



AEROSPACE MATERIAL SPECIFICATION

AMS4897™

REV. E

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Superseding AMS4897D

Titanium Alloy, Sheet and Strip
15Mo - 3.0Al - 2.8Cb - 0.20Si
(Composition Similar to UNS R58210)

RATIONALE

AMS4897E results from a Five-Year Review and update of this specification with changes to composition (3.1) adding test methods, melting practice (3.2), surface contamination (3.5.1.3) using standard wording, unauthorized exceptions per general agreement (3.5.3, 3.9, 4.4.3), AS6279 time limitation (3.8), identification (5.1), and notes (8.6, 8.8).

1. SCOPE

1.1 Form

This specification covers a titanium alloy in the form of sheet and strip 0.125 inch (3.18 mm) and under in nominal thickness.

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 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 +1 724-776-4970 (outside USA), www.sae.org.

AMS2242	Tolerances Corrosion and Heat Resistant Steel, Iron Alloy, Titanium, and Titanium Alloy Sheet, Strip, and Plate
AMS2249	Chemical Check Analysis Limits Titanium and Titanium Alloys
AMS2368	Sampling and Testing of Wrought Titanium Raw Material Except Forgings and Forging Stock

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For more information on this standard, visit
<https://www.sae.org/standards/content/AMS4897E/>

AMS2642	Structural Examination of Titanium Alloys Etch-Anodize Inspection Procedure
AMS2750	Pyrometry
AMS2809	Identification Titanium and Titanium Alloy Wrought Products
ARP1917	Clarification of Terms Used in Aerospace Metals Specifications
AS4194	Sheet and Strip Surface Finish Nomenclature
AS6279	Standard Practice for Production, Distribution, and Procurement of Metal Stock

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 A480/A480M	General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip
ASTM E8/E8M	Tension Testing of Metallic Materials
ASTM E21	Elevated Temperature Tension Tests of Metallic Materials
ASTM E112	Determining Average Grain Size
ASTM E290	Bend Testing of Material for Ductility
ASTM E539	Analysis of Titanium Alloys by Wavelength Dispersive X-Ray Fluorescence Spectrometry
ASTM E1409	Determination of Oxygen and Nitrogen in Titanium and Titanium Alloys by Inert Gas Fusion
ASTM E1447	Determination of Hydrogen in Titanium and Titanium Alloys by Inert Gas Fusion Thermal Conductivity/Infrared Detection Method
ASTM E1941	Determination of Carbon in Refractory and Reactive Metals and Their Alloys by Combustion Analysis
ASTM E2371	Analysis of Titanium and Titanium Alloys by Direct Current Plasma and Inductively Coupled Plasma Atomic Emission Spectrometry
ASTM E2994	Analysis of Titanium and Titanium Alloys by Spark Atomic Emission Spectrometry and Glow Discharge Atomic Emission 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 E1941, hydrogen in accordance with ASTM E1447, oxygen and nitrogen in accordance with ASTM E1409, and other elements in accordance with ASTM E539, ASTM E2371, or ASTM E2994. Other analytical methods may be used if acceptable to the purchaser.

Table 1 - Composition

Element	Min	Max
Molybdenum	14.0	16.0
Aluminum	2.5	3.5
Columbium (Niobium)	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	--	0.015 (150 ppm)
Other Elements, each (3.1.1)	--	0.10
Other 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 applicable requirements of AMS2249.

3.2 Melting Practice

Alloy shall be multiple melted. The first melt shall be made by vacuum consumable electrode, nonconsumable electrode, electron beam cold hearth, or plasma arc cold hearth melting practice. The subsequent melt or melts shall be made using vacuum arc remelting (VAR) practice. Alloy additions are not permitted in the final melt cycle.

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 8.2).

3.4 Solution Heat Treatment

Except as specified in 3.4.1, 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) for 3 to 30 minutes, and cooling at a rate that will produce product meeting the requirements of 3.5 (see 8.3). Pyrometry shall be in accordance with AMS2750.

3.4.1 Continuous Heat Treating of Sheet and Strip

Process parameters (e.g., furnace temperature set points, heat input, travel rate, etc.) for continuous heat treating lines shall be established by the material producer and validated by testing of product to requirements of 3.5.

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 E8/E8M with the rate of strain set at 0.005 in/in/min (0.005 mm/mm/min) and maintained within a tolerance of ± 0.002 in/in/min (± 0.002 mm/mm/min) through the 0.2% offset yield strain.

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), minimum	8%

3.5.1.2 Bending

Product 0.125 inch (3.18 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 E290 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 not show evidence of cracking when examined at 15 to 25X magnification.

Table 3 - Bending parameters

Nominal Thickness Inches	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 as in any one of the following: 3.5.1.3.1, 3.5.1.3.2, or other method acceptable to purchaser

3.5.1.3.1 The bend test of 3.5.1.2.

3.5.1.3.2 Examination of a metallographic cross section at 400X minimum magnification.

3.5.1.4 Microstructure

Shall be greater than 80% recrystallized beta grains (see 8.4.2), determined by optical examination at not lower than 100X magnification after decoration aging (see 8.4.3) a representative specimen at 900 °F (482 °C) for 1 to 2 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 AMS2642 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 E112.

