

	<b>AEROSPACE 航天</b> <b>MATERIAL 材料</b> <b>SPECIFICATION 规范</b>	<b>AMS 4975™</b>	<b>REV.M</b>
		Issued 发行	1966-09
		Revised 修订	2018-06
Titanium Alloy, Bars, Wire, Forgings, and Rings 6.0Al - 4.0V Solution Heat Treated and Aged <b>钛合金, 棒材, 线材, 锻件和环件 6.0Al-4.0V 溶液经过热处理和老化</b> <small>(Composition similar to UNS R564200) (组成类似于 UNS R56400)</small>		Superseding 取代	AMS 4976L

### RATIONALE理由

AMS4965M results from a Five-Year Review and update of this specification that includes the addition of ASTM E2994(3.1), removal of sample size allowance for hydrogen (covered by ASTM E1447) (3.1.1), prohibition of unauthorized exceptions (3.9), adds AMS2368 to Sampling and Resampling (4.3 and 4.5) and revises reporting (4.4) and marking (5.1).

AMS4965M是对本规范进行了五年审查和更新的结果,其中包括添加ASTM E2994(3.1),取消氢的样品量余量(由ASTM E1447覆盖)(3.1.1),禁止未经授权的例外(3.9),在采样和重采样(4.3和4.5)中添加了AMS2368,并修改了报告(4.4)和标记(5.1)。

## 1. SCOPE范围

### 1.1 Form形式

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

本规范涵盖了棒形,线形,锻造和4.000英寸(101.60毫米)的闪光焊环形式的钛合金,公称直径或平行边之间的最小距离以及任何尺寸的锻造和闪光焊环的备料。

### 1.2 Application应用

These products have been used typically for parts which are machined after solution heat treatment and aging and are suitable for parts requiring high strength-to-weight ratios up to moderately elevated temperatures, but usage is not limited to such applications.

这些产品通常用于固溶热处理和时效后加工的零件,适用于需要高强度/重量比直至适度升高的温度的零件,但用途不限于此类应用。

#### 1.2.1

Certain processing procedures and service conditions may cause these products to become subject to stress corrosion cracking; ARP982 recommends practices to minimize such conditions.

某些加工程序和使用条件可能会导致这些产品受到应力腐蚀开裂的影响; ARP982建议采取措施以尽量减少此类情况。

## 2. APPLICABLE DOCUMENTS 规范性引用文件

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.

在采购订单之日有效的下列文件的发行在此指定的范围内构成本说明书的一部分。除非指定了特定的文档发行版，否则供应商可以进行文档的后续修订。当参考文件已被取消且未指定替代文件时，应以该文件的最后发行版本为准。

#### 2.1 SAE Publications SAE出版物

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), [www.sae.org](http://www.sae.org).

可从SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, 电话: 877-606-7323 (美国和加拿大境内) 或724-776-4970 (美国境外), [www.sae.org](http://www.sae.org)。

AMS 2241 Tolerances, Corrosion and Heat-Resistant Steel, Iron Alloy, Titanium, and Titanium Alloy Bars and Wire

公差, 耐腐蚀和耐热钢, 铁合金, 钛和钛合金棒和线

AMS 2249 Chemical Check Analysis Limits, Titanium and Titanium Alloys

化学检查分析限值, 钛和钛合金

AMS 2368 Sampling and Testing of Wrought Titanium Raw Material Except Forgings and Forging Stock

除锻件和锻件外的变形钛原料的取样和测试

AMS 2750 Pyrometry高温计

AMS 2808 Identification, Forgings鉴定, 锻件

AMS 2809 Identification, Titanium and Titanium Alloy Wrought Products

鉴定, 钛及钛合金锻造产品

AMS 498 Rings, Flash Welded, Titanium and Titanium Alloys

环, 闪光焊接, 钛和钛合金

ARP 982 Minimizing Stress-Corrosion Cracking in Wrought Titanium Alloy Products

最小化加工钛合金产品的应力腐蚀开裂

ARP 1917 Clarification of Terms Used in Aerospace Metals Specifications

澄清航空金属规范中使用的术语

ARP 1814 Terminology for Titanium Microstructures

钛微结构术语

AS6279 Industry Standard Practices for Production, Distribution, and Procurement of Metal Stock

金属库存的生产, 分配和采购的行业标准规范

#### 2.2 ASTM Publications ASTM出版物

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, [www.astm.org](http://www.astm.org).

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ASTM E 8 Tension Testing of Metallic Materials金属材料拉伸试验

ASTM E 21 Elevated Temperature Tension Tests of Metallic Materials

金属材料的高温拉伸试验

ASTM E 139 Conducting Creep, Creep-Rupture, and Stress-Rupture Tests of Metallic Materials

进行金属材料的蠕变, 蠕变破裂和应力破裂测试

ASTM E 292 Conducting Time-for-Rupture Notch Tension Tests of Materials

进行材料的断裂时间缺口拉伸测试

ASTM E 1409 Determination of Oxygen and Nitrogen in Titanium and Titanium Alloys by the Inert Gas Fusion Technique 通过惰性气体融合技术测定钛和钛合金中的氧和氮

ASTM E 1447 Determination of Hydrogen in Titanium and Titanium Alloys by the Inert Gas Fusion Thermal Conductivity/Infrared Detection Method

通过惰性气体融合法测定钛和钛合金中的氢热导率/红外检测方法

ASTM E 1941 Standard Test Method for Determination of Carbon in Refractory and Reactive Metals and Their Alloys

耐火和反应性金属及其合金中碳的测定标准测试方法

ASTM E 2371 Standard Test Method for Analysis of Titanium and Titanium Alloys by Atomic Emission Plasma Spectrometry

通过原子发射等离子体光谱法分析钛和钛合金的标准测试方法

## 2.2 ASTM Publications ASTM出版物

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, [www.astm.org](http://www.astm.org).

可从P.O Barr Harbor Drive 100号的ASTM International获得。 邮箱C700, West Conshohocken, PA 19428-2959, 电话: 610-832-9585, [www.astm.org](http://www.astm.org)。

ASTM E3 Preparation of Metallographic Specimens

金相试样的制备

ASTM E8/ E8M Tension Testing of Metallic Materials

金属材料的拉伸试验

ASTM E399 Plane-Strain Fracture Toughness of Metallic Materials

金属材料的平面应变断裂韧性

ASTM E539 Analysis of Titanium Alloys by X-Ray Fluorescence Spectrometry

X射线荧光光谱法分析钛合金

ASTM E1409 Determination of Oxygen and Nitrogen in Titanium and Titanium Alloys by Inert Gas Fusion

惰性气体熔融法测定钛及钛合金中的氧和氮

ASTM E1447 Determination of Hydrogen in Titanium and Titanium Alloys by the Inert Gas Fusion Thermal Conductivity/Infrared Detection Method

惰性气体熔融热导率/红外检测法测定钛及钛合金中的氢

ASTM E1941 Determination of Carbon in Refractory and Reactive Metals and Their Alloys by Combustion Analysis

燃烧分析法测定难熔活性金属及其合金中的碳。

ASTM E2371 Analysis of Titanium and Titanium Alloys by Direct Current Plasma and Inductively Coupled Plasma Atomic Emission Spectrometry

直流等离子体和电感耦合等离子体原子发射光谱法分析钛和钛合金

ASTM E2994 Analysis of Titanium and Titanium Alloys by Direct Current Plasma and Inductively Coupled Plasma Atomic Emission Spectrometry

直流等离子体和电感耦合等离子体原子发射光谱法分析钛和钛合金

## 3. TECHNICAL REQUIREMENTS 技术要求

### 3.1 Composition 组成

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.

应符合表1所示的重量百分比；碳的含量应根据ASTM E1941, ASTM E1447的氢, ASTM E1409的氧和氮以及ASTM E539, ASTM E2371或ASTM E2994的其他元素确定。如果购买者可以接受, 则可以使用其他分析方法。

**TABLE 1 – COMPOSITION表1-组合物**

中国	Element 元素	Min 最小值	Max 最大值
Al	Aluminum	5.50	6.75
V	Vanadium	3.50	4.50
Fe	Iron	--	0.30
O	Oxygen	--	0.20
C	Carbon	--	0.08
Ni	Nitrogen	--	0.05 (500ppm)
H	Hydrogen (3.1.1)	--	0.0125 (125ppm)
Y	Yttrium (3.1.2)	--	0.005 (50 ppm)
单个	Other Elements, each (3.1.2)	--	0.1
总和	Other Elements, total (3.1.2)	--	0.40
钛	Titanium	remainder 余	

3.1.1 Hydrogen content of forgings may be as high as 0.0150 (150 ppm).

锻件的氢含量可高达0.0150 (150ppm)。

3.1.2 Determination not required for routine acceptance.

常规验收不需要测定。

3.1.3 Check Analysis 检查分析

Composition variations shall meet the requirements of AMS2249; no variation over maximum will be permitted for yttrium, if analyzed.

成分变化应符合AMS2249的要求；如果进行分析, 则钇的最大含量不允许有变化。

3.2 Melting Practice 熔化实践

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.

合金应多次熔化。第一次熔炼应通过真空可消耗电极, 非消耗电极, 电子束冷炉床或等离子弧冷炉床熔化方法进行。随后的熔体应使用真空电弧重熔 (VAR) 进行。在最终的熔体循环中不允许添加合金。

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.

用于非消耗性电极熔化的气氛应为真空, 或者应为绝对压力不超过1000毫米汞柱的氩气和/或氦气。

3.2.2 The electrode tip for nonconsumable electrode melting shall be water-cooled copper.

不消耗电极熔化的电极头应为水冷铜。

3.3 Condition 条件

The product shall be supplied in the following condition:

产品应在以下条件下提供:

3.3.1 Bars 棒 (条)

Hot finished with or without subsequent cold reduction, solution heat treated, aged, and descaled. 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 cut from plate.

进行热精加工，然后再进行或不进行冷轧，固溶热处理，时效和除鳞。在进行任何矫直，尺寸定径或表面精加工操作之前，应先通过冶金加工工序将产品加工至最终厚度/直径。禁止从板上切下钢筋。

### 3.3.2 Wire 线

Cold drawn, solution heat treated, aged, and descaled.

冷拔，固溶热处理，时效和除鳞。

### 3.3.3 Forgings and Flash Welded Rings 锻件和闪光焊环

Solution heat treated, aged, and descaled. 溶液经过热处理，老化和除氧化皮。

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.

除非买方零件图上有规定或允许，否则不得提供闪光焊接环。提供时，应根据AMS7498制造环。

### 3.3.4 Stock for Forging or Flash Welded Rings

锻造或闪光焊接环的坯料

As ordered by the forging or flash welded ring manufacturer.

按照锻造或闪光焊环制造商的订购。

## 3.4 Heat Treatment

Bars, wire, forgings, and flash welded rings shall be solution heat treated by heating in a suitable atmosphere to 1750 °F ± 25 °F (954 °C ± 14 °C), holding at heat for 1 to 2 hours, and quenching in agitated water, and aged by heating to a temperature within the range 900 to 1150 °F (482 to 621 °C), holding at the selected temperature within ±15 °F (±8 °C) for 4 to 8 hours, and cooling in air.

Pyrometry shall be in accordance with AMS2750.

棒，线，锻件和闪光焊环应在适当的气氛中加热到1750° F±25° F（954° C±14° C）进行固溶热处理，加热1至2小时，然后淬火 在搅拌水中，加热至900至1150° F（482至621° C）范围内的温度，在所选温度下保持在±15° F（±8° C）的温度下保持4至8个小时，并且在空气中冷却。高温测定应符合AMS2750。

## 3.5 Properties 属性

The product shall conform to the following requirements:

产品应符合以下要求：

### 3.5.1 Bars, Wire, Forgings, and Flash Welded Rings

棒，线，锻件和闪光焊接环

3.5.1.1 Shall be as shown in Table 2 for round, square, and hexagonal bars and wire, forgings, and flash welded rings and as shown in Table 3 for rectangular bars and wire. Properties of forgings having shapes and dimensions not readily classified by nominal diameter or distance between parallel sides as in Table 2 shall be as agreed upon by purchaser and producer.

对于圆形，方形和六角形的棒材和线材，锻件和闪光焊环，应如表2所示；对于矩形棒材和线材，应如表3所示。形状和尺寸不容易按表2的公称直径或平行边之间的距离分类的锻件，应经买卖双方同意。

#### 3.5.1.1.1 Tensile Properties 拉伸性能

Shall be determined in accordance with ASTM E8/E8M with the rate of strain set at 0.005

inch/inch/min (0.005 mm/mm/min) and maintained within a tolerance of ±0.002 inch/inch/min

(0.002 mm/mm/min) through the 0.2% offset yield strain.

应根据ASTM E8 / E8M确定, 应变率设置为0.005英寸/英寸/分钟(0.005毫米/毫米/分钟), 并保持在±0.002英寸/英寸/分钟(0.002毫米/毫米/分钟)通过0.2%的偏移屈服应变。

3.5.1.1.2 Tensile property requirements apply in both the longitudinal and transverse directions. Transverse properties apply only to product where a transverse tensile specimen not less than 2.50 inches (63.5 mm) in length can be obtained, but tests in the transverse direction are not required on product tested in the longitudinal direction.

拉伸性能要求在纵向和横向均适用。 横向性能仅适用于可获得长度不小于2.50英寸(63.5毫米)的横向拉伸试样的产品, 但对纵向测试的产品无需进行横向测试。

Table 2A - Round, square, and hexagonal bars and wire, forgings,

and flash welded rings minimum tensile properties, inch/pound units

表2A-圆形, 方形和六角形的棒材和金属丝, 锻件和闪光焊环的最小拉伸性能, 英寸/磅单位

Nominal Diameter or Least Distance Between Parallel Sides-inches	公称直径 mm	Tensile Strength ksi	抗拉强度 MPa	Yield Strength at 0.2% Offset ksi	屈服强度 MPa	Elongation (1) in 2 inches or 4D % L	Elongation (1) in 2 inches or 4D % T	Reduction of Area % L
Up to 0.500, incl	≤12.7	165	1138	155	1069	10	--	20
Over 0.500 to 1.000, incl	>12.7≤25.4	160	1103	150	1034	10	--	20
Over 1.000 to 1.500, incl	>25.4≤38.1	155	1069	145	1000	10	--	20
Over 1.500 to 2.000, incl	>38.1≤50.8	150	1034	140	965	10	--	20
Over 2.000 to 3.000, incl	>50.8≤76.2	140	965	130	896	10	8	20
Over 3.000 to 4.000, incl	>76.2≤101.6	130	896	120	827	8	6	20

1 For forgings, elongation shall be not lower than 8% (L) and 6% (T) for all sizes.

1对于锻件, 所有尺寸的伸长率均不得低于8% (L) 和6% (T)。

Table 3B - Rectangular bar and wire minimum tensile properties, SI units

表3B-矩形钢筋的最小拉伸性能, SI单位

标称厚度 mm	标称宽度 mm	Tensile Strength ksi	抗拉强度 MPa	Yield Strength at 0.2% Offset ksi	屈服强度 MPa	Elongation (1) in 2 inches or 4D % L	Elongation (1) in 2 inches or 4D % T	Reduction of Area % L
≤12.70	>12.70≤203.20	160	1103	150	1034	10	10	25
>12.70≤25.40	>25.40≤101.60	155	1069	145	1000	10	10	20
	>101.60≤203.20	150	1034	140	965	10	10	20
>25.40≤38.10	>38.10≤101.60	150	1034	140	1000	10	10	20
	>101.60≤203.20	145	1000	135	931	10	10	20
>38.10≤50.80	>50.80≤101.60	145	1000	135	931	10	10	20
	>101.60≤203.20	140	965	130	896	10	10	20
>50.80≤76.20	>76.20≤203.20	135	931	125	862	10	8	20
>76.20≤101.60	>101.60≤203.20	130	896	120	827	8	6	20

### 3.5.1.2 Fracture Toughness Properties 断裂韧性

When specified (see 8.6), the product shall be subjected to fracture toughness testing. Method of test, specimen orientation, and standards for acceptance shall be as agreed upon by purchaser and producer. Recommended method of test is ASTM E399.

规定时（见8.6），应对产品进行断裂韧性测试。试验方法，试样方向和验收标准应经买方和生产者同意。推荐的测试方法是ASTM E399。

#### 3.5.1.3 Microstructure 微观结构

Shall be that structure resulting from processing within the alpha-beta phase field.

Microstructure shall conform to 3.5.1.3.1 or 3.5.1.3.2.

该结构应是在alpha-beta相场中进行处理后得到的。

微观结构应符合3.5.1.3.1或3.5.1.3.2。

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

在转换后的Beta矩阵中等轴和/或细长的初等alpha，在先前的beta晶界处没有连续的alpha网络。

3.5.1.3.2 Primary alpha in an aged transformed beta matrix.

老化的转化Beta矩阵中的主要alpha。

#### 3.5.1.4 Surface Contamination 表面污染

Except as specified in 3.5.1.4.1 and 3.5.1.4.2, the product shall be free of any oxygen-rich layer, such as alpha case, or other surface contamination, determined by examination of a metallographic cross section at 400X minimum magnification or by other method acceptable to purchaser.

除3.5.1.4.1和3.5.1.4.2规定外，产品应无任何富氧层，例如 $\alpha$ 壳或其他表面污染，这是通过以400倍最小放大倍数检查金相截面而确定的。或通过买方可以接受的其他方法。

3.5.1.4.1 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.

除圆形以外的其他棒材上允许的深度不超过0.001英寸（0.025毫米）的富氧层（见8.2）。

3.5.1.4.2 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.

如果购买者允许，则要进行整体加工的锻件和闪光焊环可具有富氧层，条件是该层可在锻造或闪光焊环的加工余量内移除。

#### 3.5.2 Forging Stock 锻件

When a sample of stock is forged to a test coupon and heat treated as in 3.4, specimens taken from the heat treated coupon shall conform to the requirements of 3.5.1.1, 3.5.1.2 when specified, 3.5.1.3, and 3.5.1.4. If specimens taken from the stock after heat treatment as in 3.4 conform to the requirements of 3.5.1.1, 3.5.1.2 when specified, 3.5.1.3, and 3.5.1.4, the tests shall be accepted as equivalent to tests of a forged coupon.

当将存货样品锻造成试样并按3.4进行热处理时，从热处理的试样中取出的试样应符合3.5.1.1、3.5.1.2（规定），3.5.1.3和3.5.1.4的要求。如果按3.4的规定从热处理后的坯料中取出的样品符合3.5.1.1、3.5.1.2和3.5.1.3和3.5.1.4的要求，则该试验应等同于锻造试样的试验。

#### 3.5.3 Stock for Flash Welded Rings 闪光焊环库存

Specimens taken from the stock after heat treatment as in 3.4 shall conform to the requirements of 3.5.1.1, 3.5.1.2 when specified, 3.5.1.3, and 3.5.1.4.

按照3.4的规定，从热处理后的坯料中取出的试样应符合3.5.1.1、3.5.1.2（规定时），3.5.1.3和3.5.1.4的要求。

#### 3.6 Quality 质量

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.

购买者收到的产品应在质量和状态，声音上均一，并且没有异物和不损害产品使用的缺陷。

3.6.1 Grain flow of die forgings, except in areas which contain flash-line end grain, shall follow the general contour of the forgings showing no evidence of reentrant grain flow.

模锻件的晶粒流，除在含有闪边末晶粒的区域外，应遵循锻件的总体轮廓，没有任何凹痕的迹象。

### 3.7 Tolerances 公差范围

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

钢筋应符合AMS2241的所有适用要求。

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

金属库存的生产，分配和采购应遵守AS6279。

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

任何例外均应由买方授权并按照4.4.3的规定进行报告。

## 4. QUALITY ASSURANCE PROVISIONS 质量保证条款

### 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.

产品的生产者应提供所有样品以进行生产者测试，并对所有要求的测试负责。买方保留采样和执行任何必要的确认测试的权利，以确保产品符合指定要求。

### 4.2 Classification of Tests 测试分类

#### 4.2.1 Acceptance Tests 验收测试

The following requirements are acceptance tests and shall be performed on each heat or lot as applicable: 以下要求是验收试验，并应在适用的每个热量或批次上进行：

4.2.1.1 Composition (3.1) of each heat. 每种热的组成（3.1）。

4.2.1.2 Hydrogen content (3.1), tensile properties (3.5.1.1), fracture toughness (3.5.1.2) when specified, microstructure (3.5.1.3), and surface contamination (3.5.1.4) of each lot of bars, wire, forgings, and flash welded rings.

规定的氢含量（3.1），拉伸性能（3.5.1.1），断裂韧性（3.5.1.2），每批钢筋，焊丝，锻件和铸件的显微组织（3.5.1.3）和表面污染（3.5.1.4）闪光焊接环。

4.2.1.3 Tolerances (3.7) of each bar and wire.

每个条和线的公差（3.7）。

#### 4.2.2 Periodic Tests 定期测试

Ability of forging stock (3.5.2) and stock for flash welded rings (3.5.3) to develop required properties, and grain flow of die forgings (3.6.1), are periodic tests and shall be performed at a frequency selected by the producer unless frequency of testing is specified by purchaser.

锻造坯料（3.5.2）和快速焊接环坯料（3.5.3）形成所需性能的能力以及模锻件的颗粒流动性（3.6.1）是定期测试，并且应以钢坯选择的频率进行。生产者，除非买方指定测试频率。

### 4.3 Sampling and Testing 抽样和测试

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 solution heat treated and aged in the same heat treat batch.

应符合AMS2368及以下标准；来自同一时间，同一时间进行热处理，并在同一热处理批次中进行热处理和老化的固溶体的所有标称尺寸的所有产品都应批量生产。

#### 4.3.1 For Acceptance Tests 验收检测



#### 4.3.1.1 Composition 成分

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

每种热量取一个样品，除了要进行氢气测定外，在热处理和化学处理完成后，每批样品应取一个样品。

#### 4.3.1.2 Tensile Properties 拉伸性能

One or more sample(s) from bars, wire, and flash welded rings from each lot. One longitudinal specimen from each lot of forgings from a section having maximum thickness and from a section having minimum thickness.

每个批次的棒材，金属丝和闪光焊环中的一个或多个样品。来自每批锻件的一个纵向试样来自厚度最大的部分和厚度最小的部分。

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

闪光焊环的试样应从母材上切下，不包括焊接热影响区。

#### 4.3.1.3 Other Requirements 其他需求

One or more specimens from each lot for microstructure and surface contamination shall be prepared in accordance with ASTM E3. Machined or centerless ground bar to be used as forging stock need not be checked for surface contamination.

应根据ASTM E3准备每批中的一个或多个样品的微观结构和表面污染。无需检查用作锻件的机加工或无心接地棒的表面污染。

### 4.4 Reports 报告

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 and for the hydrogen content, tensile properties, fracture toughness properties (when specified), and results of surface examination, as applicable 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, AMS4965M, product form and mill produced size (and/or part number, if applicable) specific aging heat 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. The producer of stock for forging or flash welded rings shall furnish with each shipment a report showing the 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, AMS4965M, size, and quantity.

生产者应在每次装运时提供一份报告，以显示生产者身份，金属熔化的国家（例如，对于通过多次熔化操作处理的金属而言的最终熔化），每种热量的组成和氢含量的测试结果，拉伸性能，断裂韧性性能（如果指定）和表面检查结果（适用于每批产品），并声明产品符合其他技术要求。该报告应包括所使用的特定时效热处理的采购订单号，热和批号，AMS4965M，产品形式和轧机生产的尺寸（和/或零件号，如果适用）以及数量。如果提供了锻件，则还应包括用于制造锻件的零件号，尺寸和熔体来源。锻造或闪光焊接环的坯料生产商应在每次装运时提供一份报告，该报告应显示每种热的化学成分和每批氢含量的测试结果。该报告应包括采购订单号，热号，AMS4965M，尺寸和数量。

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

报告不同的冶金加工横截面尺寸和切割尺寸（请参见3.3.1）。

4.4.3 When material produced to this specification is beyond the sizes allowed in the scope or tables, or other 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 AMS4965M(EXC) because of the following exceptions:" and the specific exceptions shall be listed

如果按照本规范生产的材料超出了范围或表中允许的尺寸，或者购买者授权的其他例外适用于第3节中列出的技术要求，则报告应包含以下声明：“该材料经认证为AMS4965M（EXC）由于以下例外：”，并且应列出特定的例外

#### 4.5 Resampling and Retesting 重采样和重新测试

Shall be in accordance with AMS2368 and the following; if any specimen used in the above tests fails to meet 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 specified requirements shall be cause for rejection of the product represented. Results of all tests shall be reported.

应符合AMS2368及以下标准；如果上述测试中使用的任何样品均未达到规定要求，则可根据每个原始不合格样品的另外三个样品的测试结果来确定产品的处置方式。任何再测试样品均未达到规定要求，将导致所代表产品被拒收。所有测试结果均应报告。

### 5. PREPARATION FOR DELIVERY 交货准备

#### 5.1 Identification 产品鉴别

Shall be as follows: 如下：

##### 5.1.1 Bars and Wire 条和线

In accordance with AMS2809. When technical exceptions are taken (see 4.4.3), the material shall be marked with AMS4965M(EXC).

符合AMS2809。采取技术例外措施时（请参见4.4.3），材料应标记为AMS4965M（EXC）。

##### 5.1.2 Forging 锻件

In accordance with AMS2808, except that characters shall be applied using a marking fluid whose residual shall contain no more than traces of halogen bearing compound.

根据AMS2808，除了应使用标记液施加字符外，其残留物不得超过痕量的含卤素化合物。

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

闪光焊环和锻造料或闪光焊环

#### 5.2 Packaging 打包

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.

产品应根据商业惯例并符合与产品处理，包装和运输有关的适用规则和法规，以准备装运，以确保承运人接受并安全交付。

### 6. ACKNOWLEDGMENT 确认

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

确认订单时，供货方应在所有报价单上注明本标准编号以及版次。

### 7. REJECTIONS 拒收

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

产品不符合要求或者经采购方同意修补之后仍不符合要求的，可拒收。

## 8. NOTES 注释说明

8.1 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.

位于左边距的更改条 (I) 是为了方便用户查找对本文档的上一期进行技术修订而不是编辑更改的区域。文档标题左侧的 (R) 符号表示文档的完整修订版, 包括技术修订版。原始出版物或仅包含编辑更改的文档中都不会使用更改条和 (R)。

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

富氧层, 例如  $\alpha$  壳, 是硬且脆的, 并导致疲劳性能的显著降低。

8.3 Terms used in AMS are clarified in ARP1917.

ARP1917中阐明了AMS中使用的术语。

8.4 Terminology relating to titanium microstructures is presented in AS1814.

AS1814中介绍了与钛微结构有关的术语。

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.

以英寸/磅为单位的尺寸和特性以及华氏温度是主要因素; 以 SI 单位表示的尺寸和特性以及摄氏温度以基本单位的近似等效值显示, 仅供参考。

8.6 Purchase documents should specify not less than the following:

采购文件应指定不少于以下内容:

AMS4965M

Product form and size (and/or part number, if applicable) of product desired

Quantity of product desired

If fracture toughness is required (see 3.5.1.2) and method of test, specimen orientation, and standards for acceptance

AMS4965M

所需产品的产品形式和尺寸 (和/或部件号, 如果适用)

所需产品数量

如果要求断裂韧性 (见3.5.1.2) 和试验方法, 试样方向和验收标准

8.7 Unless otherwise specified, the material producer shall work to the revision of this specification (AMS4965) in effect on the date of order placement. Unless otherwise specified, material manufactured and certified to the immediately previous revision of this specification (AMS4965) may be procured and used until inventory is depleted.

除非另有说明, 否则材料生产商应努力对自下订单之日起生效的本规范 (AMS4965) 进行修订。除非另有说明, 否则可以采购和使用经制造且已通过本规范的上一修订版本 (AMS4965) 的材料, 直到耗尽库存为止。

8.8 Similar Specifications 相似规格

AMS-T-9047 and MIL-T-9047, Alpha-Beta Titanium Alloy Ti-6Al-4V

AMS-T-9047和MIL-T-9047, Alpha-Beta钛合金Ti-6Al-4V

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由AMS委员会 "G" 准备