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THE PREPARATION AND SOME PROPERTIES OF CURIUM METAL

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August 1, 1950

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Curium metal has been prepared on the microgram scale by reduction of curium trifluoride with barium metal vapor at 1275°C., using a vacuum furnace and double crucible system similar to that described by Fried and Davidson.[1]

(1) Fried and Davidson, J. Am. Chem. Soc., 70, 3539 (1948).

Six successful reductions, which yielded bright metallic globules of metal ranging in mass from about 0.01 μg. to 4 μg. have been made. The metal is silvery in appearance and about as malleable as plutonium prepared under the same conditions. The metal retained its bright appearance in the dry atmosphere of a nitrogen "dry box" for some hours but gradually tarnished, and on standing for about 24 hours was rather badly corroded. Under the same conditions, samples of other actinide metals, such as americium or plutonium, have shown less evidence of reaction. The greater reactivity of curium probably is to be attributed to the radioactivity of the isotope[2] Cm^{242} (equivalent to a power output of 1.2×10^{-4} watts/μg.), which is sufficient to maintain the temperature of the sample substantially above that of its environment. Approximate calculations show that

(2) The isotope used for this work was the 162-day Cm^{242}. The preparation and isolation of microgram quantities of Cm^{242} has been described by Werner and Perlman, National Nuclear Energy Series, Plutonium Project Record, Vol. 14B, "The Transuranium Elements: Research Papers," Paper No. 22.5 (McGraw-Hill Book Co., Inc., New York, 1949).

the steady state temperatures of our samples probably were from 50-100°C. above that of the surroundings.

The trifluoride used for the reductions was prepared by precipitating Cm(III) in dilute nitric acid in a fluorothene microcone with an excess of hydrofluoric acid, washing the precipitate with dilute hydrofluoric acid, and drying the CmF_3 in platinum under a heat lamp. Pieces of the dry fluoride were then transferred to the inner crucible for reduction. When the quantities of curium were relatively large (ca. 10 μg), the trifluoride was compacted in the bottom of the crucible by tamping with a quartz rod.

The conditions for reduction to usable metal were rather critical. Reduction at 1380°C. left the metal as a thin film adhering to the wall of the crucible. Reduction at about 1250°C. resulted in the formation of a cokey residue, indicating poor agglomeration of the metal. Reduction with barium vapor at 1275°C. for 45 seconds, followed by additional heating at 1100°C. for 45 seconds and a final heating at 960°C. for 20 seconds produced optimum results. In one such run on 12 μg. of CmF_3, reduction yielded a single 4 μg. spheroidal piece of metal. This piece was separated from the crucible, intact and free of slag or other residues.

The volume of the piece was estimated by measurement with a filar micrometer under about 200x magnification. The mass of the sample was determined by weighing with a torsion microgram balance and the mass of curium by radiometric assay for Cm^{242}. The results of the last two measurements (which constitute a specific activity determination) indicated that the curium metal was pure, within the limit of error of the measurements (±5%).

From the mass and volume measurements the density of the metal was computed to be ca. 7. This is a surprisingly low value and perhaps is to be explained by the presence of a void in the piece of metal examined. Additional measurements of the density will be made as more curium becomes available.

This work was performed under the auspices of the U. S. AEC.