Table 4 - Average grain size

Nominal Thickness Inches	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 Tables 5, 6, 7, and 8, after precipitation heat treatment as in 3.5.2.1 or 3.5.2.2, as applicable. Room temperature tensile tests shall be determined in accordance with ASTM E8/E8M with the rate of strain set at 0.005 in/in/min (0.005 mm/mm/min) and maintained within a tolerance of ± 0.002 in/in/min (± 0.002 mm/mm/min) through the 0.2% offset yield strain.

3.5.2.1 Product shall conform to requirements shown in Tables 5 and 6 after being heated to $1100 \text{ }^\circ\text{F} \pm 10 \text{ }^\circ\text{F}$ ($593 \text{ }^\circ\text{C} \pm 6 \text{ }^\circ\text{C}$), held at heat for 8 hours ± 0.5 hour, and cooled in air.

3.5.2.1.1 At Room Temperature

Shall be as shown in Table 5, determined in accordance with ASTM E8/E8M and 3.5.2.

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 E21 on specimens heated to $900 \text{ }^\circ\text{F} \pm 5 \text{ }^\circ\text{F}$ ($482 \text{ }^\circ\text{C} \pm 3 \text{ }^\circ\text{C}$), held at heat for 20 to 30 minutes before testing, and tested at $900 \text{ }^\circ\text{F} \pm 5 \text{ }^\circ\text{F}$ ($482 \text{ }^\circ\text{C} \pm 3 \text{ }^\circ\text{C}$).

Table 6 - Minimum tensile properties at 900 °F (482 °C)

Property	Value
Tensile Strength	95 ksi (655 MPa)
Yield Strength at 0.2% Offset	75 ksi (517 MPa)
Elongation in 2 Inches (50.8 mm)	15%

3.5.2.2 Product shall conform to requirements shown in Tables 7 and 8 after being heated to $1275 \text{ }^\circ\text{F} \pm 10 \text{ }^\circ\text{F}$ ($691 \text{ }^\circ\text{C} \pm 6 \text{ }^\circ\text{C}$), held at heat for 8 hours ± 0.5 hour, cooled in air, reheated to $1200 \text{ }^\circ\text{F} \pm 10 \text{ }^\circ\text{F}$ ($649 \text{ }^\circ\text{C} \pm 6 \text{ }^\circ\text{C}$), held at heat for 8 hours ± 0.5 hour, and cooled in air.

3.5.2.2.1 At Room Temperature

Shall be as shown in Table 7, determined in accordance with ASTM E8/E8M and 3.5.2.

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 E21 on specimens heated to 1100 °F ± 5 °F (593 °C ± 3 °C), held at heat for 20 to 30 minutes before testing, and tested at 1100 °F ± 5 °F (593 °C ± 3 °C). 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	49.0 ksi (338 MPa)
Elongation in 2 Inches (50.8 mm)	17%

3.5.3 Mechanical property requirements for product outside the size range covered by 1.1 shall be agreed upon between purchaser and producer and reported per 4.4.3.

3.6 Quality

The product, as received by purchaser, shall be uniform in quality and condition, sound, and free from "oil cans" (see 8.4.1) of depth in excess of the flatness tolerances, ripples, and foreign materials and from imperfections detrimental to usage of the product.

3.7 Tolerances

Except for flatness, shall conform to all applicable requirements of AMS2242.

3.7.1 Flatness shall be as shown in Table 9

Table 9 - Maximum deviation from a horizontal flat surface

Specified Thickness		Variation from Flat	
Inches	Millimeters	Inches	Millimeters
Up to 0.062, excl	Up to 1.57, excl	2	51
0.062 to 0.1875, excl	1.57 to 4.762, excl	1	25

3.8 Production, distribution, and procurement of metal stock shall comply with AS6279.

3.9 Exceptions

Any exceptions shall be authorized by the purchaser and reported as in 4.4.3.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for Inspection

The producer of the product shall supply all samples for producer'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 AMS2368 and 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, Surface Contamination, and Microstructure

One or more samples from each lot for each requirement.

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 direction; for widths under 9 inches (229 mm), specimens shall be taken in the longitudinal direction.

4.4 Reports

4.4.1 The producer shall furnish with each shipment a report showing producer identity, country where the metal was melted (i.e., final melt in the case of metal processed by multiple melting operations), results of tests for composition of each heat and for hydrogen content, room temperature tensile properties, bending, average grain size, surface contamination, and room and elevated temperature tensile properties after aging of each lot, and state that the product conforms to the other technical requirements. This report shall include the purchase order number, heat and lot numbers, AMS4897E, product form, mill produced size, and quantity.

4.4.2 When the product size is outside the range covered by 1.1, the report shall contain a statement to that effect.

4.4.3 When material produced to this specification is beyond the sizes allowed in the scope or tables, or other exceptions are taken to the technical requirements listed in Section 3, the report shall contain a statement "This material is certified as AMS4897E(EXC) because of the following exceptions:" and the specific exceptions shall be listed (also see 5.1).

4.5 Resampling and Retesting

In accordance with AMS2368.