SAE Aerospace
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AEROSPACE MATERIAL SPECIFICATION

SAE AMS2368 | REV. C

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Superseding AMS2368B

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

RATIONALE

AMS2368C results from a Five Year Review and update of this specification.

1. SCOPE

1.1 Purpose

This specification provides a standard set of procedures for sampling and testing to meet the requirements of material specifications for wrought titanium and titanium alloy products except forgings and forging stock. It is applicable to the extent specified in a material specification.

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

AMS2249 Chemical Check Analysis Limits, Titanium and Titanium Alloys

AMS2631 Ultrasonic Inspection, Titanium and Titanium Alloy Bar and Billet

AMS2632 Inspection, Ultrasonic, of Thin Materials, 0.50 inch (12.7 mm) and Under in Cross-Sectional Thickness

AMS2634 Ultrasonic Inspection, Thin Wall Metal Tubing

AMS2801 Heat Treatment of Titanium Alloy Parts

TO PLACE A DOCUMENT ORDER: Tel: 877-606-7323 (inside USA and Canada)
Tel: +1 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: CustomerService@sae.org
SAE WEB ADDRESS: http://www.sae.org

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 E 8 / E 8M	Tension Testing of Metallic Materials
ASTM E 10	Brinell Hardness of Metallic Materials
ASTM E 18	Rockwell Hardness of Metallic Materials
ASTM E 21	Elevated Temperature Tension Tests for Metallic Materials
ASTM E 112	Determining Average Grain Size
ASTM E 139	Conducting Creep, Creep-Rupture, and Stress-Rupture Tests of Metallic Materials
ASTM E 290	Bend Testing of Material for Ductility
ASTM E 292	Conducting Time for Rupture Notch Tension Tests of Materials
ASTM E 384	Knoop and Vickers Hardness of Materials
ASTM E 399	Linear-Elastic Plane-Strain Fracture Toughness K_{IC} of Metallic Materials
ASTM E 1304	Plane-Strain (Chevron Notch) Fracture Toughness of Metallic Materials
ASTM E 539	X-Ray Fluorescence Spectrometric Analysis of 6Al-4V Titanium Alloy
ASTM E 1409	Determination of Oxygen and Nitrogen 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/Infrared Detection Method
ASTM E 1450	Tension Testing of Structural Alloys in Liquid Helium
ASTM E 1941	Determination of Carbon in Refractory and Reactive Metals and Their Alloys by Combustion Analysis
ASTM E 2371	Analysis of Titanium and Titanium Alloys by Atomic Emission Plasma Spectrometry

3. TECHNICAL REQUIREMENTS

3.1 General

3.1.1 Conformance

The vendor shall be responsible for furnishing products which conform to all requirements of the material specification. Sampling and testing for any requirements not covered herein or in the material specification shall be optional, unless otherwise specified by purchaser.

3.1.2 Lot

A lot shall be all product of the same nominal size and shape, from the same ingot (heat), processed in the same manner, and presented for vendor's inspection at one time. When processing includes heat treatment, product shall have been heat treated in one or more furnaces in the same load or sequentially heat treated in a series of furnaces (See 8.2) or a continuous furnace over not more than 48 hours providing there is no interruption in operations or change in furnace temperature setting(s), charge rate, or racking pattern.

3.1.3 Sampling and Testing

3.1.3.1 Composition

Sampling and testing shall conform to 3.2.3.

3.1.3.2 Other Properties

Except as otherwise specified below, at least one test of each type shall be performed on specimens, located and oriented in accordance with 3.1.3.2.1 and 3.1.3.2.2, from a random sample from each lot.

3.1.3.2.1 Location of Specimens

When practical, tests shall be performed on full thickness specimens. When the product is too thick for testing its full thickness, the center of the specimen shall be located at the center of the thickness of the product for sizes less than or equal to 1.5 inches (38 mm) and at the mid-radius or quarter thickness for sizes greater than 1.5 inches (38 mm) or least difference between parallel sides. Short transverse specimens shall be located at the middle of the width of the product. Transverse specimens for rounds shall be radial or tangential (or mid-radius chord) for product that a tensile specimen not less than 2.50 inches (63.5 mm) in length can be obtained. Specimens from flash welded rings shall not include the weld or heat affected zone (See 8.5).

3.1.3.2.2 Orientation of Specimens

Shall be tangential for flash welded rings and longitudinal for other products unless a specific test direction is referenced in the material specification, then the test direction listed in the material specification takes precedence. Stock for flash welded rings shall be tested longitudinally.

3.2 Tests (In alphabetical order)

3.2.1 Bending

3.2.1.1 Bend tests shall be performed using the U-channel or free bend procedure in accordance with ASTM E 290. In case of dispute, the free bend procedure shall govern.

3.2.1.2 The axis of bend shall be parallel to the direction of rolling (transverse specimen).

3.2.1.3 Width of specimens shall be 10 times the nominal thickness of the product or 1 inch (25 mm), whichever is greater, except that for free bend tests the width need not be greater than 1 inch (25 mm).

3.2.2 Coiling

Tests shall be performed on two samples from each lot.

3.2.3 Composition

3.2.3.1 Consumable Melted Ingots and Cold Hearth Melted Ingots

Composition, except for hydrogen, shall be determined at the top and bottom of each ingot in accordance with ASTM E 1941 for carbon, ASTM E 1409 for oxygen and nitrogen, and other elements by other analytical methods in accordance with ASTM E 2371 (and ASTM E 539 for Ti 6Al - 4V). Other analytical methods can be used if acceptable to purchaser. Each analysis shall meet the composition requirements; the reported composition shall be the average of the analyses. Hydrogen content shall be determined, in accordance with ASTM E 1447 or other method acceptable to purchaser, on a random sample from each lot after completion of all thermal and chemical processing.

3.2.3.1.1 For hydrogen analysis, conducted in accordance with ASTM E 1447, sample size may be as large as 0.35 gram.

3.2.3.2 Nonconsumable Melted Ingots

Composition shall be determined as specified in 3.2.3.1; it shall also be determined at three additional ingot locations; the middle, midway between the middle and the bottom, and midway between the middle and the top.

3.2.3.3 Check Analysis

Composition variations shall meet the requirements of AMS2249.

3.2.4 Creep

Tests shall conform to ASTM E 139.

3.2.5 Fracture Toughness

When specified, the product shall be subject to fracture toughness testing on specimens from two locations oriented in the TL direction. There is no recognized standard for fracture toughness testing of sheet, strip, and plate under ½ inch thick. Method of test and acceptance standards shall be as specified by the purchaser. Procedure for thicker product shall conform to ASTM E 399 or, when permitted by purchaser, ASTM E 1304.

3.2.6 Average Grain Size

Shall be determined by comparison of a polished and etched longitudinal specimen in accordance with the chart in ASTM E 112.

3.2.7 Hardness

Shall be determined in accordance with ASTM E 10 or ASTM E 18.

3.2.8 Heat Treatment Response

Heat treatment of samples, to confirm that product will develop required properties, shall conform to AMS2801.

3.2.9 Microstructure

Shall be determined by examination of a polished and etched longitudinal specimen at 100X magnification. Round bar may be examined immediately prior to grinding or turning to final size.

3.2.10 Stress Rupture, Notched

Tests shall conform to ASTM E 292.