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Carrier-Free Radioisotopes from Cyclotron Targets VIII. Preparation and Isolation of $Cu^{64,67}$ from Zinc

Herman R. Haymond, Roy D. Maxwell, Warren M. Garrison, and Joseph G. Hamilton

March 27, 1950

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CARRIER FREE RADIOISOTOPES FROM CYCLOTRON TARGETS VIII. PREPARATION AND ISOLATION OF $Cu^{64,67}$ FROM ZINC*

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March 27, 1950

The radio copper was produced by bombardment of zinc with 19 Mev deuterons in the 60 inch cyclotron at Crocker Laboratory. At this energy, the longer lived radioisotopes[1] of copper, $Cu^{64,67}$, are produced in a thick target by the nuclear reactions, $Zn^{64}(d,2p)Cu^{64}$, $Zn^{66}(d,\alpha)Cu^{64}$, $Zn^{67}(d,2p)Cu^{67}$. Radioisotopes of gallium are produced concurrently by the reactions, Zn(d,xn)Ga. The carrier-free radio copper was separated from the target element and from the radioisotopes of gallium by a solvent extraction method based on the selective solubility of copper dithizonate in carbon tetrachloride. This procedure[2], originally developed for the colorimetric determination of microgram quantities of copper, quantitatively extracted $Cu^{64,67}$ from solutions containing less than approximately 10^{-8} gm of copper, the minimum amount detectable by colorimetry under the experimental conditions used.

A block of spectrographically pure[3,4] zinc was soldered to a water cooled aluminum target and bombarded for a total of 20 μa-hr at an average beam intensity of 10 μa. Approximately 1.0 gm of the bombarded surface was removed by milling

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**Lieutenant Colonel, U. S. Army, now stationed at Walter Reed Hospital, Washington, D. C.

1 G. T. Seaborg and I. Perlman, Rev. Mod. Phys. 20, 585 (1948)

2 E. B. Sandell, Colorimetric Determination of Traces of Metals, Interscience Publishers, Inc. New York, N. Y., 1944

3 The zinc was obtained from Johnson Mathey & Co. Copper was not detected by spectrographic analysis.

4 The reagents and solutions used in the isolation of Cu^{64} were tested for copper impurity using the method described in ref.2. The water was triple-distilled from glass.

and dissolved in a minimum volume of 12N HCl. The solution was diluted to 5.5 N and the gallium activities were extracted with ether after the addition of 10 mg of $GaCl_3$ carrier. The aqueous phase was evaporated almost to dryness, adjusted to pH 1.0 1.2 with NaOH to a volume of 50 ml and extracted three times with equal volumes of CCl_4 containing .001% dithizone. Under these conditions, the carrier-free $Cu^{64,67}$ was quantitatively separated from the target element and from traces of gallium which may not have been completely removed in the previous extraction. The CCl_4 phases were combined, washed twice with 0.1 N HCl and evaporated to dryness in a porcelain dish. To remove excess dithizone and to destroy the copper dithizone complex, the dish was heated at 500°C. for 1/2 hour. The carrier-free $Cu^{64,67}$ was dissolved in an amount of 0.1 N HCl which on neutralization gave an isotonic saline solution of the desired volume for subsequent biological investigation.

The radio-copper was identified by half-life determination, absorption measurement, and by chemical separation with carriers. The decay curve was followed for 500 hours and showed the 12.8 hour period[5] of Cu^{64} and a longer-lived activity which after 100 hours leveled off into a 72 hour period. This activity, presumably Cu^{67},[6] was followed for four half lives and accounted for approximately 3.0% of the total beta activity corrected to the time of bombardment. Absorption measurements 10 hours after bombardment showed the 0.6 Mev beta particle and 1.2 Mev gamma ray reported[5,7] for Cu^{64}. A tracer amount of activity added to a 1 N HCl solution of Ni, Cu and Ge in carrier amounts was quantitatively recovered in the CuS fraction following precipitation with H_2S.

We wish to thank Mr. T. Putnam, Mr. B. Rossi and the 60-inch cyclotron crew at Crocker Laboratory for bombardments and Professor G. T. Seaborg for helpful suggestions.

5 S. N. Van Voorhis, Phys. Rev. 50, 895 (1936)

6 R. H. Goeckermann and I. Perlman, Phys. Rev. 73, 1127 (1948)

7 H. Bradt et al. Helv. Phys. Acta. 19, 219 (1946)