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Production of ^{61}Cu by α and ^{3}He Bombardment on Cobalt Targets*

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^{61}Cu has better nuclear properties for use in nuclear medicine.[1] Its 3.32h half-life and 284 keV γ-ray make it a particularly useful diagnostic scanning agent giving a much lower absorbed dose for a given count rate than the more readily available ^{64}Cu and ^{67}Cu. ^{61}Cu can be produced with a cyclotron by a $^{59}Co(\alpha, 2n)$ ^{61}Cu reaction : this reaction results in a maximum of 6 mCi/μAh for 40 MeV α bombardment.[1] Bombardment of cobalt has an additional advantage in that the inexpensive monoisotopic element cobalt can be used.

In producing a short-lived radionuclide for use in clinical diagnostic procedures, two factors of prime importance are the yield of the desired nuclide and the degree of contamination with other isotopes, particularly those which have relatively long half-lives and which cannot be separated chemically. To determine the optimum irradiation condition to maximize the yield of the desired nuclide and to minimize the yield of other by-product nuclides, the excitation curves for the reactions concerned must be known.

We have investigated the excitation curves and the thick-target yield curves of ^{61}Cu and by-product nuclides such as ^{56}Co, ^{57}Co, and ^{58}Co. Photopeak efficiencies have been calculated at γ-ray energies of these nuclides for sodium iodide crystals.

Target Preparation. A thin cobalt target (15—25 mg/cm^2) was electro-deposited from a cobalt sulfate solution ($CoSO_4 \cdot 7H_2O$ 500g/1, NaCl 17g/1, H_3BO_4 45g/1) onto a disk of electrolytic copper foil (35 μ thick).

Bombardment. The stacked target was attached to the beam duct of No. 2 of IPCR cyclotron and bombarded with 0.5—1 μA beam of 40 MeV α and ^{3}He particles. A collimater situated in front of the target reduced the spead in width of beam to *ca.* 1.5×1.5cm^2. The beam current was measured with a beam current integrator.

Measurement. After bombardment, γ-ray spectra of each foil were measured with a 15cm^3 Ge(Li) detector, which had been accurately calibrated using IAEA γ-ray standard sources. The specific γ-rays and half-lives were sufficiently distinguished without chemical separation. The principal photopeaks of nuclide were followed in order to determine the half-life and confirm the identily of the nuclides.

The excitation curves for the production of ^{61}Cu by α bombardment on cobalt are shown in Fig. 1. The maximum cross section of 350mb is shown at 25 MeV. Above 25MeV the cross section for ^{61}Cu production decreases ; probably because the $^{59}Co(\alpha, \alpha n)^{58}Co$ and $^{59}Co(\alpha, \alpha 2n)^{57}Co$ reactions are more probable than the $^{59}Co(\alpha, 2n)^{61}Cu$ reaction in this region.

* 本報告は Bull. Chem. Soc. Japan, **50,** 1251—1255 (1977) に発表

1) Y. Homma and Y. Murakami, *Chem. Lett,* **1976,** 397.

The Coulomb barrier for the interaction of ^{3}He with ^{59}Co is about 9.72MeV, whereas the Q values for the $^{59}Co(^{3}He,n)^{61}Cu$, $^{59}Co(^{3}He,\alpha)^{58}Co$, $^{59}Co(^{3}He,\alpha n)^{57}Co$, and $^{59}Co(^{3}He,\alpha 2n)^{56}Co$ reactions are +6.6, +10.1, +1.5, and −9.4 MeV, respectively. This indicates that, for the ^{3}He particles with sufficient kinetic energy to cross the Coulomb barrier, the cross section for the first reaction is negligibly small. (Fig. 2).

We found the bombardment of cobalt at 40MeV to be the best method to produce ^{61}Cu in sufficient quantity for radiopharmaceutical studies. Advantages are the relatively high yield as compared with other methods, and the high radionuclidic purity of carrier-free ^{61}Cu. For routine production we have chosen the following bombardment conditions : energy of the incident particles 40 MeV, target thickness 250 mg/cm², beam current 5μA. The irradiation time varies according to the required quantity of ^{61}Cu from 1—2h. Under these conditions, the yield of ^{61}Cu obtained at the end of 1 and 2h of bombardment is *ca*. 13 and 26mCi, respectively, corrected for losses during the course of recovery.

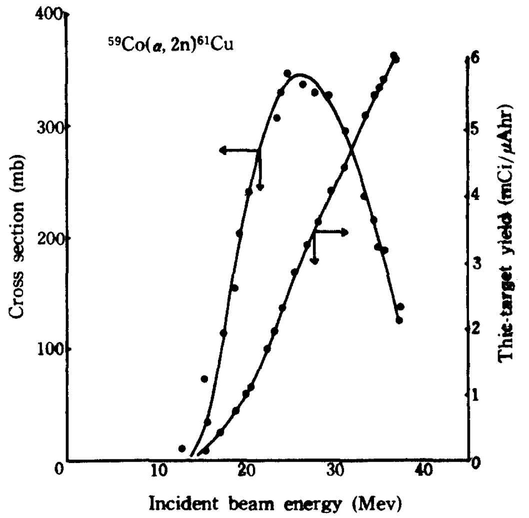

Fig. 1 Excitation curve and thick-target yield curve for α reaction on cobalt producing ^{61}Cu.

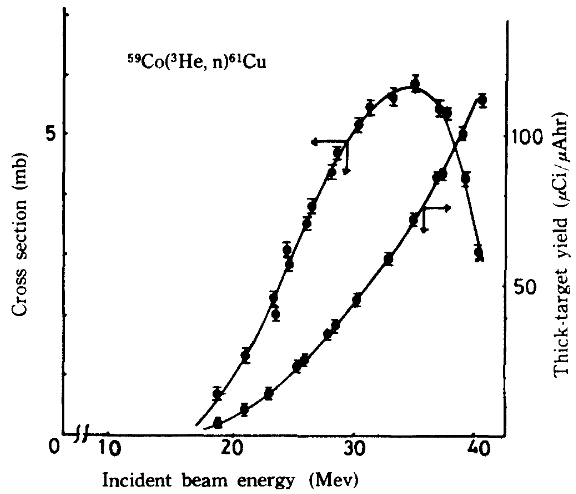

Fig. 2 Excitation curve and thick-target yield curve for ^{3}He reaction on cobalt producing ^{61}Cu.