

National Bureau of Standards

Certificate of Analysis

Standard Reference Material 394

Unalloyed Copper - Cu I

(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.

Element	Certified Value ^a μg/g	Estimated Uncertainty ^b	Element	Certified Value ^a μg/g	Estimated Uncertainty ^b
Antimony ^c	4.5	0.3	Nickel ^d	11.7	0.1
Arsenic ^c	2.6	0.3	Selenium ^c	2.00	0.15
Bismuth ^c	0.35	0.05	Silver ^d	50.5	0.5
Chromium ^c	2.0	0.1	Sulfur ^c	15	3
Cobalt ^c	0.5	0.1	Tellurium ^c	0.58	0.03
Iron ^d	147	8	Tin ^c	70	5
Lead ^d	26.5	0.2	Zinc ^c	405	15
Manganese ^c	3.7	0.7			
Element		Certified Value ^a	Estimated Uncertainty ^b		
		Percent by Weight			
Copper ^c , assay		99.908	0.005		

^aThe value listed for an element is the *present best estimate* of the "true" value based on the results of the analytical program for certification.

^bThe 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.)

^cValues for Sb, As, Cr, Co, Mn, Se, Te, Sn, Zn, and Cu are based on agreement of determinations at NBS and cooperating laboratories; values for Bi and S are based on agreement of determinations at cooperating laboratories.

^dValues for Fe, Pb, Ni, and Ag are based on determinations at NBS by two or more of the following methods: atomic absorption and flame emission spectrometry, isotopic dilution mass spectrometry, neutron activation analysis, polarography, and spark source mass spectrometry.

*Material from the same original ingot was processed to the form of rods 6.4 mm (1/4 in) in diameter, designated SRM 494.

Gaithersburg, MD 20899
April 10, 1986
(Revision of Certificates
dated 7-4-76 and 1-20-78)

Stanley D. Rasberry, Chief
Office of Standard Reference Materials

(Over)

PLANNING, PREPARATION, TESTING, ANALYSIS: This material is one in a series of twelve different composition copper "Benchmark" materials, Cu "O" through Cu XI, that were being prepared in a cooperative Industry-ASTM-NBS-Program.

Base material for the preparation of Cu I, was supplied by Esco Corporation, Portland, Ore. Melting and casting were done at the Esco Corporation, Portland, Ore.

Preliminary results, primarily by optical emission methods of analysis, indicated a useful concentration level was present for most of the desired impurity elements and the ingot was accepted. The preliminary analyses were performed in the analytical laboratories of:

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

Hecla Mining Company, Lakeshore Project, Casa Grande, Ariz., N. Ciani.

Kennecott Copper Corporation, Ledgesmont Laboratory, Lexington, Mass., F.D. Leipziger.

Kennecott Copper Corporation, Kennecott Research Center, Salt Lake City, Utah, A.P. Langheinrich.

Kennecott Copper Corporation, Utah Copper Division, Refinery Plant, Magna, Utah, N.N. Linde.

Kennecott Refining Corporation, Baltimore, Md., A.A. DiLeonardi.

Magma Copper Company, San Manuel Division, San Manuel, Ariz., T.L. Young and S.K. Young.

Phelps Dodge Refining Corporation, El Paso Works, El Paso, Tex., A.L. Cardinal.

U.S. Metals Refining Company, AMAX Copper Division, Carteret, N.J., R.M. Kennedy.

The ingot was processed by the U.S. Bureau of Mines, Albany, Ore., R.A. Beall, to provide material of the highest possible homogeneity, both in billet and rod forms. The ingot was approximately 24 cm (9 1/2 in) in diameter, 81 cm (32 in) long, weighing about 318 kg (700 lb). The ingot was forged to produce a bar 15 cm (6 in) square. Five percent of the total volume was cropped from the end of the bar representative of the bottom of the original ingot and fifteen percent from the top. The bar was then cut into equal lengths of approximately 46 cm (18 in) to form three billets. One billet, selected for the chip material, was end-milled at NBS. The lot of chips was sieved and blended.

Cooperative homogeneity studies were made at Kennecott Refining Corp., Baltimore, Md., by optical emission spectrochemical analysis, A.A. DiLeonardi. Extensive homogeneity studies were made at NBS Boulder, by residual resistivity ratio measurements, J.G. Hust and at NBS Washington, by chemical analyses (see listing below). 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:

Anaconda American Brass Company, Research and Technical Center, Waterbury, Conn., J.T. McCrackan and V.M. Horrigan.

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

Bridgeport Brass Company, Bridgeport, Conn., A.W. Young.

Carpenter Technology Corporation, Research and Development Center, Reading, Pa., C.T. Polinko.

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.

International Nickel Company of Canada, Limited, J. Roy Gordon Research Laboratory, Sheridan Park, Mississauga, Ontario, Canada, St. J.H. Blakeley.

Kennecott Copper Corporation, Ledgemont Laboratory, Lexington, Mass., F.D. Leipziger.

Kennecott Copper Corporation, Research Center, Salt Lake City, Utah, A.P. Langheinrich.

Kennecott Copper Corporation, Utah Copper Division, Refinery Plant, Magna, Utah, N.N. Linde.

Kennecott Refining Corporation, Baltimore, Md., A.A. DiLeonardi.

National Research Council of Canada, Division of Chemistry, Ottawa, Canada, D.S. Russell.

Phelps Dodge, Copper Products Company, Elizabeth, N.J., J.R. Conniff.

Phelps Dodge Refining Corporation, El Paso Works, El Paso, Tex., A.L. Cardinal.

Phelps Dodge Refining Corporation, Laurel Hill Works, Maspeth, N.Y., W.D. Charles and R. Kretschmann.

Revere Copper and Brass Incorporated, Rome, N.Y., S. Glessner.

Scovill, Metals Division, Waterbury, Conn., E.D. Wade.

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

Southwire Company, Copper Division, Carrollton, Ga., G.S. Bowers.

Analyses were performed in the NBS Analytical Chemistry Division by the following: I.L. Barnes, D.A. Becker, R.K. Bell, R.W. Burke, B.I. Diamondstone, M.S. Epstein, E.L. Garner, T.E. Gills, J.W. Gramlich, E.F. Heald, L.A. Machlan, E.J. Maienthal, T.J. Murphy, P.J. Paulsen, L.J. Powell, T.C. Rains, T.A. Rush, and M.J. Seward.

The overall direction and coordination of the preparation and fabrication of this material were performed by J.G. Hust, M.B. Kasen, and R.P. Reed, NBS, Boulder, Colorado.

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

The technical and support aspects involved in the preparation, certification, and issuance of this Standard Reference Material were coordinated through the Office of Standard Reference Materials by R.E. Michaelis.

ADDITIONAL INFORMATION: Details concerning the planning, preparation, testing, and analysis of this material and other copper "Benchmark" materials are to be published in an NBS Special Publication (260 Series). Information that should be of immediate interest to the user laboratories follows:

Analysts should use this chip material in the "as received" condition.

Some surface oxidation (discoloration) is present on this 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. These are *not certified* but are given as additional information on the composition.

Elements Detected	Information Value, $\mu\text{g/g}$
Aluminum	(<2)
Cadmium	(0.5)
Gold	(0.07)
Magnesium	(<1)
Oxygen*	(230)
Silicon	(<2)
<u>Elements Not Detected</u>	
Calcium	(<0.3)
Titanium	<0.3)

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