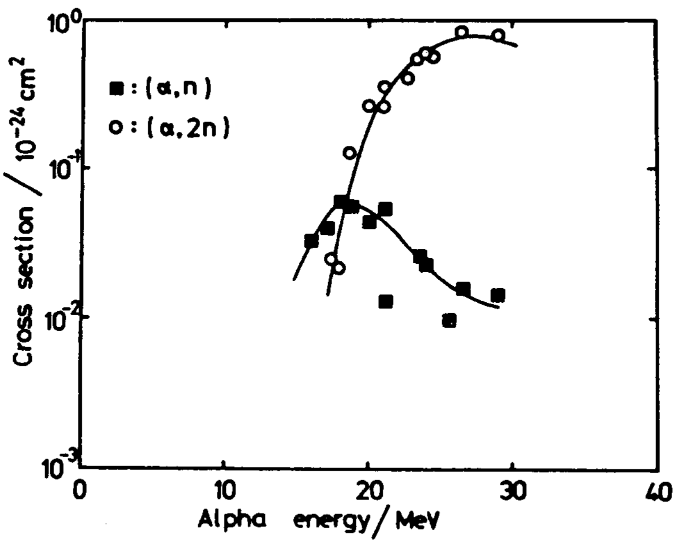

Fig. 2. Excitation functions of ^{165}Ho(α,n)^{168}Tm and ^{165}Ho(α,2n)^{167}Tm reactions.

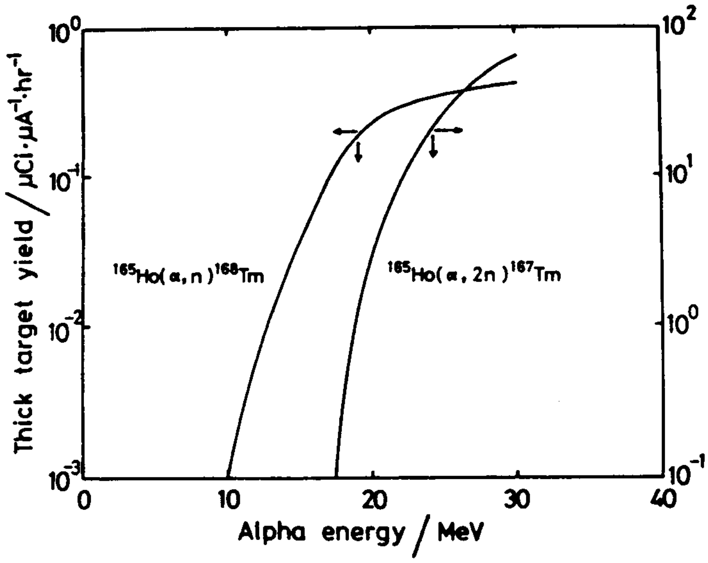

Fig. 3. Thick target yields of $^{165}Ho(\alpha,n)^{168}Tm$ and $^{165}Ho(\alpha,2n)^{167}Tm$ reactions.