SAE Aerospace
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AEROSPACE MATERIAL SPECIFICATION

AMS 7905B

Issued APR 1991
Revised JUN 2006

Superseding AMS 7905A

Beryllium Bars, Rods, Tubing, and Shapes
Optical Grade

RATIONALE

AMS 7905B is a Five Year Review and update of this specification.

1. SCOPE

1.1 Form

This specification covers beryllium in the form of bars, rods, tubing, and machined shapes fabricated from vacuum hot pressed powder.

1.2 Application

These products have been used typically for parts requiring a combination of high strength-to-weight ratio, high modulus of elasticity, high density, low oxide content, and good polishing characteristics, 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 that 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.

1.3.1 WARNING

Beryllium Product: Inhaling dust or fumes may cause chronic beryllium disease, a serious chronic lung disease, in some individuals. Cancer hazard. Over time, lung disease and cancer can be fatal. Target organ is primarily the lung.

2. APPLICABLE DOCUMENTS

The issue of the following documents in effect on the date of the purchase order forms a part of this specification to the extent specified herein. The supplier may work to a subsequent revision of a document unless a specific document issue is specified. When the referenced document has been cancelled and no superseding document has been specified, the last published issue of that document shall apply.

2.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), or www.sae.org.

AMS 2806 Identification, Bars, Wire, Mechanical Tubing, and Extrusions, Carbon and Alloy Steel and Corrosion and Heat Resistant Steels and Alloys

2.2 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, or www.astm.org.

ASTM E 8 Tension Testing of Metallic Materials
ASTM E 112 Determining Average Grain Size
ASTM E 1417 Liquid Penetrant Examination
ASTM E 1742 Radiographic Examination

2.3 ASME Publications

Available from American Society of Mechanical Engineers, 22 Law Drive, P.O. Box 2900, Fairfield, NJ 07007-2900, Tel: 973-882-1170, or www.asme.org.

ASME B46.1 Surface Texture
ASME Y14.5M Dimensioning and Tolerancing

3. TECHNICAL REQUIREMENTS

3.1 Composition

Shall conform to the percentages by weight shown in Table 1; beryllium oxide shall be determined by gas fusion; aluminum, iron, magnesium, silicon, and other elements by spectrochemical methods; and carbon by combustion. Beryllium shall be determined by difference. In case of disputes between analysis by different spectrochemical methods, IC plasma shall govern.

TABLE 1 - COMPOSITION

Element	min	max
Beryllium Oxide	--	0.7
Aluminum	--	0.07
Carbon	--	0.07
Iron	--	0.10
Magnesium	--	0.07
Silicon	--	0.07
Other Elements, each (3.1.1)	--	0.04
Beryllium	99.0	--

3.1.1 Determination is not required for routine acceptance of each lot

3.2 Condition

Hot pressed with secondary options of heat treatment, stress relief, and/or hot isostatic pressing (HIP) after hot pressing.

3.2.1 Surface Finish

If surface finish is not specified, the material shall be furnished with an as-sawed, as HIP, and/or machined surface. Machined surfaces shall have surface finish no greater than 110 Ra [125 microinches (3.2 µm) rms], determined in accordance with ASME B46.1.

3.3 Properties

The product shall conform to the following requirements.

3.3.1 Tensile Properties

Shall be as shown in Table 2, determined at room temperature in accordance with ASTM E 8.

TABLE 2 - MINIMUM TENSILE PROPERTIES

Property	Value
Tensile Strength	35.0 ksi (241 MPa)
Yield Strength at 0.2% Offset	25.0 ksi (172 MPa)
Elongation in 4D	2.0%
Micro-Yield Strength	To Be Reported

3.3.1.1 Micro-Yield Strength

The stress required to produce a permanent strain of 1.0×10^{-6} inch/inch (cm/cm). The test procedure consists of repeated static loading and unloading the test specimen. The stresses are higher on each succeeding cycle and any permanent strain is recorded to the accuracy of 0.1×10^{-6} after each cycle. The procedure is repeated until the permanent strain is higher than 1.0×10^{-6}.

3.3.2 Grain Size

Shall average no larger than 20 microns (20 µm), determined in accordance with ASTM E 112, using the intercept method at 500X magnification.

3.3.3 Coefficient of Thermal Expansion

The linear coefficient of thermal expansion (CTE) shall be measured in three orthogonal directions. The overall average CTE from 5 °C (41 °F) to 65 °C (149 °F) shall be reported for each direction.

3.4 Quality

The 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.

3.4.1 Soundness

3.4.1.1 The product shall be free from cracks, determined as in 3.4.2.1 or 3.4.2.2.

3.4.1.2 Density

Shall be at least 99.3% of theoretical density, determined using the water displacement method. Density determination shall be accurate to the second decimal or better.

