National Institute of Standards & Technology

Certificate of Analysis

Standard Reference Material 398

Unalloyed Copper - Cu V

(In Cooperation with the American Society for Testing and Materials)

This Standard Reference Material (SRM) is in the form of small chips, sized between 0.5 mm and 1.4 mm sieve openings (35 - 14 mesh). The SRM is intended for use in trace elemental analysis of copper materials. It is designed for all techniques applicable to compositional analysis of unalloyed copper and it is particularly well suited for calibration with optical emission methods of analysis. Material from the same original ingot, designated SRM 498, was processed in the form of rods 6.4 mm (1/4 in) in diameter.

Element	Certified Value[a] mg/kg	Estimated Uncertainty[b]	Element	Certified Value[a] mg/kg	Estimated Uncertainty[b]
Antimony[c]	7.5	0.1	Nickel[d]	7.0	0.1
Arsenic[c]	25	3	Selenium[c]	17.5	0.8
Bismuth[c]	2.0	0.3	Silver[d]	20.1	0.2
Cobalt[c]	2.8	0.1	Tellurium[c]	10.1	0.2
Iron[d]	11.4	0.5	Tin[c]	4.8	0.6
Lead[d]	9.9	0.6	Zinc[c]	24	1

Element	Certified Value[a] wt %*	Estimated Uncertainty[b]
Copper[c], assay	99.98	0.01

*wt % = mg/kg x 10^{-4}

[a]The value listed for an element is the *present best estimate* of the "true" value based on the results of the analytical program for certification.
[b]The estimated uncertainty listed for a constituent is based on judgment and represents an evaluation of the combined effects of method imprecision, possible systematic errors among methods, and material variability for samples of 0.25 g or more, used in the "as received" condition. (No attempt was made to derive exact statistical measures of imprecision because several methods were involved in the analysis of most constituents.)
[c]Values are based on agreement of determinations at NIST and cooperating laboratories; values for Bi are based on agreement of determinations at cooperating laboratories.
[d]Values based on determinations at NIST by two or more of the following methods: atomic absorption and flame emission spectrometry, isotopic dilution mass spectrometry, neutron activation analysis, and spark source mass spectrometry.

Gaithersburg, MD 20899
July 21, 1993
(Revision of certificate dated 4-10-86)

Thomas E. Gills, Acting Chief
Standard Reference Materials Program

(over)

This Certificate of Analysis has undergone editorial revision to reflect program and organizational changes at NIST and at the Department of Commerce. No attempt was made to reevaluate the certificate values or any technical data presented on this certificate.

The overall direction and coordination of the preparation and fabrication of this material was performed by J.G. Hust, NIST, Boulder, CO.

The overall coordination of the NIST analytical measurements leading to certification was under the direction of I.L. Barnes.

The technical and support aspects involved in the original certification and issuance of this SRM were coordinated through the Standard Reference Materials Program by R.E. Michaelis. Revision of this certificate was coordinated through the Standard Reference Materials Program by P.A. Lundberg.

PLANNING, PREPARATION, TESTING, ANALYSIS

This material is one in a series of twelve different composition copper "Benchmark" materials, Cu "O" through Cu XI, that was prepared in a cooperative Industry-ASTM-NIST Program.

Base materials for the preparation of Cu V were supplied by the Kennecott Copper Corp., Salt Lake City, UT and Baltimore, MD. Melting and casting of Cu V was done at Iowa State University, Ames, IA. Some of the additions were provided by the Wolverine Tube Co., Decatur, AL, courtesy of R.E. Stanton.

Preliminary analyses, primarily by optical emission methods of analysis, were performed in the analytical laboratories of:

Anaconda Co., Primary Metals Division, Raritan Copper Works, Perth Amboy, NJ, P.F. Stryker and A.J. Simon.

Iowa State University, Ames, IA, R. Smitt.

Kennecott Copper Corp., Kennecott Research Center, Salt Lake City, UT, A.P. Langheinrich and T.N. Andersen.

Kennecott Refining Corp., Baltimore, MD, A.A. DiLeonardi.

Reading Metals Refining Corp., Reading, PA, W.P. Darrow.

U.S. Metals Refining Co., AMAX Copper Division, Carteret, NJ, R.M. Kennedy.

The ingot was processed by the U.S. Bureau of Mines, Albany, OR, R.A. Beall, to provide material of the highest possible homogeneity, both in billet and rod forms. The ingot was approximately 25.4 cm (10 in) in diameter, 56 cm (22 in) long, and weighed about 273 kg (600 lb). About five percent of the total volume was cropped from the bottom end of the ingot and about fifteen percent from the top. A bottom ingot section approximately 25.4 cm (10 in) in diameter, 15.2 cm (6 in) thick, and about 77 kg (170 lb), was cleaned and end-milled at NIST to form the chips which were sieved and blended.

Cooperative homogeneity studies were made at Kennecott Refining Corp., Baltimore, MD, by optical emission spectro-chemical analysis, A.A. DiLeonardi. Extensive homogeneity studies were made at NIST Boulder, CO by residual resistivity ratio measurements, J.G. Hust and at NIST Gaithersburg, MD by chemical analyses (see listing on page 3). The results indicated the maximum gross material variability to be less than 5%.

Cooperative chemical analyses for certification were made on composite samples in the following analytical laboratories:

Anglo-American Corp. of South Africa Limited, Johannesburg, Republic of South Africa, R. Murray-Smith.

Council for Scientific and Industrial Research, National Physical Research Laboratory, Pretoria, Republic of South Africa, L.R.P. Butler, D.B. deVilliers, and J.H. Wepener.

Kennecott Copper Corp., Research Center, Salt Lake City, UT, A.P. Langheinrich and T.N. Andersen.

Kennecott Refining Corp., Baltimore, MD, A.A. DiLeonardi.

South African Bureau of Standards, Physical Chemistry Division, Pretoria, Republic of South Africa, H.P. Beyers and P.G. Odendaal.

Analyses were performed in the NIST Analytical Chemistry Division by the following: I.L. Barnes, R.W. Burke, B.I. Diamondstone, M.G. Diaz, E.L. Garner, L.A. Geldner, J.W. Gramlich, G.J. Lutz, L.A. Machlan, T.J. Murphy, P.J. Paulsen, L.J. Powell, P.A. Sleeth, and R.K. Bell, ASTM-NIST Assistant Research Associate.

SUPPLEMENTAL INFORMATION

Details concerning the planning, preparation, testing, and analysis of this material is found in the ASTM Special Technical Publication 831, "Copper Standard Reference Materials," Barnes, I.L., Gills, T.E., and Reed, W.P., "Sampling and Analysis of Copper Cathodes", Tuddenham, W.M. and Hibbeln, R.S., Eds. American Society for Testing and Materials, 1984.

Analysts should use this chip material in the "as received" condition. Some surface oxidation (discoloration) is present on the chip material, but the amount is not analytically significant for the elements certified. The analyst should keep the container tightly capped when not in use.

Elements other than those certified may be present in this material as indicated below. Values in parentheses are *not certified*, but are given as additional information on the composition.

Elements Detected	Information Value μg/g
Aluminum	(<2)
Cadmium	(22)
Chromium	(0.3)
Gold	(0.1)
Magnesium	(<1)
Manganese	(0.3)
Oxygen*	(30)
Silicon	(<2)
Sulfur	(11)
Elements Not Detected	
Calcium	(<0.3)
Titanium	(<1)

*The value for oxygen on this chip material is subject to change because of surface oxidation.