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INTERNATIONAL
400 Commonwealth Drive, Warrendale, PA 15096-0001

AEROSPACE MATERIAL SPECIFICATION

SAE AMS 4914A

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Superseding AMS 4914

Submitted for recognition as an American National Standard

TITANIUM ALLOY COLD ROLLED SHEET AND STRIP
15V - 3A1 - 3Cr - 3Sn
Solution Heat Treated

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 requiring high strength-to-weight ratio and stability up to 550 °F (288 °C) in the precipitation heat treated condition, 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 2750 Pyrometry
AMS 2809 Identification, Titanium and Titanium Alloy Wrought Products

2.2 ASTM Publications:

Available from ASTM, 1916 Race Street, Philadelphia, PA 19103-1187.

ASTM E 8 Tension Testing of Metallic Materials
ASTM E 8M Tension Testing of Metallic Materials (Metric)
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

2.3 U.S. Government Publications:

Available from Standardization Documents Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

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

3. TECHNICAL REQUIREMENTS:

3.1 Composition:

Shall conform to the percentages by weight shown in Table 1, determined 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
Vanadium	14.0	16.0
Chromium	2.5	3.5
Tin	2.5	3.5
Aluminum	2.5	3.5
Iron	--	0.25
Oxygen	--	0.13
Carbon	--	0.05
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.

3.1.2 Check Analysis: Composition variations shall meet the requirements of (R) AMS 2249.

3.2 Melting Practice:

3.2.1 (R) Alloy shall be multiple melted; the final melting cycle shall be under vacuum. The first melt shall be by consumable electrode, nonconsumable electrode, electron beam, or plasma arc melting practice. The subsequent melt or melts shall be made using consumable electrode practice with no alloy additions permitted in the last consumable electrode melt.

3.2.1.1 (R) 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.

3.2.1.2 (R) The electrode tip for nonconsumable electrode melting shall be water-cooled copper.

3.3 Condition:

Hot rolled with subsequent cold reduction, solution heat treated, descaled, and leveled, having a surface appearance comparable to a commercial corrosion-resistant steel No. 2D finish (See 8.2).

3.4 Heat Treatment:

(R) Product shall be solution heat treated by heating to a temperature within the range 1450 to 1500 °F (788 to 816 °C), holding at the selected temperature within ±25 °F (±14 °C) for 3 to 30 minutes, and cooling at a rate which will produce product meeting the requirements of 3.5 (See 8.3). 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 crosshead speed of 0.10 inch (2.5 mm) per minute above the yield strength.

TABLE 2 - Tensile Properties

Property	Value
Tensile Strength	102 - 137 ksi (703 - 945 MPa)
Yield Strength at 0.2 % Offset	100 - 126 ksi (689 - 869 MPa)
Elongation in 2 Inches (50.8 mm) or 4D	12%

3.5.1.1.1 (R) Tensile property requirements for product over 0.125 inch (0.32 mm) in nominal thickness shall be as agreed upon by purchaser and vendor.

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 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 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

Nominal Thickness Inch	Nominal Thickness Millimeters	Bend Factor
Up to 0.070, incl	Up to 1.78, incl	4
Over 0.070 to 0.125, incl	Over 1.78 to 3.18, incl	5

3.5.1.2.1 Bending requirements for product over 0.125 inch (3.18 mm) in nominal thickness shall be as agreed upon by purchaser and vendor.

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 or other method acceptable to purchaser.

3.5.2 After Precipitation Heat Treatment:

3.5.2.1 (R) Tensile Properties: Shall be as shown in Table 4 for product 0.125 inch (0.32 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 (2.5 mm) per minute above the yield strength. Properties shall be verified for each precipitation heat treatment condition.

TABLE 4A - Minimum Tensile Properties

After heating to 1000 °F ± 10 (538 °C ± 6), holding at heat for 8 hours ± 0.5, and cooling in air:

Property	Value
Tensile Strength	145 ksi (1000 MPa)
Yield Strength at 0.2% Offset	140 ksi (965 MPa)
Elongation in 2 Inches (50.8 mm) or 4D	7%

TABLE 4B - Minimum Tensile Properties

After heating to 900 °F ± 10 (482 °C ± 6), holding at heat for 16 hours ± 0.5, and cooling in air:

Property	Value
Tensile Strength	180 ksi (1241 MPa)
Yield Strength at 0.2% Offset	170 ksi (1172 MPa)
Elongation in 2 Inches (50.8 mm) or 4D	5%

3.5.2.1.1 (R) Property requirements for product over 0.125 inch (3.18 mm) in nominal thickness shall be as agreed upon by purchaser and vendor.

3.5.2.2 Grain Size: Shall be predominantly 6 or finer with occasional grains as large as 2 permissible, determined by comparison of a polished and etched specimen with the chart in ASTM E 112.

3.6 Quality:

The product, as received by purchaser, shall be uniform in quality and condition, sound, and free from "oil cans" (See 8.4) of depth in excess of the flatness tolerances, ripples, and foreign materials and from imperfections detrimental to usage of the product.

3.7 Tolerances:

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

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection:

(R) The vendor of the product shall supply all samples for vendor's tests and shall be responsible for performing all required tests. Purchaser reserves the right to sample and to perform any confirmatory testing deemed necessary to ensure that the product conforms to the requirements of this specification.

4.2 Classification of Tests:

Tests for all technical requirements are acceptance tests and shall be performed on each heat or lot as applicable.

4.3 Sampling and Testing:

(R) 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.

4.3.2 Tensile Properties, Bending, Grain Size, and Surface Contamination:

(R) Not less than one sample from each lot.

4.3.2.1 Specimens for tensile tests of widths 9 inches (229 mm) and over shall be taken and tested in both the longitudinal and transverse directions; for widths under 9 inches (229 mm), specimens shall be taken in longitudinal direction.

4.3.2.2 For V-block or U-channel bend tests, specimen width shall be not less than 10 times the nominal thickness or 1 inch, (25 mm), whichever is greater. For free bend tests, minimum specimen width shall, when possible, be not less than 10 times the nominal thickness; maximum width need not be greater than 1 inch (25 mm).