SAE Aerospace
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AEROSPACE MATERIAL SPECIFICATION

AMS 4898B

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Superseding AMS 4898A

Titanium Alloy, Sheet
6Al - 2Sn - 2Zr - 2Mo - 2Cr - 0.15Si
Annealed

RATIONALE

AMS 4898B results from a Five Year Review and update of this specification.

1. SCOPE

1.1 Form

This specification covers a titanium alloy in the form of sheet.

1.2 Application

This sheet has been used typically for parts requiring high strength, toughness, and fatigue strength up to 750 °F (399 °C), but usage is not limited to such applications. The product can be superplastically formed above 1500 °F (816 °C) and it can be aged after air cooling from the solution treatment or super-plastic forming temperature to increase the strength.

1.2.1 Certain processing procedures and service conditions may cause this sheet to become subject to stress-corrosion cracking; ARP982 recommends practices to minimize such conditions.

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), www.sae.org.

AMS 2242	Tolerances, Corrosion and Heat-Resistant Steel, Iron Alloy, Titanium, and Titanium Alloy Sheet, Strip, and Plate
AMS 2368	Sampling and Testing of Wrought Titanium Raw Material, Except Forgings and Forging Stock
AMS 2750	Pyrometry
AMS 2809	Identification, Titanium and Titanium Alloy Wrought Products
ARP982	Minimizing Stress-Corrosion Cracking in Wrought Titanium Alloy Products

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, www.astm.org.

ASTM E 290	Bend Testing Material for Ductility
ASTM E 1409	Determination of Oxygen and Nitrogen in Titanium and Titanium Alloys by the Inert Gas Fusion Technique
ASTM E 1447	Determination of Hydrogen in Titanium and Titanium Alloys by the Inert Gas Fusion Thermal Conductivity/Infrared Detection Method
ASTM E 1941	Determination of Carbon in Refractory and Reactive Metals and Their Alloys
ASTM E 2371	Analysis of Titanium and Titanium Alloys by Atomic Emission Plasma Spectrometry

3. TECHNICAL REQUIREMENTS

3.1 Composition

Shall conform to the percentages by weight shown in Table 1; carbon shall be determined in accordance with ASTM E 1941, hydrogen in accordance with ASTM E 1447, oxygen and nitrogen in accordance with ASTM E 1409, and other elements in accordance with ASTM E 2371. Other analytical methods may be used if acceptable to the purchaser.

TABLE 1 - COMPOSITION

Element	min	max
Aluminum	5.25	6.25
Tin	1.75	2.25
Zirconium	1.75	2.25
Molybdenum	1.75	2.25
Chromium	1.75	2.25
Silicon	0.10	0.20
Iron	--	0.15
Oxygen	--	0.15
Carbon	--	0.08
Nitrogen	--	0.05
Hydrogen	--	0.015 (500 ppm)
Other Elements, each (3.1.1)		0.10 (150 ppm)
Other Elements, total (3.1.1)		0.40
Titanium	remainder	

3.1.1 Determination not required for routine acceptance.

3.2 Melting Practice

Alloy shall be multiple melted. Melting cycle(s) prior to the final melting cycle shall be made using vacuum consumable electrode, nonconsumable electrode, electron beam cold hearth, or plasma arc cold hearth melting practice(s). The final melting cycle shall be made under vacuum using vacuum arc remelting (VAR) practice with no alloy additions permitted.

3.2.1 The atmosphere for nonconsumable electrode melting shall be vacuum or shall be argon and/or helium at an absolute pressure not higher than 1000 mm of mercury.

3.2.2 The electrode tip for nonconsumable electrode melting shall be water-cooled copper.

3.3 Condition

Hot rolled, annealed, ground, and pickled. Surface appearance shall be comparable to a commercial corrosion-resistant steel No. 2D finish (See 8.4).

3.3.1 Annealing

Heat to a temperature within the range 1300 to 1650 °F (704 to 899 °C), hold at the selected temperature within ±25 °F (±14 °C) for a time commensurate with product thickness and the heating equipment and procedure used, and cool to room temperature at a rate equivalent to an air cool or faster. Pyrometry shall be in accordance with AMS 2750.

3.4 Properties

The product shall conform to the following requirements, determined in accordance with AMS 2368, except bending shall be determined in accordance with 3.4.1.2.

3.4.1 As Annealed

3.4.1.1 Tensile Properties

Shall be as shown in Table 2. Tensile property requirements apply in both the longitudinal and transverse directions.

TABLE 2A - MINIMUM TENSILE PROPERTIES, INCH/POUND UNITS

Nominal Thickness Inch	Tensile Strength ksi	Yield Strength at 0.2% Offset ksi	Elongation in 2 Inches %
0.016 to 0.025, incl	155	150	5
Over 0.025 to 0.032, incl	155	150	6
Over 0.032 to 0.080, incl	155	150	7
Over 0.080 to 0.1874, incl	155	150	8

TABLE 2B - MINIMUM TENSILE PROPERTIES, SI UNITS

Nominal Thickness Millimeters	Tensile Strength MPa	Yield Strength at 0.2% Offset MPa	Elongation in 51 Millimeters %
0.41 to 0.64, incl	1069	1034	5
Over 0.64 to 0.81, incl	1069	1034	6
Over 0.81 to 2.03, incl	1069	1034	7
Over 2.03 to 4.760, incl	1069	1034	8

3.4.1.2 Bending

Product 0.1874 inch (4.76 mm) and under in nominal thickness, shall have a test sample prepared nominally 0.750 inch (19.06 mm) in width, with its axis of bending parallel to the direction of rolling. The sample shall be bend tested in conformance with the guided bend test defined in ASTM E 290 through an angle of 105 degrees. The test fixture supports shall have a contact radius 0.010 minimum, and the plunger shall have a radius equal to the bend factor shown in Table 3 times the nominal thickness. Examination of the bent sample shall no evidence of cracking when examined at 15 - 25 X magnification.

TABLE 3 - BENDING PARAMETERS

Nominal Thickness inch	Nominal Thickness Millimeters	Bend Factor
0.016 to 0.070, incl	0.41 to 1.78, incl	4.5
Over 0.070 to 0.1874, incl	Over 1.78 to 4.760, incl	5

3.4.1.3 Average Grain Size

Sheet 0.125 inch (3.18 mm) and under in nominal thickness, shall have an average grain size of ASTM No. 10 or finer (See 8.5).

3.4.1.4 Microstructure

Shall be that structure resulting from processing within the alpha-beta phase field. Microstructure shall conform to 3.4.1.4.1 or 3.4.1.4.2.

3.4.1.4.1 Equiaxed and/or elongated primary alpha in a transformed beta matrix with no continuous network of alpha at prior beta grain boundaries.

3.4.1.4.2 Essentially complete field of equiaxed and/or elongated alpha with or without intergranular beta and with no continuous network of alpha at prior beta grain boundaries.

3.4.1.5 Surface Contamination

Sheet shall be free of any oxygen-rich layer, such as alpha case, or other surface contamination.

3.4.2 Response to Heat Treatment

When specified by purchaser, sheet, 0.016 to 0.1874 inch, (0.41 to 4.760 mm), inclusive, in nominal thickness, shall meet the requirements shown in Table 4 after being solution heat treated by heating to a temperature within the range 1600 to 1700 °F (871 to 927 °C), holding at the selected temperature within ±25 °F (±14 °C) for 15 to 60 minutes, cooling to room temperature at a rate equivalent to an air cool or faster, followed by aging within the range of 900 to 1000 °F (482 to 538 °C), holding at the selected temperature within ±15 °F (±8 °C) for 8 to 12 hours (See 8.1 and 8.2), and cooling to room temperature.

TABLE 4 - MINIMUM TENSILE PROPERTIES

Property	Value
Tensile Strength	180 ksi (1241 MPa)
Yield Strength at 0.2% Offset	160 ksi (1103 MPa)
Elongation in 2 Inches (50.8 mm)	5% (See 3.4.2.1)

3.4.2.1 Elongation requirement applies only to sheet 0.032 inch (0.81 mm) and over in nominal thickness.

3.5 Quality

Sheet, as received by purchaser, shall be uniform in quality and condition, sound, and free from “oil canning” (See 8.6.1) of depth in excess of one-half of the flatness tolerances, ripples, foreign materials and from imperfections detrimental to usage of the sheet.

3.6 Tolerances

Shall conform to all applicable requirements of AMS 2242 except the variation in flatness, unless otherwise specified, shall not exceed one-half of the standard flatness tolerance.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for Inspection

The vendor of sheet 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

4.2.1 Acceptance Tests

Composition (3.1), surface appearance (3.3), tensile properties as annealed (3.4.1.1), bending (3.4.1.2), average grain size (3.4.1.3), microstructure (3.4.1.4), and tolerances (3.6) are acceptance tests and shall be performed on each heat or lot as applicable.