SAE The Engineering Society For Advancing Mobility Land Sea Air and Space ®
INTERNATIONAL
400 Commonwealth Drive, Warrendale, PA 15096-0001

AEROSPACE MATERIAL SPECIFICATION

SAE AMS 4897

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Submitted for recognition as an American National Standard

TITANIUM ALLOY, SHEET, STRIP, AND PLATE
77Ti - 15Mo - 3.0Al - 2.8Cb - 0.20Si

1. SCOPE:

1.1 Form:

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

1.2 Application:

These products have been used typically for parts to be formed in the solution heat treated condition and subsequently precipitation heat treated to obtain high strength-to-weight ratio or stability up to 1100 °F (593 °C), but usage is not limited to such applications.

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 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
AMS 2249	Chemical Check Analysis Limits, Titanium and Titanium Alloys
AMS 2642	Structural Examination of Titanium Alloys, Etch-Anodize Inspection Procedure
AMS 2750	Pyrometry
AMS 2809	Identification, Titanium and Titanium Alloy Wrought Products

2.2 ASTM Publications:

Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

ASTM E 8	Tension Testing of Metallic Materials
ASTM E 8M	Tension Testing of Metallic Materials (Metric)
ASTM E 21	Elevated Temperature Tension Tests of Metallic Materials
ASTM E 112	Determining the Average Grain Size
ASTM E 120	Chemical Analysis of Titanium and Titanium Alloys
ASTM E 290	Semi-Guided Bend Test for Ductility of Metallic Materials
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 by wet chemical methods in accordance with ASTM E 120, by spectrochemical methods, or by other analytical methods acceptable to purchaser.

TABLE 1 - Composition

Element	min	max
Molybdenum	14.0	16.0
Aluminum	2.5	3.5
Columbium	2.4	3.2
Silicon	0.15	0.25
Oxygen	0.11	0.15
Carbon	--	0.05
Iron	--	0.40
Nitrogen	--	0.05 (500 ppm)
Hydrogen (3.1.2)	--	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.

3.1.2 Sample size when using ASTM E 1447 for hydrogen analysis may be as large as 0.35 gram.

3.1.3 Check Analysis: Composition variations shall meet the requirements of AMS 2249.

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:

Rolled, solution heat treated, descaled, and leveled, having a surface appearance comparable to a commercial corrosion-resistant steel No. 2D finish (See 8.1).

3.4 Solution Heat Treatment:

Product shall be solution heat treated by heating to a temperature within the range 1500 to 1650 °F (816 to 899 °C), holding at the selected temperature within ±25 F (±14 C) degrees for 3 to 30 minutes, and cooling at a rate which will produce product meeting the requirements of 3.5 (See 8.2). Pyrometry shall be in accordance with AMS 2750.

3.5 Properties:

The product shall conform to the following requirements:

3.5.1 As Solution Heat Treated:

3.5.1.1 Tensile Properties: Shall be as shown in Table 2 for product 0.125 inch (3.18 mm) and under in nominal thickness, determined in accordance with ASTM E 8 or ASTM E 8M with the rate of strain maintained at 0.003 to 0.007 inch/inch/minute (0.003 to 0.007 mm/mm/minute) through the yield strength and then increased so as to produce failure in approximately one additional minute. When a dispute occurs between purchaser and vendor over the yield strength values, a referee test shall be performed on a machine having a strain rate pacer using a rate of 0.005 inch/inch/minute (0.005 mm/mm/minute) through the yield strength and a minimum cross head speed of 0.10 inch per minute (0.04 mm/s) above the yield strength.

TABLE 2 - Room-Temperature Tensile Properties

Property	Value
Tensile Strength	120 to 145 ksi (827 to 1000 MPa)
Yield Strength at 0.2% Offset	115 to 140 ksi (793 to 965 MPa)
Elongation in 2 Inches (50.8 mm), min	8%

3.5.1.2 Bending: Product 0.125 inch (3.18 mm) and under in nominal thickness shall withstand, without evidence of cracking when examined at 20X magnification, bending in accordance with ASTM E 290 through an angle of 105 degrees around a diameter equal to the bend factor shown in Table 3 times the nominal thickness of the product using either V-block, U-channel, or free bend procedure with axis of bend parallel to the direction of final rolling. Only one of these tests will be required in routine inspection. In case of dispute, results of bend tests using the V-block procedure shall govern.

TABLE 3 - Bending Parameters

Nominal Thickness Inch	Nominal Thickness Millimeters	Bend Factor
Up to 0.070, incl	Up to 1.78, incl	3
Over 0.070 to 0.125, incl	Over 1.78 to 3.18, incl	3.5

3.5.1.3 Surface Contamination: The product shall be free of any oxygen-rich layer, such as alpha case, or other surface contamination, determined by the bend test of 3.5.1.2, by microscopic examination at 200X magnification, or by other method acceptable to purchaser.

3.5.1.4 Microstructure: Shall be greater than 80% recrystallized beta grains (see 8.3.2), determined by optical examination at 100X magnification after decoration aging (See 8.3.3) a representative specimen at 900 °F (482 °C) for one to two hours. Silicides are an intrinsic feature of this product and, therefore, shall not be cause for rejection. Specimens shall be polished and etched as in AMS 2642 or by other suitable polishing and etching techniques.

