Society of Automotive Engineers, Inc.
400 COMMONWEALTH DRIVE, WARRENDALE, PA. 15096

AEROSPACE MATERIAL SPECIFICATION

AMS7898A
Superseding AMS 7898

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TUNGSTEN SHEET, STRIP, PLATE, AND FOIL
Pressed, Sintered, and Wrought

1. SCOPE:

1.1 Form: This specification covers tungsten in the form of pressed, sintered, and wrought sheet, strip, plate, and foil.

1.2 Application: Primarily for parts and assemblies requiring exposure at ultrahigh temperatures. Applications in oxidizing atmospheres necessitate a protective coating.

2. APPLICABLE DOCUMENTS: The following publications form a part of this specification to the extent specified herein. The latest issue of Aerospace Material Specifications (AMS) shall apply. The applicable issue of other documents shall be as specified in AMS 2350.

2.1 SAE Publications: Available from Society of Automotive Engineers, Inc., 400 Commonwealth Drive, Warrendale, PA 15096.

2.1.1 Aerospace Material Specifications:

AMS 2242 - Tolerances, Corrosion and Heat Resistant Steel and Iron Base Alloy Sheet, Strip, and Plate and Titanium and Titanium Alloy Sheet, Strip, and Plate
AMS 2350 - Standards and Test Methods
AMS 2630 - Ultrasonic Inspection
AMS 2645 - Florescent Penetrant Inspection

2.2 ASTM Publications: Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.

ASTM E21 - Elevated Temperature Tension Tests of Metallic Materials
ASTM E92 - Vickers Hardness of Metallic Materials

2.3 Government Publications: Available from Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120.

2.3.1 Federal Standards:

Federal Test Method Standard No. 151 - Metals; Test Methods

2.3.2 Military Standards:

MIL-STD-163 - Steel Mill Products, Preparation for Shipment and Storage

2.4 ANSI Publications: Available from American National Standards Institute, 1430 Broadway, New York, NY 10018.

ANSI B46.1 - Surface Texture

3. TECHNICAL REQUIREMENTS:

Printed in U.S.A.

3.1 Composition: Shall conform to the following percentages by weight; carbon shall be determined conductometrically, nitrogen and oxygen by the vacuum fusion or conductometric method, hydrogen by the vacuum extraction method, and metallic elements by spectrographic methods in accordance with Federal Test Method Standard No. 151, Method 112, or by other approved analytical methods:

	min	max
Molybdenum	--	0.020
Carbon	--	0.008
Nickel	--	0.005
Silicon	--	0.005
Iron	--	0.005
Aluminum	--	0.005
Oxygen	--	0.005 (50 ppm)
Nitrogen	--	0.002 (20 ppm)
Hydrogen	--	0.001 (10 ppm)
Tungsten	remainder	

3.2 Condition: Hot-cold rolled, stress-relieved, and descaled having a surface roughness not greater than 125 microin. (3.18 μ m), determined in accordance with ANSI B46.1.

3.2.1 Edges shall be sheared, machined, or ground straight, with the corners square.

3.3 Properties: The product shall conform to the following requirements:

3.3.1 Hardness: Shall be not lower than 400 HV30 or equivalent for any determination and not lower than 440 HV30 or equivalent for the average of all determinations, determined in accordance with ASTM E92.

3.3.2 Tensile Properties at 1000°F (537.8°C): Shall be as shown in Table I, determined in accordance with ASTM E21 on specimens as in 4.3.2.1, heated to 1000°F ± 15 (537.8°C ± 8.3) in an inert atmosphere, held at heat for 10 min. ± 1 before testing, and tested at 1000°F ± 15 (537.8°C ± 8.3) at a strain rate of 0.05 in. per in. per min. (0.05 mm/mm/min.):

TABLE I

Nominal Thickness Inches	Tensile Strength psi, min	Yield Strength at 0.2% Offset psi, min	Elongation in 2 in. %, min
Over 0.010 to 0.060, incl	84,000	75,000	3
Over 0.060 to 0.100, incl	82,000	73,000	3
Over 0.100 to 0.150, incl	80,000	71,000	3
Over 0.150 to 0.200, incl	78,000	69,000	3
Over 0.200 to 0.250, incl	76,000	67,000	3

TABLE I (SI)

Nominal Thickness Millimetres	Tensile Strength MPa, min	Yield Strength at 0.2% Offset MPa, min	Elongation in 50.8 mm %, min
Over 0.25 to 1.52, incl	579	517	3
Over 1.52 to 2.54, incl	565	503	3
Over 2.54 to 3.81, incl	552	490	3
Over 3.81 to 5.08, incl	538	476	3
Over 5.08 to 6.35, incl	524	462	3

3.3.2.1 Ø Tensile property requirements for product 0.010 in. (0.25 mm) and under or over 0.250 in. (6.35 mm) in nominal thickness and for specimens taken with the axis of the specimen perpendicular to the direction of rolling shall be as agreed upon by purchaser and vendor.

3.3.3 Specific Gravity: Shall be not less than 19.20 for product up to 0.150 in. (3.81 mm), incl, in nominal thickness and not less than 19.15 for product over 0.150 in. (3.81 mm) in nominal thickness.

3.3.4 Microstructure: Shall exhibit a completely worked structure with no evidence of recrystallization. The product shall not have a mixed grain size or duplex structure. Standards for acceptance shall be as agreed upon by purchaser and vendor.

3.3.5 Recrystallization: Specimens heated to 1850°F ± 25 (1010°C ± 14) in an inert atmosphere, held at heat for 30 min. ± 3, and cooled to room temperature, shall show no recrystallization as evidenced by a change in average Vickers hardness of more than 20 points from the original average hardness for nominal thicknesses 0.030 in. (0.76 mm) and over and 50 points for thicknesses under 0.030 in. (0.76 mm).

3.3.6 Bend Ductility: Product over 0.010 to 0.250 in. (0.25 to 6.35 mm), incl, in nominal thickness shall withstand, without cracking, bending in accordance with Table II with axis of bend perpendicular to the direction of rolling. The speed of the bending stroke shall be 0.5 to 0.7 in. per min. (0.21 to 0.30 mm/s). Specimens shall be bent to a 90 deg (1.57 rad) included angle after springback. Specimens shall be bent in dies having the dimensions shown in Fig. 1.

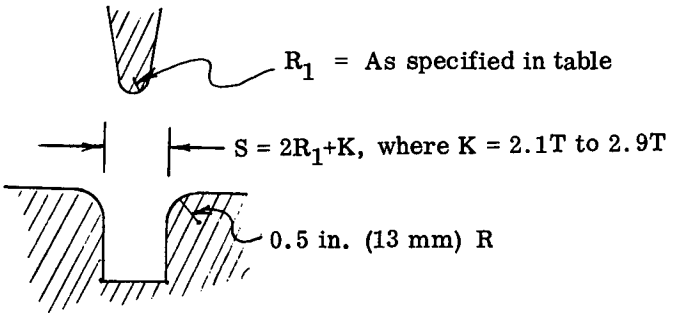
TABLE II

Nominal Thickness (T) Inches	Bend Radius (R_1)	Test Temperature °F, +0, -25
Over 0.010 to 0.060, incl	1T	400
Over 0.060 to 0.100, incl	2T	425
Over 0.100 to 0.150, incl	2T	450
Over 0.150 to 0.200, incl	4T	475
Over 0.200 to 0.250, incl	4T	500

TABLE II (SI)

Nominal Thickness Millimetres	Bend Radius (R_1)	Test Temperature °C, +0, -14
Over 0.25 to 1.52, incl	1T	204.4
Over 1.52 to 2.54, incl	2T	218.3
Over 2.54 to 3.81, incl	2T	232.2
Over 3.81 to 5.08, incl	4T	246.1
Over 5.08 to 6.35, incl	4T	260.0

3.3.6.1 Ø Bend ductility requirements for product 0.010 in. (0.25 mm) and under or over 0.250 in. (6.35 mm) in nominal thickness shall be as agreed upon by purchaser and vendor.



