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AEROSPACE MATERIAL SPECIFICATION

AMS4930™	REV. L
Issued 1966-03 Revised 2020-10 Superseding AMS4930K	

Titanium Alloy Bars, Wire, Forgings, and Rings
6Al - 4V, Extra Low Interstitial
Annealed
(Composition similar to UNS R56401)

RATIONALE

AMS4930L changes yttrium back to being not required for routine acceptance (Table 1).

AMS4930K added continuous annealing of wire (3.4.1).

1. SCOPE

1.1 Form

This specification covers a titanium alloy in the form of bars, wire, forgings, flash welded rings 4.000 inches (101.60 mm) and under in nominal diameter or distance between parallel sides, and stock for forging or flash welded rings of any size.

1.2 Application

These products have been used typically for parts requiring good weldability and ductility, combined with good notch-toughness down to -320 °F (-196 °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.

AMS2241	Tolerances, Corrosion and Heat-Resistant Steel, Iron Alloy, Titanium, and Titanium Alloy Bars and Wire
AMS2249	Chemical Check Analysis Limits, Titanium and Titanium Alloys
AMS2368	Sampling and Testing of Wrought Titanium Raw Material, Except Forging and Forging Stock
AMS2750	Pyrometry

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For more information on this standard, visit
https://www.sae.org/standards/content/AMS4930L/

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AMS2808	Identification, Forgings
AMS2809	Identification, Titanium and Titanium Alloy Wrought Products
AMS7498	Rings, Flash Welded, Titanium and Titanium Alloys
ARP1917	Clarification of Terms Used in Aerospace Metals Specifications
AS1814	Terminology for Titanium Microstructures
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 E8/E8M	Tension Testing of Metallic Materials
ASTM E539	Analysis of Titanium Alloys by 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 the 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	
Aluminum	5.50	6.50	
Vanadium	3.50	4.50	
Iron	--	0.25	
Oxygen	--	0.13	
Carbon	--	0.08	
Nitrogen	--	0.05	(500 ppm)
Hydrogen	--	0.0125	(125 ppm)
Yttrium (see 3.1.1)	--	0.005	(50 ppm)
Other Elements, each (see 3.1.1)	--	0.10	
Other Elements, total (see 3.1.1)	--	0.40	
Titanium	remainder		

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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 inert gas at a 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 Bars

Hot finished with or without subsequent cold reduction, annealed, and descaled. A machined or ground surface is permitted unless prohibited by purchaser. The product shall be processed to the final thickness/diameter by metallurgical working operations prior to any straightening, dimensional sizing, or surface finishing operations. Bar shall not be cut from plate.

3.3.2 Wire

Cold drawn, annealed, and descaled.

3.3.3 Forgings and Flash Welded Rings

Annealed and descaled.

3.3.3.1 Flash welded rings shall not be supplied unless specified or permitted on purchaser's part drawing. When supplied, rings shall be manufactured in accordance with AMS7498.

3.3.4 Stock for Forging or Flash Welded Rings

As ordered by the forging or flash welded ring manufacturer.

3.4 Annealing

Bars, wire, forgings, and flash welded rings shall be annealed by heating to a temperature within the range 1300 to 1450 °F (704 to 788 °C), holding at the selected temperature within ±25 °F (±14 °C) for not less than 1 hour, and cooling at a rate which will produce product meeting the requirements of 3.5. Pyrometry shall be in accordance with AMS2750.

3.4.1 Wire 0.125 inch (3.18 mm) and under in diameter may be continuously heat treated provided that 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.

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3.5 Properties

The product shall conform to the following requirements.

3.5.1 Bars, Wire, Forgings, and Flash Welded Rings

3.5.1.1 Tensile Properties

Shall be as specified in Table 2 for product 4.000 inches (101.60 mm) and under in nominal diameter or distance between parallel sides, determined in accordance with ASTM E8/E8M on specimens as in 4.3.1.2 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.

3.5.1.1.1 Longitudinal requirements in Table 2 apply to specimens from bars, forgings, and wire taken with the axis approximately parallel to the grain flow and to specimens from flash welded rings taken in the circumferential direction.

3.5.1.1.2 Transverse tensile properties in Table 2 apply only to product from which a test specimen not less than 2.50 inches (63.5 mm) in length can be taken.

3.5.1.1.3 Yield strength and reduction of area requirements do not apply to wire under 0.125 inch (3.18 mm) in diameter.

3.5.1.1.4 Tests in the transverse direction are not required from product tested in the longitudinal direction.

Table 2A - Minimum tensile values, inch-pound units

Nominal Diameter or Distance Between Parallel Sides Inches	Tensile Strength ksi	Yield Strength at 0.2% Offset ksi	Elongation in 4D % Long.	Elongation in 4D % L.T.	Elongation in 4D % S.T.	Reduction of Area % Long.	Reduction of Area % L.T.	Reduction of Area % S.T.
Up to 1.500, incl	125	115	10	10	--	25	20	--
Over 1.500 to 2.000, incl	120	110	10	10	--	20	15	--
Over 2.000 to 2.500, incl	120	110	8	8	--	15	15	--
Over 2.500 to 4.000, incl	120	110	8	8	8	15	15	15

Table 2B - Minimum tensile values, SI units

Nominal Diameter or Distance Between Parallel Sides Millimeters	Tensile Strength MPa	Yield Strength at 0.2% Offset MPa	Elongation in 4D % Long.	Elongation in 4D % L.T.	Elongation in 4D % S.T.	Reduction of Area % Long.	Reduction of Area % L.T.	Reduction of Area % S.T.
Up to 38.10, incl	862	793	10	10	--	25	20	--
Over 38.10 to 50.80, incl	827	758	10	10	--	20	15	--
Over 50.80 to 63.50, incl	827	758	8	8	--	15	15	--
Over 63.50 to 101.60, incl	827	758	8	8	8	15	15	15

NOTE: Long. = Longitudinal
L.T. = Long-Transverse
S.T. = Short-Transverse

3.5.1.1.5 Properties of forgings having shapes and dimensions not readily classified by nominal diameter or distance between parallel sides as in Table 1 shall be as agreed upon by purchaser and producer.

3.5.1.1.6 Mechanical property requirements for product outside the range covered by 1.1 shall be agreed upon between purchaser and producer.

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3.5.1.2 Microstructure

Shall be that structure resulting from processing within the alpha-beta field. Microstructure shall conform to 3.5.1.2.1 or 3.5.1.2.2.

3.5.1.2.1 Equiaxed and/or elongated primary alpha in a transformed beta matrix with no continuous network of alpha at prior beta grain boundaries.

3.5.1.2.2 Essentially complete field of equiaxed and/or elongated alpha with no continuous network of alpha at prior beta grain boundaries.

3.5.1.3 Surface Contamination

Except as specified in 3.5.1.3.1 and 3.5.1.3.2, the product shall be free of any oxygen-rich layer, such as alpha case, or other surface contamination, determined by microscopic examination at not lower than 400X magnification or other method agreed upon by purchaser and producer.

3.5.1.3.1 An oxygen-rich layer (see 8.2) not greater than 0.001 inch (0.025 mm) in depth will be permitted on bars other than rounds.

3.5.1.3.2 When permitted by purchaser, forgings and flash welded rings to be machined all over may have an oxygen-rich layer, provided such layer is removable within the machining allowance on the forging or flash welded ring.

3.5.2 Forging Stock

When a sample of stock is forged to a test coupon and annealed as in 3.4, specimens taken from the annealed coupon shall conform to the requirements of 3.5.1.1, and, when specified, 3.5.1.2. If specimens taken from the stock after annealing as in 3.3 conform to the requirements of 3.5.1.1 and, when specified, 3.5.1.2, the tests shall be accepted as equivalent to tests of a forged coupon.

3.5.3 Stock for Flash Welded Rings

When a sample of stock is annealed as in 3.4, specimens taken from the annealed coupon shall conform to the requirements of 3.5.1.1 and, when specified, 3.5.1.2.

3.6 Quality

3.6.1 The product, as received by purchaser, shall be uniform in quality and condition, sound, and free from foreign materials and from imperfections detrimental to usage of the product.

3.7 Tolerances

Bars and wire shall conform to all applicable requirements of AMS2241.

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

3.9 Exceptions

Any exceptions shall be authorized by purchaser and reported as in 4.4.4.

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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

4.2.1 Acceptance Tests

The following requirements are acceptance tests and shall be performed on each heat or lot as applicable:

4.2.1.1 Composition (see 3.1) of each heat.

4.2.1.2 Tensile properties (see 3.5.1.1), microstructure (see 3.5.1.2), and surface contamination (see 3.5.1.3) of each lot of bars, wire, forgings, and flash welded rings.

4.2.1.3 Tolerances (see 3.7) of each lot of bars and wire.

4.2.2 Periodic Tests

Tests of forging stock (see 3.5.2) and of stock for flash welded rings (see 3.5.3) to demonstrate ability to develop required properties are periodic tests and shall be performed at a frequency selected by the producer unless frequency of testing is specified by purchaser:

4.3 Sampling and Testing

Shall be in accordance with AMS2368 and as follows; 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 treat batch:

4.3.1 For Acceptance Tests

4.3.1.1 Composition

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

4.3.1.2 Tensile Properties

One sample from bars, wire, and flash welded rings from each lot. The number, location, and orientation of samples from each lot of forgings shall be as agreed upon by purchaser and producer. If not specified, not less than two specimens shall be taken, one each, from areas of minimum and maximum thickness of the forging.

4.3.1.2.1 Specimens from flash welded rings shall be taken from parent metal not including the weld-heat-affected zone.

4.3.1.3 Microstructure and Surface Contamination

As agreed upon by purchaser and producer. If not specified, at least one specimen from each lot shall be prepared metallographically for examination.

4.3.2 For Periodic Tests

As agreed upon by purchaser and producer.

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4.4 Reports

4.4.1 The producer shall furnish with each shipment a report showing producer identity, country where the metal was melted (e.g., final melt in the case of metal processed by multiple melting operations), results of tests for composition of each heat, the hydrogen content, tensile properties, surface contamination, and microstructure of each lot and state that the product conforms to the other technical requirements. This report shall include the purchase order number, lot number, AMS4930L, product form and mill produced size (and/or part number, if applicable), specific annealing treatment used, and quantity. If forgings are supplied, the part number and the size and melt source of stock used to make the forgings shall also be included.

4.4.2 Report the nominal metallurgically worked cross sectional size and the cut size, if different (see 3.3.1).

4.4.3 The producer of stock for forging or flash welded rings shall furnish with each shipment a report showing the producer identity, country where the metal was melted (e.g., final melt in the case of metal processed by multiple melting operations), results of tests for chemical composition of each heat and for the hydrogen content of each lot. This report shall include the purchase order number, heat number, AMS4930L, size, and quantity.

4.4.4 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 AMS4930L(EXC) because of the following exceptions:” and the specific exceptions shall be listed (see 5.1.1).

4.5 Resampling and Retesting

In accordance with AMS2368, except that for forgings and forging stock, if any specimen used in the above tests fails to meet the specified requirements, disposition of the product may be based on the results of testing three additional specimens for each original nonconforming specimen. Failure of any retest specimen to meet the specified requirements shall be cause for rejection of the product represented. Results of all tests shall be reported.

5. PREPARATION FOR DELIVERY

5.1 Identification

5.1.1 Bars and Wire

In accordance with AMS2809, as applicable. When technical exceptions are taken (see 4.4.4), the material shall be marked with AMS4930L(EXC).

5.1.2 Forgings

In accordance with AMS2808.

5.1.3 Flash Welded Rings and Stock for Forging or Flash Welded Rings

As agreed upon by purchaser and producer.

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.

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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.

8.1.1 This AMS4930L is an editorial correction necessary to correct publication errors in the K revision. In this instance, the change bars are for the convenience of the user in locating areas where technical changes have been made to the J and K revisions of the specification.

8.2 An oxygen-rich layer, such as alpha case, is hard and brittle and results in marked lowering of fatigue properties.

8.3 Terminology for titanium microstructures is presented in AS1814.

8.4 Terms used in AMS are clarified in ARP1917.

8.5 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.

8.6 Purchase documents should specify not less than the following:

AMS4930L
Product form and size (and/or part number, if applicable) of product desired
Quantity of product desired
If forging stock, specify any additional property requirements beyond those reported in 4.4.3 and provide details of how to obtain the desired samples

8.7 Unless otherwise specified, the material producer shall work to the revision of this specification (AMS4930) in effect on the date of order placement. Unless otherwise specified, material manufactured and certified to the immediately previous revision of this specification (AMS4930) may be procured and used until inventory is depleted.

PREPARED BY AMS COMMITTEE “G”