Concentration of Radioactive Copper by Use of a High Speed Rotating Cathode*

Radioactive copper (period 12.8 hours), formed from zinc by neutron bombardment, has previously been concentrated in three ways: addition of inactive copper ion, followed by precipitation of CuS;[1] addition of inactive copper ion followed by deposition on a zinc plate;[1] and partial solution of zinc dust in acid, followed by electrochemical displacement on a lead plate.[2] This communication describes a fourth method, which may find wide general use in problems of concentrating minute quantities of such isotopes. The high speed rotating cathode,[3, 4] it has been found, will separate a considerable proportion of the radioactive copper from solution, without the addition of its nonradioactive isotope as a "carrier." It is thus possible to obtain extremely thin layers of radioactive copper on a variety of surfaces, including copper itself.

The procedure consists of irradiating overnight 90 grams of zinc dust with a radon-beryllium source (300 to 600 millicuries) of neutrons. The zinc is then treated with concentrated hydrochloric acid until all but five grams have dissolved, which undissolved part carries practically all the activity.[2] This is next dissolved in hydrochloric acid; 30 to 40 cc of concentrated sulphuric acid are added, and the mixture evaporated until fumes of SO_3 are given off. It is then diluted to 400 cc and filtered. This solution is then electrolyzed with the use of a rapidly rotating disk cathode of copper, platinum or other metal, of 3 cm diameter, 0.25 mm thickness. With a platinum anode, under these conditions, satisfactory operation was obtained with currents of 10 to 18 milliamperes and voltages ranging from 2.1 to 2.7 volts. The optimum speed of rotation of the cathode was about 4500 r.p.m.

Activities of various disks, sulphide precipitates, etc., were measured with a thin silvered-wall Geiger counter or with a pressure ion chamber electrometer system.

The following preliminary results are reported:

(a) The amount of radioactive copper ion deposited is approximately a linear function of the duration of the electrolysis in the initial period up to 30 minutes.

(b) The effect of the stirring rate on the removal of activity is such that there is a maximum between 2300 and 5000 r.p.m. The speeds tested ranged from 2300 to 12,000 r.p.m.

(c) The efficiency of cathode materials in the removal of radioactive copper decreased in the order: copper, molybdenum, platinum, tungsten, tantalum.

(d) It is estimated that a copper disk, running for 45 minutes, at 4500 r.p.m., 11 milliamperes and 2.1 volts, removed at least 50 percent of the activity in solution. The estimate is based upon a comparison of the activity of an aliquot of solution before electrolysis as CuS, and of the activity of the solution after electrolysis as CuS.

(e) The high speed rotating cathode gives very sharp separations. When a current of 10 to 11 milliamperes was used, it was found that the appearance of the disk after electrolysis was unchanged, and retained its mirrored finish, with no evidence of the deposition of other elements. At higher currents the appearance of the disks after electrolysis indicated that some impurities had plated out as well. They then presented a somewhat darkened appearance, although still retaining the mirrored surface which had been imparted to them by buffing.

This method permits a much higher concentration ratio of active to inactive isotope to be achieved than under ordinary conditions, since it eliminates the need for the addition of the inactive isotope to active solutions. It should be applicable to a large number of elements. It can facilitate the study of various diffusion and exchange phenomena and any researches which require high concentration and purity of the radioactive indicator.

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[1] Fermi, Amaldi *et al*, Proc. Roy. Soc. **A146**, 492 (1934).

[2] Haissinsky, Nature **136**, 141 (1935).

[3] Fink and Rohrman, Trans. Am. Electrochem. Soc. **58**, p. 403.

[4] Dunning and Pegram, Phys. Rev. **47**, 325 (1935).