

**AEROSPACE
MATERIAL
SPECIFICATION**

SAE

AMS 4533A

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Superseding AMS 4533

Submitted for recognition as an American National Standard

COPPER-BERYLLIUM ALLOY, BARS AND RODS
98Cu - 1.9Be
Solution and Precipitation Heat Treated (TF00, formerly AT)

UNS C17200

1. SCOPE:

1.1 Form:

This specification covers a copper-beryllium alloy in the form of bars and rods.

1.2 Application:

These products have been used typically for parts requiring a combination of high strength, wear resistance, and corrosion resistance and where thermal conductivity, electrical conductivity, and low magnetic susceptibility may be important, but usage is not limited to such applications.

1.3 Safety - Hazardous Materials:

While the materials, methods, applications, and processes described or referenced in this specification may involve the use of hazardous materials, this specification does not address the hazards which may be involved in such use. It is the sole responsibility of the user to ensure familiarity with the safe and proper use of any hazardous materials and to take necessary precautionary measures to ensure the health and safety of all personnel involved.

2. APPLICABLE DOCUMENTS:

The following publications form a part of this specification to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order.

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2.1 SAE Publications:

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

AMS 2221 Tolerances, Copper and Copper Alloy Bars and Rods
 MAM 2221 Tolerances, Metric, Copper and Copper Alloy Bars and Rods
 AMS 2750 Pyrometry

2.2 ASTM Publications:

Available from ASTM, 1916 Race Street, Philadelphia, PA 19103-1187.

ASTM B 249 General Requirements for Wrought Copper and Copper Alloy Rod, Bar, and Shapes
 ASTM B 249M General Requirements for Wrought Copper and Copper Alloy Rod, Bar, and Shapes (Metric)
 ASTM E 3 Preparation of Metallographic Specimens
 ASTM E 8 Tension Testing of Metallic Materials
 ASTM E 8M Tension Testing of Metallic Materials (Metric)
 ASTM E 18 Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials
 ASTM E 112 Determining the Average Grain Size
 ASTM E 478 Chemical Analysis of Copper Alloys

2.3 U.S. Government Publications:

Available from DODSSP, Subscription Services Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

MIL-C-3993 Copper and Copper-Base Alloy Mill Products, Packaging of

3. TECHNICAL REQUIREMENTS.

3.1 Composition:

Shall conform to the percentages by weight shown in Table 1, determined by wet chemical methods in accordance with ASTM E 478, by spectrochemical methods, or by other analytical methods acceptable to purchaser.

TABLE 1 - Composition

Element	min	max
Beryllium	1.80	2.00
Cobalt + Nickel	0.20	--
Cobalt + Nickel + Iron	--	0.6
Aluminum	--	0.20
Silicon	--	0.20
Copper (3.1.1)	remainder	
Copper + sum of all named elements (3.1.2)	99.5	--

3.1.1 Applicable when copper is not determined by analysis. The reported (certified) value is the difference between the sum of all other specified elements and 100% and will therefore include unnamed elements. Limits for unnamed elements may be established by agreement between purchaser and manufacturer or supplier.

3.1.2 Applicable only when copper is determined by direct analysis.

3.2 Condition:

Hot reduced or hot and cold reduced, solution and precipitation heat treated; TFOO temper (see 8.2).

3.3 Heat Treatment:

Product shall be heat treated as follows; pyrometry shall be in accordance with AMS 2750:

3.3.1 Solution: Heat within the range 1400 to 1475 °F (760 to 802 °C), hold at heat for 30 to 60 minutes, and water quench.