Bend Test Apparatus

FIGURE 1

3.4 Quality:

3.4.1 The product, as received by the purchaser, shall be uniform in quality and condition, clean, and free from foreign materials and from internal and external imperfections detrimental to usage of the product.

3.4.1.1 Minor surface imperfections which are removable within 1/2 of the thickness tolerance will not be considered objectionable if removed and smoothly blended into adjacent surface area.

3.4.2 Each piece shall be fluorescent penetrant inspected in accordance with AMS 2645 and ultrasonically Ø inspected in accordance with AMS 2630, unless otherwise specified. Standards for acceptance shall be as agreed upon by purchaser and vendor.

3.5 Tolerances: Unless otherwise specified, the tolerances in Table III shall apply.

3.5.1 Thickness:

TABLE III

Nominal Thickness Inch	Tolerance, Inch plus and minus
Up to 0.005, incl	0.0007
Over 0.005 to 0.007, incl	0.0008
Over 0.007 to 0.010, incl	0.0012
Over 0.010 to 0.015, incl	0.0015
Over 0.015 to 0.020, incl	0.0020
Over 0.020 to 0.030, incl	0.0025
Over 0.030 to 0.040, incl	0.0032
Over 0.040 to 0.060, incl	0.0050
Over 0.060 to 0.100, incl	0.0080
Over 0.100 to 0.125, incl	0.0100
Over 0.125 to 0.150, incl	0.0110
Over 0.150 to 0.200, incl	0.0130
Over 0.200 to 0.250, incl	0.0150

TABLE III (SI)

Nominal Thickness Millimetres	Tolerance, Millimetre plus and minus
Up to 0.13, incl	0.018
Over 0.13 to 0.18, incl	0.020
Over 0.18 to 0.25, incl	0.030
Over 0.25 to 0.38, incl	0.038
Over 0.38 to 0.51, incl	0.051
Over 0.51 to 0.76, incl	0.064
Over 0.76 to 1.02, incl	0.081
Over 1.02 to 1.52, incl	0.127
Over 1.52 to 2.54, incl	0.203
Over 2.54 to 3.18, incl	0.254
Over 3.18 to 3.81, incl	0.279
Over 3.81 to 5.08, incl	0.330
Over 5.08 to 6.35, incl	0.381

3.5.1.1 Thickness tolerance for product over 0.250 in. (6.35 mm) in nominal thickness shall be as agreed upon by purchaser and vendor.

3.5.2 Length, Width, and Camber: Shall conform to the requirements of AMS 2242.

3.5.3 Flatness: When measured using a straight edge touching the product at two points, the perpendicular distance from the straight edge to the product shall not exceed 0.015 x L at any point between the two points of contact, where "L" is the distance between the two points of contact. The distance from a 12-in. (305-mm) straight edge to the product shall not exceed 0.125 in. (3.18 mm).

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection: The vendor of the product shall supply all samples and shall be responsible for performing all required tests. Results of such tests shall be reported to the purchaser as required by 4.4. Purchaser reserves the right to perform such confirmatory testing as he deems necessary to ensure that the product conforms to the requirements of this specification.

4.2 Classification of Tests: Tests to determine conformance to all technical requirements of this specification are classified as acceptance tests.

4.3 Sampling: Shall be as follows; a batch shall be all product pressed, sintered, and wrought from one lot of powder in a continuous series of operations:

4.3.1 Composition: One specimen from each batch.

4.3.2 Tensile Properties: One spciemen from each thickness from each batch selected with the axis of specimen parallel to the direction of rolling.

4.3.3 Hardness: Five determinations from each thickness from each batch. The bend test specimen of 4.3.4 may be used for the hardness test sample.

4.3.4 Bend Ductility: One specimen from each thickness from each batch. The nominal width of the bend specimen shall be 1.0 in. (25 mm) up to a thickness of 0.100 in. (2.54 mm), incl, and 2.5 in. (64 mm) for thicknesses greater than 0.100 in. (2.54 mm). Specimens may have as-cut edges or may be hand polished with emery cloth. Specimens shall not be electropolished.

4.3.5 Specific Gravity, Microstructure, and Recrystallization: One specimen from each thickness from each batch.

4.4 Reports: