



AEROSPACE MATERIAL SPECIFICATION

AMS4902™

REV. L

Issued 1955-08
Revised 2018-08

Superseding AMS4902K

Titanium Sheet, Strip, and Plate
Commercially Pure
Annealed 40.0 ksi (276 MPa) Yield Strength
(Composition similar to UNS R50400)

RATIONALE

AMS4902L results from a Five-Year Review and update of this specification that includes the addition of ASTM E539 and ASTM E2994 (3.1), removal of sample size allowance for hydrogen of Table 1 (covered by ASTM E1447), removes compulsory use of chart for grain size (3.5.3), the addition of AS6279 (3.8), prohibits unauthorized exceptions (3.9), imposes AMS2368 (4.3 and 4.5) and revises reporting and marking when size exceptions are taken (4.4.2 and 5.1).

1. SCOPE

1.1 Form

This specification covers one grade of commercially-pure titanium in the form of sheet, strip, and plate up through 1.000 inch (25.40 mm), inclusive.

1.2 Application

This material typically has been used for parts requiring aqueous corrosion resistance, moderate strength up to 400 °F (204 °C) and oxidation resistance up to 600 °F (316 °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.

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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), or 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
AMS2750	Pyrometry
AMS2809	Identification, Titanium and Titanium Alloy Wrought Products
ARP1917	Clarification of Terms Used in Aerospace Metals Specifications
AS1814	Terminology for Titanium Microstructures
AS4194	Sheet and Strip Surface Finish Nomenclature
AS6279	Industry Standard Practices 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 19248-2959, Tel: 610-832-9585, or 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 E112	Determining Average Grain Size
ASTM E290	Bend Testing Material for Ductility
ASTM E384	Microindentation Hardness of Materials
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 the Inert Gas Fusion Thermal Conductivity/Infrared Detection Method
ASTM E1941	Determination of Carbon in Refractory and Reactive Metals and Their Alloys
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
Iron	--	0.30
Oxygen	--	0.20
Carbon	--	0.08
Nitrogen	--	0.05 (500 ppm)
Hydrogen	--	0.0150 (150 ppm)
Other Elements, each (3.1.1)	--	0.10
Other Elements, total (3.1.1)	--	0.30
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 produced by electron beam cold hearth or plasma arc cold hearth melting method, or shall be multiple melted with the final melting cycle under vacuum. When multiple melted, the first melt shall be made using a 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 remelt 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

The product shall be supplied in the following condition:

3.3.1 Sheet and Strip

Hot rolled with or without subsequent cold reduction, annealed, descaled, and leveled, having a surface appearance comparable to a commercial corrosion-resistant steel No. 2D finish (see 8.2).

3.3.2 Plate

Hot rolled, annealed, descaled, and flattened, having a surface appearance comparable to a commercial corrosion-resistant steel No. 1 finish (see 8.2). Plate product shall be produced using standard industry practices designed strictly for the production of plate stock to the procured thickness. Bar, billet, forgings, or forging stock shall not be supplied in lieu of plate.

3.4 Annealing

Pyrometry shall be in accordance with AMS2750.

3.4.1 The product shall be annealed by heating to a temperature within the range 1200 to 1500 °F (649 to 816 °C), holding at the selected temperature within ± 25 °F (± 14 °C) for a time commensurate with the thickness and the heating equipment and procedure used, and cooling at a rate that will produce product meeting the requirements of 3.5.

3.4.2 Continuous Anneal of Sheet and Strip

When continuous annealing is used, 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 Tensile Properties

Shall be as shown in Table 2 on product 1.000 inch (25.40 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 - Tensile properties

Property	Value
Tensile Strength, minimum	50.0 ksi (345 MPa)
Yield Strength at 0.2% Offset	40.0 to 65.0 ksi (276 to 448 MPa)
Elongation in 2 Inches (50.8 mm) or 4D, minimum	20%

3.5.1.1 Elongation requirement applies only to product 0.025 inch (0.64 mm) and over in nominal thickness.

3.5.2 Bending

Product under 0.1875 inch (4.763 mm) in nominal thickness shall withstand, without evidence of cracking when examined at 20X magnification, bending in accordance with ASTM E290 through an angle of 105 degrees around a radius equal to the bend factor shown in Table 3 times the nominal thickness of the product with the axis of bend parallel to the direction of rolling. In case of dispute, results of bend tests using the end supported guided bend test procedure shall govern.

Table 3 - Bend factor

Nominal Thickness Inch	Nominal Thickness Millimeters	Bend Factor
Up to 0.070, incl	Up to 1.78, incl	2
Over 0.070 to 0.1874, incl	Over 1.78 to 4.76, incl	2.5

3.5.3 Grain Size

Shall be 6 or finer, determined in accordance with ASTM E112.

3.5.4 Surface Contamination

The product shall be free of any oxygen-rich layer, such as alpha case, or other surface contamination, determined as in 3.5.4.1 or 3.5.4.2 or other method acceptable to purchaser.

3.5.4.1 The bend test of 3.5.2.

3.5.4.2 Hardness differential; a surface hardness more than 40 points higher than the subsurface hardness, determined in accordance with ASTM E384 on the Knoop scale using a 200 g load, being evidence of unacceptable surface contamination.

3.6 Quality

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 AMS2242.

3.8 Production, distribution, and procurement of metal stock shall comply with AS6279. This requirement becomes effective January 1, 2020.

3.9 Any exceptions shall be authorized by purchaser and reported as in 4.4.2.

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 annealed 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 Property, Bending, Grain Size, and Surface Contamination Requirements

At least one sample from each lot.

4.3.2.1 Specimens for tensile tests from material of width 9 inches (228.6 mm) and over shall be taken with specimen axis in both the longitudinal and long-transverse directions; from material of width under 9 inches (228.6 mm), specimens shall be taken with the specimen axis in the longitudinal directions.

4.3.2.2 For guided bend tests, specimen width shall be not less than 10 times the nominal thickness but not less than 1 inch (25 mm). 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).

4.4 Reports

4.4.1 The producer shall furnish with each shipment a report showing the 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 the hydrogen content, tensile, and bending properties, and grain size of each lot and stating that the product conforms to the other technical requirements. This report shall include the purchase order number, lot number, AMS4902L, type, specific annealing treatment used, product form, size, and quantity.

4.4.2 When material produced to this specification is beyond the sizes allowed in the scope or tables, or exceptions authorized by purchaser are taken to the technical requirements listed in Section 3, the report shall contain a statement, "This material is certified as AMS4902L(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.

5. PREPARATION FOR DELIVERY

5.1 Identification

Shall be in accordance with AMS2809. When size exceptions are taken (see 4.4.2), the material shall be marked with AMS4902L(EXC).

5.2 Packaging

The product shall be prepared for shipment in accordance with commercial practice and in compliance with applicable rules and regulations pertaining to the handling, packaging, and transportation of the product to ensure carrier acceptance and safe delivery.

6. ACKNOWLEDGMENT

A producer shall include this specification number and its revision letter in all quotations and when acknowledging purchase orders.

7. REJECTIONS

Product not conforming to this specification, or to modifications authorized by purchaser, will be subject to rejection.

8. NOTES

8.1 Revision Indicator

A change bar (I) located in the left margin is for the convenience of the user in locating areas where technical revisions, not editorial changes, have been made to the previous issue of this document. An (R) symbol to the left of the document title indicates a complete revision of the document, including technical revisions. Change bars and (R) are not used in original publications, nor in documents that contain editorial changes only.

8.2 Commercial corrosion-resistant steel finishes are defined in ASTM A480/A480M and AS4194.

8.3 Terms used in AMS are clarified in ARP1917 and as follows:

8.3.1 "Oil Can"

An excess of material in a localized area of a sheet that causes the sheet to buckle in that area. When the sheet is placed on a flat surface and hand pressure applied to the buckle, the buckle will spring through to the opposite surface or spring up in another area of the sheet.

8.4 Dimensions and properties in inch/pound units and the Fahrenheit temperatures are primary; dimensions and properties in SI units and the Celsius temperatures are shown as the approximate equivalents of the primary units and are presented only for information.

8.5 Purchase documents should specify not less than the following:

AMS4902L

Type of melting practice, if desired (see 3.2.1)

Product form and size of product desired

Quantity of product desired

8.6 Unless otherwise specified, the material producer shall work to the revision of this specification in effect on the date of order placement. Unless otherwise specified, material manufactured and certified to the immediately previous revision of this specification may be procured and used until inventory is depleted.

PREPARED BY AMS COMMITTEE "G"