3.3.2 Precipitation: Heat to 600 to 660 °F (316 to 349 °C), hold at heat for not less than 3 hours, and air cool.

3.4 Properties:

The product shall conform to the following requirements (see 8.3):

3.4.1 Tensile Properties: Shall be as shown in Table 2, determined in accordance with ASTM E 8 or ASTM E 8M.

TABLE 2 - Minimum Tensile Properties

Property	Value
Tensile Strength	165 ksi (1138 MPa)
Yield Strength at 0.2% Offset	140 ksi (965 MPa)
Elongation in 2 Inches (50.8 mm) Nominal Diameter or Least Distance Between Parallel Sides	
3 Inches (76 mm) and Under	4%
Over 3 Inches (76 mm)	3%

3.4.2 Hardness:

(R)

Bars and rods 0.188 inch (4.78 mm) and over in nominal diameter or least distance between parallel sides shall have hardness of 36 to 45 HRC, or equivalent (see 8.4), determined in accordance with ASTM E 18. Hardness requirements for bars and rods under 0.188 inch (4.78 mm) in nominal diameter or least distance between parallel sides shall be agreed upon by purchaser and vendor.

3.4.3 Average Grain Size: The product shall have average grain size not coarser than shown in Table 3, determined in accordance with ASTM E 112.

TABLE 3 - Maximum Average Grain Size

Nominal Diameter or Least Distance Between Parallel Sides Inches	Nominal Diameter or Least Distance Between Parallel Sides Millimeters	Grain Size Millimeter
Up to 1.000, excl	Up to 25.40, excl	0.050
1.000 to 1.500, excl	25.40 to 38.10, excl	0.075
1.500 to 2.000, excl	38.10 to 50.80, excl	0.100
2.000 to 3.000, excl	50.80 to 76.20, excl	0.125

3.4.3.1 Grain size requirements for product 3.00 inches (76.2 mm) and over in nominal diameter or least distance between parallel sides shall be agreed upon by purchaser and vendor.

3.4.4 Microstructure: Product shall contain not more than 6% beta phase constituent, determined at 100X magnification on specimens prepared in accordance with ASTM E 3.

3.5 Quality:

Product, as received by purchaser, shall be uniform in quality and condition, sound, and free from foreign materials and from imperfections detrimental to usage of the product.

3.6 Tolerances:

Shall conform to AMS 2221 or MAM 2221 as applicable to refractory alloys.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection:

The vendor of the product shall supply all samples for vendor's tests and shall be responsible for performing all required tests. Purchaser reserves the right to sample and to perform any confirmatory testing deemed necessary to ensure that the product conforms to the requirements of this specification.

4.2 Classification of Tests:

Tests for all technical requirements are acceptance tests and shall be performed on each heat or lot as applicable.

4.3 Sampling and Testing:

Shall be in accordance with ASTM B 249 or ASTM B 249M and the following; a lot shall be all product with the same form, from the same heat, processed at one time through all steps of manufacture.

4.3.1 One or more chemical analysis samples from each heat shall be analyzed in accordance with 3.1.

4.3.2 One or more longitudinal tensile specimens from each lot shall be tested in accordance with 3.4.1. The axis of tensile specimens shall be located midway between the center and surface of product over 1.50 inches (38.1 mm) in nominal cross-sectional thickness.

4.3.3 One or more hardness specimens from each lot shall be tested in accordance with 3.4.2.

4.3.4 One or more specimens for grain size from each lot shall be tested in accordance with 3.4.3.

4.3.5 One or more specimens for microstructure from each lot shall be tested in accordance with 3.4.4.

4.4 Reports:

The vendor of the product shall furnish with each shipment a report showing the results of tests on each lot to determine conformance to the technical requirements. This report shall include the purchase order number, lot number, AMS 4533A, size and quantity.

4.5 Resampling and Retesting:

If any specimen used in the above tests fails to meet the specified requirements, disposition of the product may be based on the results of testing two additional specimens for each original nonconforming specimen. Failure of any retest specimen to meet the specified requirements shall be cause for rejection of the product represented. Results of all tests shall be reported.

5. PREPARATION FOR DELIVERY:

5.1 Identification:

Individual pieces or bundles shall have attached a durable tag marked with not less than the purchase order number, AMS 4533A, and nominal size or shall be boxed and the box marked with the same information.