3.4.1.2.1 Theoretical density shall be calculated using Equation 1:

$$\text{Theoretical Density (gm/cm}^3\text{)} = \frac{100\%}{\frac{100 - \%\text{Be0}}{1.8477\ \text{gm/cm}^3} + \frac{\%\text{Be0}}{3.009\ \text{gm/cm}^3}}$$

3.4.1.3 Radiographic Inspection

Radiographic inspection, to a penetrameter sensitivity of 2%, shall be performed in accordance with ASTM E 1742; however, exceptions are taken to the penetrameter contrast requirement and applicable area of penetrameter density ranges of +30% or -15% from the density at penetrameter location(s). The decision to accept or reject may be made directly beneath the IQI/Shim combination.

3.4.1.3.1 Radiographic indications (voids or inclusions) shall conform to the following requirements:

3.4.1.3.1.1 Maximum Dimension of any Indication

Any dimension of any indication, measured in the plane of the radiograph, shall not exceed 0.030 inch (0.76 mm).

3.4.1.3.1.2 Maximum Average Dimension of any Indication

The average dimension of an indication shall be the arithmetic average of the maximum and minimum dimensions, measured in the plane of the radiograph, and shall not exceed 0.020 inch (0.51 mm).

3.4.1.3.1.3 Total Combined Volume Per Cubic Inch (16.4 cm^2) of All Indications

The total combined volume per cubic inch (16.4 cm^3) of all detectable radiographic indications shall not exceed the volume of a 0.050 inch (1.27 mm) diameter sphere (e.g., total spherical volume shall not exceed 6.5 x 10^{-5} in^3 [1.07 mm^3]). For calculation purposes, assume all indications are spherical.

3.4.1.3.1.4 Part Density Uniformity

The terms variable density areas, banding, or striations denote relatively large areas of a radiograph, which vary in density as compared to the surrounding area. These areas shall not vary in radiographic density by more than 5% compared to the surrounding area of comparable section thickness. Suspect areas shall be re-radiographed and interpreted with the appropriate penetrameter or beryllium of 5% in thickness placed as follows:

a.Less dense (darker radiograph) areas shall be covered by the penetrameter. The radiograph of the covered area shall appear lighter than that of the adjacent area.

b.More dense (lighter radiograph) areas shall have the penetrameter placed immediately adjacent to them. The radiograph of the covered area shall appear lighter than that of the suspect more-dense area.

3.4.1.3.1.5 Discrete high density (light radiograph) indications, or areas in product 1.000 inch (25.40 mm) and under in nominal thickness, which are 5% or less in radiographic density variation compared to the surrounding material, are acceptable.(Note: The minimum detectable size of voids and inclusions will increase as section thickness increases)

3.4.2 Surface Condition

3.4.2.1 Visual

No restrictions to size or number of visual imperfections if they do not hold fluorescent penetrant dye.

3.4.2.2 Surface Indications

Penetrant inspection shall be performed in accordance with ASTM E 1417, Type 1, Level 2.

3.4.2.2.1 Individual Indications

Shall not exceed 0.050 inch (1.27 mm) in major dimension.

3.4.2.2.2 Frequency

Any one square inch (6.45 cm^2) shall contain no more than three indications measuring 0.003 to 0.050 inch (0.08 to 1.27 mm) in major dimension.

3.5 Tolerances

Product shall conform to the dimensions and dimensional tolerances specified in the purchase order and applicable drawings. If tolerances are not specified, the following standard tolerances shown in Table 3 in accordance with ASME Y14.5M, shall apply:

TABLE 3A - TOLERANCES, INCH/POUND UNITS

Feature	Size, Inches	Tolerance, Inch plus	Tolerance, Inch minus
Diameter, Width, or Thickness	Up to 3, incl	0.016	0.000
Diameter, Width, or Thickness	Over 3 to 20, incl	0.062	0.000
Diameter, Width, or Thickness	Over 20	0.250	0.000
Length	Up to 20, incl	0.125	0.000
Length	Over 20	0.250	0.000

TABLE 3B - TOLERANCES, SI UNITS

Feature	Size, Millimeters	Tolerance, Millimeters plus	Tolerance, Millimeters minus
Diameter, Width, or Thickness	Up to 76, incl	0.41	0.00
Diameter, Width, or Thickness	Over 76 to 508, incl	1.57	0.00
Diameter, Width, or Thickness	Over 508	6.35	0.00
Length	Up to 508, incl	3.18	0.00
Length	Over 508	6.35	0.00

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 the performance of all required tests. Purchaser reserves the right to sample and to perform any confirmatory testing deemed necessary to ensure that the product conforms to specified requirements.

4.2 Classification of Tests

All technical requirements are acceptance tests and shall be performed on each lot as applicable.

4.3 Sampling and Testing

Shall be in accordance with the following; a lot shall consist of all product manufactured from a single hot-pressed billet, processed at the same time to the same condition as defined in 3.2:

4.3.1 Composition

Not less than one sample from each lot.

4.3.2 Tensile Properties

Not less than one longitudinal and one transverse round specimen from each lot, at any location.