



AEROSPACE MATERIAL SPECIFICATION

AMS7011™

Issued

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Electron Beam-Powder Bed Fusion (EB-PBF) Produced Preforms and Parts
Titanium Alloy, 6Al - 4V
Hot Isostatically Pressed
(Composition similar to UNS R56401)

RATIONALE

This SAE Aerospace Material Specification is intended to provide technical requirements and quality assurance provisions and to reference additional required specifications for precursor materials, process, and all secondary operations for the electron beam-powder bed processing of the Ti-base alloy Ti-6Al-4V. No such standard currently exists.

1. SCOPE

1.1 Form

This specification covers a titanium alloy in the form of preforms and parts produced by electron beam-powder bed fusion (EB-PBF) that are subjected to post-deposition hot isostatic press (HIP). Preforms may require subsequent machining or surface finishing to meet requirements for their intended final part application.

1.2 Application

These products have been used typically for parts requiring strength up to 750 °F (399 °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 producer 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), <http://www.sae.org/>.

AMS2249	Chemical Check Analysis Limits, Titanium and Titanium Alloys
AMS2750	Pyrometry
AMS4999	Titanium Alloy Direct Deposited Products, 6Al - 4V, Annealed
AMS7002	Process Requirements for Production of Metal Powder Feedstock for Use in Additive Manufacturing of Aerospace Parts

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Full document details: SAE AMS7011

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<https://www.sae.org/standards/content/AMS7011/>

Documents

Document Sharing Hub

AMS7007	Electron Beam-Powder Bed Fusion Process
AMS7015	Titanium 6 - Aluminum 4 - Vanadium Powder for Additive Manufacturing
AMS7025	Metal Powder Feedstock Size Classifications
ARP982	Minimizing Stress-Corrosion Cracking in Wrought Titanium Alloy Products
AS7766	Terms Used in Aerospace Metals Specifications

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, <http://www.astm.org/>.

ASTM B600	Descaling and Cleaning Titanium and Titanium-Alloy Surfaces
ASTM E3	Standard Guide for Preparation of Metallographic Specimens
ASTM E8	Tension Testing of Metallic Materials
ASTM E29	Standard Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications
ASTM E539	Analysis of Titanium Alloys by X-Ray Fluorescence Spectrometry
ASTM E1409	Determination of Oxygen and Nitrogen in Titanium and Titanium Alloys by the Inert Gas Fusion Technique
ASTM E1417	Standard Practice for Liquid Penetrant Examination
ASTM E1447	Determination of Hydrogen in Titanium and Titanium Alloys by the Inert Gas Fusion Thermal Conductivity/Infrared Detection Method
ASTM E1570	Standard Practice for Computed Tomographic (CT) Examination
ASTM E1742	Standard Practice for Radiographic Examination
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 Atomic Emission Spectrometry
ISO/ASTM 52900:2015	Standard Terminology for Additive Manufacturing - General Principles - Terminology

2.3 Definitions

Terms used in AMS7007 are clarified in AS7766 and ISO/ASTM 52900:2015 and as follows:

2.3.1 PROCESS CONTROL DOCUMENTATION (PCD)

A collection of procedures and requirements that are used to document and to control variation of the product.

2.3.2 ELECTRON BEAM POWDER BED FUSION (EB-PBF)

Additive manufacturing process in which thermal energy supplied by one electron beam selectively fuses regions of a powder bed.

2.3.3 TECHNICAL DATA PACKAGE (TDP)

A technical description of an item adequate for supporting an acquisition, production, engineering, and logistics support (e.g., engineering data for provisioning, training, and technical manuals). The description defines the required design configuration or performance requirements, and procedures required to ensure adequacy of item performance. It consists of applicable technical data such as models, drawing, associated lists, specifications, standards, performance requirements, QAP, software documentation, and packaging details.

2.3.4 WITNESS SPECIMEN

A test specimen produced during the build cycle with representative feedstock materials and process parameters that is used to determine if a specific build yields similar mechanical properties compared to the original qualification build cycle.

2.3.5 KEY PROCESS VARIABLES

Aspects of the manufacturing process that may impact the capability to meet the specified requirements. These include physical, chemical, metallurgical, mechanical property, or dimensional requirements (see 3.3.2).

3. TECHNICAL REQUIREMENTS

3.1 Chemical Composition

The chemical composition of the preforms or parts 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 by other analytical methods acceptable to the cognizant engineering organization (CEO). Rounding of test results shall be performed as directed in ASTM E29, Rounding Method, unless an alternative rounding method is specified by the CEO or applicable specification.

Table 1 - Composition

Element	Min	Max
Aluminum	5.50	6.75
Vanadium	3.50	4.50
Iron	--	0.30
Oxygen	0.11	0.20
Carbon	--	0.08
Nitrogen	--	0.05 (500 ppm)
Hydrogen	--	0.015 (150 ppm)
Yttrium (3.1.1)	--	0.005 (50 ppm)
Other Elements, each (3.1.1)	--	0.10
Other Elements, total (3.1.1)	--	0.40
Titanium	remainder	

3.1.1 Determination

Determination not required for routine acceptance.

3.1.2 Check Analysis

Chemical composition variations shall meet the applicable requirements of AMS2249.

3.2 Condition

Electron beam-powder bed fusion (EB-PBF) produced parts shall be hot isostatically pressed.