

AEROSPACE MATERIAL SPECIFICATION

SAE AMS4998D

Issued 1977-03
Revised 2008-11

Superseding AMS4998C

Titanium Alloy Powder
6Al - 4V

(Composition similar to UNS R56400)

RATIONALE

AMS4998D results from a Five Year Review and update of this specification.

1. SCOPE

1.1 Form

This specification covers a titanium alloy in the form of prealloyed powder.

1.2 Application

This powder has been used typically for compaction into net or near net shapes and into forging stock in the form of billets or preforms, but usage is not limited to such applications.

1.3 Safety - Hazardous Materials

While the materials, methods, applications, and processes described or referenced in this specification may involve the use of hazardous materials, this specification does not address the hazards that may be involved in such use. It is the sole responsibility of the user to ensure familiarity with the safe and proper use of any hazardous materials and to take necessary precautionary measures to ensure the health and safety of all personnel involved.

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

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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 B 214	Sieve Analysis of Granular Metal Powders
ASTM B 215	Sampling Metal Powders
ASTM B 311	Density Determination for Powder Metallurgy (P/M) Materials Containing Less than Two Percent Porosity
ASTM B 527	Determination of Tap Density of Metallic Powders and Compounds
ASTM E 539	X-Ray Emission 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 1742	Radiographic Examination
ASTM E 1941	Determination of Carbon in Refractory and Reactive Metals and Their Alloys
ASTM E 2371	Analysis of Titanium and Titanium Alloys by Atomic Emission Plasma 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 E 1941, hydrogen in accordance with ASTM E 1447, oxygen and nitrogen in accordance with ASTM E 1409, and other elements in accordance with ASTM E 539 and ASTM E 2371. Other analytical methods may be used if acceptable to the purchaser.

TABLE 1 - COMPOSITION

Element	min	max
Aluminum	5.50	6.75
Vanadium	3.50	4.50
Oxygen	0.13	0.18
Iron	--	0.30
Carbon	--	0.10
Tin (3.1.1)	--	0.10
Molybdenum (3.1.1)	--	0.10
Copper (3.1.1)	--	0.10
Manganese (3.1.1)	--	0.10
Zirconium	--	0.10
Nitrogen	--	0.04 (400 ppm)
Hydrogen (3.1.2)	--	0.012 (120 ppm)
Other Elements, total (3.1.3)	--	0.20
Titanium	remainder	

3.1.1 Tin plus molybdenum plus copper plus manganese shall not exceed 0.20%.

3.1.2 Sample size may be as large as 0.35 gram.

3.1.3 Determination not required for routine acceptance.

3.1.4 Check Analysis

Composition variations shall meet the applicable requirements of AMS2249.

3.2 Powder Production

Powder shall be produced in lots by a suitable process in an appropriate noncontaminating atmosphere. A lot shall be all powder produced from common feed material (an ingot, billet, or cast electrode from a common ingot) in one production run of the equipment. When approved by purchaser, a lot may be the powder produced from common feed material in a series of consecutive runs in the same equipment under essentially the same fixed parameters; the powder from all such runs shall be thoroughly blended. The total weight of powder blended in one lot shall not exceed 10,000 pounds (4536 kg).

3.2.1 Ingot from which powder is made shall be produced by triple melting using consumable electrode practice; at least one of the melting cycles shall be under vacuum. The final melting may be performed during powder production when a fusion method is used to produce powder.

3.3 Condition

As manufactured.

3.4 Properties

The powder shall conform to the following requirements:

3.4.1 Particle Size

The particles shall pass through a No. 35 (500 μm) sieve, with not more than 5% by weight passing through a No. 325 (45 μm) sieve, determined in accordance with ASTM B 214 or other method acceptable to purchaser.

3.4.2 Powder Tap Density

When specified, shall be not less than 60% of the density value obtained in 3.4.3, determined in accordance with ASTM B 527 or other procedure acceptable to purchaser.

3.4.3 Powder Compaction and Evaluation

A sample, weighing not less than 0.75 pound (340 grams), from each powder lot shall be hot-compacted using a method that will not contaminate the powder particles during compaction. Each compacted sample shall have a density, determined in accordance with ASTM B 311, not less than 0.1594 pounds per cubic inch (4.412 Mg/m^3) and shall be divided into panels or discs totaling not less than 18 square inches (116 cm^2) in area with thickness of 0.200 inch ± 0.015 , -0.025 (5.08 mm, ± 0.38 , -0.64). Panels shall be free of any deleterious high- or low-density inclusions, except as provided by standards agreed upon by purchaser and vendor, determined by radiographic examination in accordance with ASTM E 1742.

3.5 Quality

The powder, as received by purchaser, shall be uniform in color and quality, dry, free from agglomerated masses, and free from foreign materials and from imperfections detrimental to its performance during compaction or in resultant preforms or forgings.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for Inspection

The vendor of powder 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 powder conforms to specified requirements.

4.2 Classification of Tests

All technical requirements are acceptance tests and preproduction tests and shall be performed prior to or on the initial shipment of powder to a purchaser, on each lot, when a change in ingredients and/or processing requires reapproval as in 4.4.2, and when purchaser deems confirmatory testing to be required.

4.3 Sampling and Testing

Shall be in accordance with ASTM B 215; sufficient powder shall be taken from each lot to perform all required tests in duplicate.

4.4 Approval

4.4.1 The processes and control procedures, a preproduction sample, or both, whichever is specified, shall be approved by the cognizant engineering organization before powder for production parts is supplied.

4.4.2 The supplier shall make no significant changes to ingredients, processes, or controls from those that the approval was based, unless the change is approved by the cognizant engineering organization. A significant change is one that, in the judgment of the cognizant engineering organization, could affect the properties or performance of the powder.

4.5 Reports

The vendor of powder shall furnish with each shipment a report showing the results of tests for composition of each heat and the oxygen and hydrogen content of each lot and stating that the powder conforms to the other technical requirements. This report shall include the purchase order number, lot number, AMS4998D, vendor's product designation, feed material, and quantity.

4.6 Resampling and Retesting

If any specimen used in the above tests fails to meet the specified requirements, disposition of the powder 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 powder represented. Results of all tests shall be reported.

5. PREPARATION FOR DELIVERY

5.1 Packaging and Identification

5.1.1 Powder shall be packaged in containers of a type and size acceptable to purchaser. A lot may be packaged in small quantities and delivered separately under the basic lot approval provided lot identity is maintained. Each container shall be thoroughly cleaned and dried immediately prior to filling, and shall be sealed immediately after filling to protect the contents from contamination during shipment and under normal dry storage conditions. Seals used on the containers shall be so designed that they must be destroyed in order for the container to be opened.

5.1.2 Each individual container shall be legibly identified with not less than the following information, using characters that will not be obliterated by normal handling:

TITANIUM ALLOY POWDER, 6Al - 4V

AMS4998D

MANUFACTURER'S IDENTIFICATION _____

PURCHASE ORDER NUMBER _____

QUANTITY _____

PRODUCTION METHOD _____

LOT NUMBER _____