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INTERNATIONAL
400 Commonwealth Drive, Warrendale, PA 15096-0001

AEROSPACE MATERIAL SPECIFICATION

SAE AMS 4533

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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:

This alloy has been used typically for parts requiring a combination of high strength, good wear resistance, and corrosion resistance and where thermal conductivity, electrical conductivity and low magnetic susceptibility are 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.

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 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 106 Chemical Analysis of Copper-Beryllium Alloys
ASTM E 112 Determining Average Grain Size
ASTM E 478 Chemical Analysis of Copper Alloys

2.3 U.S. Government Publications:

Available from Standardization Documents Order 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; TF00 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° - 1475°F (760° - 802°C), hold at heat for 30 - 60 minutes, and water quench.

3.3.2 Precipitation: Heat to 600° - 660°F (316° - 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:

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

TABLE 2 - Tensile Properties

Property	Minimum
Tensile Strength	165 ksi (1138 MPa)
Yield Strength at 0.2% offset	140 ksi (965 MPa)
Elongation, in 2 Inches (76.2 mm),	
3 Inches (76.2 mm) and Under	4%
Over 3 Inches (76.2 mm)	3%

3.4.2 Hardness:

Bars and rods 0.188 inch (4.78 mm) and over in nominal diameter or least distance between parallel sides should have hardness of 36-45 HRC, or equivalent, determined in accordance with ASTM E 18, but the product shall not be rejected on the basis of hardness if the tensile properties of 3.4.1 are met. Hardness requirements for bars and rods under 0.188 inch (4.78 mm) in nominal diameter or least distance between parallel sides shall be as agreed upon by purchaser and vendor.

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

TABLE 3 - Grain Size

Nominal Diameter or Distance Between Parallel Sides Inches	Nominal Diameter or Distance Between Parallel Sides Millimeters	Average Grain Size mm, max
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 as agreed upon by purchaser and vendor.

3.4.4 Microstructure: Shall contain not more than 6% beta phase constituent, determined at 100% magnification. Any beta phase present shall be fine and well dispersed and shall not be in the form of stringers.

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 At least one chemical analysis specimen from each heat shall be analyzed in accordance with 3.1.

4.3.2 At least one longitudinal tensile specimen 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 At least one hardness specimen from each lot shall be tested in accordance with 3.4.2.

4.3.4 At least one specimen for grain size from each lot shall be tested in accordance with 3.4.3.