3.5.1.5 Average Grain Size: Shall be as shown in Table 4, determined in accordance with ASTM E 112.

TABLE 4 - Average Grain Size

Nominal Thickness Inch	Nominal Thickness Millimeters	ASTM Grain Size Number
Up to 0.100, incl	Up to 2.54, incl	6
Over 0.100 to 0.125, incl	Over 2.54 to 3.18, incl	4

3.5.2 Response to Heat Treatment: Product 0.125 inch (3.18 mm) and under in nominal thickness shall meet the requirements of Table 5, Table 6, Table 7, and Table 8, after precipitation heat treatment as in 3.5.2.1 or 3.5.2.2 as applicable, determined with the rate of strain maintained at 0.003 to 0.007 inch/inch/minute (0.003 to 0.007 mm/mm/minute) through the yield strength and then increased so as to produce failure in approximately one additional minute. When a dispute occurs between purchaser and vendor over the yield strength values, a referee test shall be performed on a machine having a strain rate pacer, using a rate of 0.005 inch/inch/minute (0.005 mm/mm/minute) through the yield strength and a minimum cross head speed of 0.10 inch per minute (0.04 mm/s) above the yield strength.

3.5.2.1 Product shall conform to requirements shown in Table 5 and Table 6 after being heated to 1100 °F ± 10 (593 °C ± 6), held at heat for 8 hours ± 0.5, and cooled in air.

3.5.2.1.1 At Room Temperature: Shall be as shown in Table 5, determined in accordance with ASTM E 8 or ASTM E 8M.

TABLE 5A - Minimum Room Temperature Tensile Properties, Inch/Pound Units

Grain Direction	Ultimate Tensile Strength ksi	Yield Strength at 0.2% Offset ksi	Elongation %
Longitudinal	144	136	5
Transverse	147	138	5

TABLE 5B - Minimum Room Temperature Tensile Properties, SI Units

Grain Direction	Ultimate Tensile Strength MPa	Yield Strength at 0.2% Offset MPa	Elongation %
Longitudinal	993	938	5
Transverse	1014	951	5

3.5.2.1.2 At 900 °F (482 °C): Shall be as shown in Table 6, determined in accordance with ASTM E 21 on specimens heated to 900 °F ± 5 (482 °C ± 3), held at heat for 20 to 30 minutes before testing, and tested at 900 °F ± 5 (482 °C ± 3).

TABLE 6 - Minimum Tensile Properties at 900 °F (482 °C)

Property	Value
Tensile Strength	95.0 ksi (655 MPa)
Yield Strength at 0.2% Offset	75.0 ksi (517 MPa)
Elongation in 2 Inches (50.8 mm)	15%

3.5.2.2 Product shall conform to requirements shown in Table 7 and Table 8 after being heated to 1275 °F ± 10 (691 °C ± 6), held at heat for 8 hours ± 0.5, cooled in air, reheated to 1200 °F ± 10 (649 °C ± 6), held at heat for 8 hours ± 0.5, and cooled in air.

3.5.2.2.1 At Room Temperature: Shall be as shown in Table 7, determined in accordance with ASTM E 8 or ASTM E 8M.

TABLE 7A - Minimum Room Temperature Tensile Properties, Inch/Pound Units

Grain Direction	Ultimate Tensile Strength ksi	Yield Strength at 0.2% Offset ksi	Elongation in 2 Inches %
Longitudinal	125	115	6
Transverse	125	115	5

TABLE 7B - Minimum Room Temperature Tensile Properties, SI Units

Grain Direction	Ultimate Tensile Strength MPa	Yield Strength at 0.2% Offset MPa	Elongation in 50.8 mm %
Longitudinal	862	793	6
Transverse	862	793	5

3.5.2.2.2 At 1100 °F (593 °C): Shall be as shown in Table 8, determined in accordance with ASTM E 21 on specimens heated to 1100 °F ± 5 (593 °C ± 3), held at heat for 20 to 30 minutes before testing, and tested at 1100 °F ± 5 (593 °C ± 3). Properties shown apply to both the longitudinal and transverse grain orientation.

TABLE 8 - Minimum Tensile Properties at 1100 °F (593 °C)

Property	Value
Tensile Strength	60 ksi (414 MPa)
Yield Strength at 0.2% Offset	49 ksi (338 MPa)
Elongation in 2 Inches (50.8 mm)	17%

3.6 Quality:

3.6.1 The product, as received by purchaser, shall be uniform in quality and condition, sound, and free from "oil cans" (See 8.3.1) of depth in excess of the flatness tolerances, ripples, and foreign materials and from imperfections detrimental to usage of the product.

3.7 Tolerances:

Shall conform to all applicable requirements of AMS 2242 or MAM 2242.

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 heat or lot as applicable.

4.3 Sampling and Testing:

Shall be in accordance with the following; a lot shall be all product of the same nominal size from the same heat processed at the same time and in the same heat treatment batch.

4.3.1 Composition: One sample from each heat, except that for hydrogen determinations, one sample from each lot obtained after thermal and chemical processing is completed.