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INTERNATIONAL
400 Commonwealth Drive, Warrendale, PA 15096-0001

AEROSPACE MATERIAL SPECIFICATION

SAE AMS 4898A

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Superseding AMS 4898

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

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 canceled and no superseding document has been specified, the last published issue of that document shall apply.

2.1 SAE Publications:

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001 or www.sae.org.

AMS 2242	Tolerances, Corrosion and Heat Resistant Steel, Iron Alloy, Titanium, and Titanium Alloy Sheet, Strip, and Plate
MAM 2242	Tolerances, Metric, Corrosion and Heat Resistant Steel, Iron Alloy, Titanium, and Titanium Alloy Sheet, Strip, and Plate

QUESTIONS REGARDING THIS DOCUMENT: (724) 772-7161 FAX: (724) 776-0243
TO PLACE A DOCUMENT ORDER: (724) 776-4970 FAX: (724) 776-0790
SAE WEB ADDRESS: http://www.sae.org

2.1 (Continued):

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, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959 or www.astm.org.

ASTM E 1409 Determination of Oxygen 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 Method

3. TECHNICAL REQUIREMENTS:

3.1 Composition:

Shall conform to the percentages by weight shown in Table 1; oxygen shall be determined in accordance with ASTM E 1409, hydrogen in accordance with ASTM E 1447, and other elements in accordance with ASTM E 120, by spectrochemical methods, or by other analytical methods acceptable to 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	(500 ppm)
Hydrogen	--	0.015	(150 ppm)
Residual Elements, each (3.1.1)		0.10	
Residual 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 consumable electrode, nonconsumable electrode, electron beam, or plasma arc melting practice(s). The final melting cycle shall be made under vacuum using consumable electrode 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:

Shall be as follows, determined in accordance with AMS 2368:

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 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).

3.4.1.3 Bending: Sheet shall withstand, without evidence of cracking when examined at 20X magnification, bending through an angle of 105 degrees around a diameter equal to the bend factor shown in Table 3 times the nominal thickness of the sheet.

TABLE 3 - Bending Parameters

Nominal Thickness inch	Nominal Thickness Millimeters	Bend Factor
0.016 to 0.070, incl	0.41 to 1.78 , incl	9
Over 0.070 to 0.1874, incl	Over 1.78 to 4.760, incl	10

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 8to 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 or MAM 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), average grain size (3.4.1.2), bending (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.

4.2.2 Periodic Tests: Surface contamination (3.4.1.5) and tensile properties after solution heat treatment and aging (3.4.2) are periodic tests and shall be performed at a frequency selected by the vendor unless frequency of testing is specified by the purchaser.

4.3 Sampling and Testing:

Shall be in accordance with AMS 2368 except for the following:

4.3.1 For Acceptance Tests: