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INTERNATIONAL
400 Commonwealth Drive, Warrendale, PA 15096-0001

AEROSPACE MATERIAL SPECIFICATION

SAE AMS 4934D

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Superseding AMS 4934C

Titanium Alloy, Extrusions and Flash Welded Rings
6Al - 4V
Solution Heat Treated and Aged

(Composition similar to UNS R56400)

1. SCOPE:

1.1 Form:

This specification covers a titanium alloy in the form of extruded bars, tubes, and shapes, flash welded rings, and stock for flash welded rings.

1.2 Application:

These products have been used typically for parts that require high mechanical properties and are machined from product in the heat treated condition, but usage is not limited to such applications. This alloy exhibits high strength-to-weight ratios up to 750 °F (399 °C).

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 canceled and no superseding document has been specified, the last published issue of that document shall apply.

2.1 SAE Publications:

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001 or www.sae.org.

AMS 2245	Tolerances, Titanium and Titanium Alloy Extruded Bars, Rods, and Shapes
MAM 2245	Tolerances, Metric, Titanium and Titanium Alloy Extruded Bars, Rods, and Shapes
AMS 2249	Chemical Check Analysis Limits, Titanium and Titanium Alloys
AMS 2750	Pyrometry
AMS 2809	Identification, Titanium and Titanium Alloy Wrought Products
AMS 7498	Rings, Flash Welded, Titanium and Titanium Alloys

QUESTIONS REGARDING THIS DOCUMENT: (724) 772-7161 FAX: (724) 776-0243
TO PLACE A DOCUMENT ORDER: (724) 776-4970 FAX: (724) 776-0790
SAE WEB ADDRESS: http://www.sae.org

2.2 ASTM Publications:

Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959 or www.astm.org.

ASTM E 8	Tension Testing of Metallic Materials
ASTM E 8M	Tension Testing of Metallic Materials (Metric)
ASTM E 120	Chemical Analysis of Titanium and Titanium Alloys
ASTM E 292	Conducting Time-for-Rupture Notch Tension Tests of 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, determined by analytical methods in accordance with ASTM E 120, ASTM E 1409, or ASTM E 1447, by spectrochemical methods, or by other analytical methods acceptable to purchaser.

TABLE 1 - Composition

Element	min	max	
Aluminum	5.50	6.75	
Vanadium	3.50	4.50	
Iron	--	0.30	
Oxygen	--	0.20	
Carbon	--	0.10	
Nitrogen	--	0.05	(500 ppm)
Hydrogen (3.1.2)	--	0.0125	(125 ppm)
Yttrium	--	0.005	(50 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 may be as large as 0.35 gram when ASTM E 1447 is used for hydrogen determination.

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:

The product shall be supplied in the following condition:

3.3.1 Bars, Tubes, and Shapes: Extruded, solution heat treated, aged, and descaled.

3.3.2 Flash Welded Rings: Fabricated in accordance with AMS 7498, solution heat treated, and aged.

3.3.3 Stock for Flash Welded Rings: As ordered by the flash welded ring manufacturer.

3.4 Heat Treatment:

Bars, tubes, shapes, and flash welded rings shall be solution treated by heating in a suitable atmosphere to a temperature within the range 1700 to 1750 °F (927 to 954 °C), holding at the selected temperature within ±25 °F (±14 °C) for a time commensurate with section thickness, and quenching in water and aged by heating to a temperature within the range 950 to 1050 °F (510 to 566 °C), holding at the selected temperature within ±15 °F (±8 °C) for a suitable time, and cooling as required. Extrusions shall be descaled by wet or dry abrasive blasting, by chemical procedures, or by other methods approved by purchaser. Extrusions may be straightened cold prior to aging or at 950 to 1050 °F (510 to 566 °C) after aging. Pyrometry shall be in accordance with AMS 2750.

3.5 Properties:

Extrusions and flash welded rings shall conform to the following requirements:

3.5.1 Tensile Properties: Shall be as specified in Table 2 (See 8.3) for product 3.000 inches (76.20 mm) and under, in nominal diameter or distance between parallel sides, determined in accordance with ASTM E 8 or ASTM E 8M on specimens selected in either the long-transverse or the longitudinal direction 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 2A - Minimum Tensile Properties, Inch/Pound Units

Nominal Diameter or Least Distance Between Parallel Sides Inches	Tensile Strength ksi	Yield Strength at 0.2% Offset ksi	Elongation in 2 Inches or 4D %	Reduction of Area %
Up to 0.500, incl	160	150	6	12
Over 0.500 to 0.750, incl	155	145	6	12
Over 0.750 to 1.000, incl	150	140	6	12
Over 1.000 to 2.000, incl	140	130	6	12
Over 2.000 to 3.000, incl	130	120	6	12

TABLE 2B - Minimum Tensile Properties, SI Units

Nominal Diameter or Least Distance Between Parallel Sides mm	Tensile Strength MPa	Yield Strength at 0.2% Offset MPa	Elongation in 50.8 mm or 4D %	Reduction of Area %
Up to 12.70, incl	1103	1034	6	12
Over 12.70 to 19.05, incl	1069	1000	6	12
Over 19.05 to 25.40, incl	1034	965	6	12
Over 25.40 to 50.80, incl	965	896	6	12
Over 50.80 to 76.20, incl	896	827	6	12

3.5.1.1 Tests in the transverse direction are not required on product tested in the longitudinal direction.

3.5.2 Compressive Properties: Extrusions shall show a longitudinal compressive yield strength equal to or greater than the specified yield strength in tension.

3.5.3 Room-Temperature Notched Stress-Rupture Properties: Notched cylindrical specimens as in 4.3.2.1 machined to the dimensions shown in ASTM E 292, maintained at room temperature, shall not rupture in less than 5hours while an axial stress of 185 ksi (1276 Mpa) is applied continuously. The initial load may be lower than required to produce a stress of 185 ksi (1276 MPa) and increased to 185 ksi (1276 MPa), based on the initial diameter at root of notch, in increments of 10 ksi (69MPa) at intervals of not less than 5 hours. Tests shall be conducted in accordance with ASTM E 292.

3.5.4 Surface Contamination: The product shall be free of any oxygen-rich layer, such as alpha case, or other surface contamination.

3.6 Quality:

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:

Extrusions shall conform to all applicable requirements of AMS 2245 or MAM 2245.

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 the 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 (3.1) of each heat.

4.2.1.2 Tensile properties (3.5.1) and surface contamination (3.5.4) of each lot of extrusions and flash welded rings.

4.2.2 Periodic Tests: Tests of extrusions and flash welded rings for compressive properties (3.5.2) and room-temperature notched stress-rupture properties (3.5.3) are periodic tests and shall be performed at a frequency selected by the vendor unless frequency of testing is specified by purchaser.

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:

4.3.1 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 and Surface Contamination: At least one sample from each lot.