



AEROSPACE MATERIAL SPECIFICATION

AMS7004™**REV. A**Issued 2019-01
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Superseding AMS7004

(R) Titanium Alloy Preforms from Plasma Arc Directed Energy Deposition Additive
Manufacturing on Substrate,
Ti-6Al-4V,
Stress Relieved

RATIONALE

Five-Year Review led to significant changes. Major technical changes are material width (y-direction) updated to 22.0 inches (560 mm) from 5.5 (140 mm) (see Table 2). Added provision to permit the CEO to define an alternate substrate material (see 3.3), updated microstructure requirements (see 3.7.2), and updated surface contamination requirements (see 3.7.4).

1. SCOPE

1.1 Form

This specification covers preforms fabricated up through 22.0 inches (560 mm), inclusive, in deposition width thickness (see 2.4) using a wire-fed plasma arc directed energy deposition (PA-DED) additive-manufacturing process on a Ti-6Al-4V substrate that are subjected to post-deposition stress-relief heat treatment. If required by the cognizant engineering organization (CEO), preforms may require subsequent machining 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 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 (U.S. and Canada only) or +1 724-776-4970 (outside U.S. and Canada), www.sae.org.

AMS2249 Chemical Check Analysis Limits, Titanium and Titanium Alloys

AMS2631 Ultrasonic Inspection, Titanium and Titanium Alloy Bar, Billet, and Plate

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Full document details: SAE AMS7004A

For more information on this standard, visit <https://www.sae.org/standards/content/AMS7004A/>

Documents

Standard, visit Sharing Hub

AMS2801	Heat Treatment of Titanium Alloy Parts
AMS4911	Titanium Alloy, Sheet, Strip, and Plate, 6Al - 4V, Annealed
AMS4928	Titanium Alloy Bars, Wire, Forgings, Flash-Welded Rings, and Drawn Shapes, 6Al - 4V Annealed
AMS4954	Titanium Alloy, Welding Wire, 6Al - 4V
AMS7005	Wire Fed Plasma Arc Directed Energy Deposition Additive Manufacturing Process
ARP1917A	Clarification of Terms Used in Aerospace Metals Specifications
AS1814	Terminology for Titanium Microstructures
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, www.astm.org.

ASTM E8/E8M	Standard Test Methods for Tension Testing of Metallic Materials
ASTM E539	Standard Test Method for Analysis of Titanium Alloys by X-Ray Fluorescence Spectrometry
ASTM E1409	Standard Test Method for Determination of Oxygen and Nitrogen in Titanium and Titanium Alloys by Inert Gas Fusion
ASTM E1447	Standard Test Method for Determination of Hydrogen in Titanium and Titanium Alloys by 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	Standard Test Method for Determination of Carbon in Refractory and Reactive Metals and Their Alloys by Combustion Analysis
ASTM E2371	Standard Test Method for Analysis of Titanium and Titanium Alloys by Direct Current Plasma and Inductively Coupled Plasma Atomic Emission Spectrometry (Performance-Based Test Methodology)

ISO/ASTM 52900 Additive manufacturing - General principles - Fundamentals and Vocabulary

2.3 AWS Publications

Available from American Welding Society, 8669 NW 36 Street, #130, Miami, FL 33166-6672, Tel: 1-800-443-9353 or 305-443-9353, www.aws.org.

AWS A5.16/A5.16M	Titanium and Titanium-Alloy Welding Electrodes and Rods
AWS D17.1	Specification for Fusion Welding of Aerospace Applications
AWS G2.4/G2.4M	Guide for the Fusion Welding of Titanium and Titanium Alloys

2.4 Definitions

The following definitions apply in addition to those defined in ISO/ASTM 52900, AS7766, and ARP1917A. Where a conflict is found, definitions provided here supersede those elsewhere, but are limited in application to AMS7004A.

AUTHORIZED BY THE CEO: Requires prior written approval from the CEO.

ACCEPTABLE TO THE CEO: Does not require prior written approval from the CEO prior to implementation into production. Any changes require written notification to the CEO prior to part shipment. This allows the producer to make a decision and the CEO the right to disapprove the decision.

DEPOSITION WIDTH THICKNESS: The maximum dimension of the deposit in the Y direction.

HEAT-AFFECTED ZONE: The non-melted area of substrate that has undergone changes in material properties as a result of being exposed to high temperatures. This material exists adjacent to, or between, the substrate and the deposited material.

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 [3.5.2.1](#)).

NONDESTRUCTIVE EVALUATION: A method of inspecting materials or components to assess their integrity without causing damage.

PREFORM: The product that results from the deposition of wire feedstock onto a substrate.

PROCESS CONTROL DOCUMENTATION (PCD): A collection of procedures and requirements that are used to document and to control variation of the product.

PRODUCER: The entity using the PA-DED process to produce a preform.

PRODUCTION LOT: All PA-DED preforms manufactured in accordance with a single PCD, either produced consecutively or concurrently in a single-chamber atmosphere, with the same wire and substrate heat treated in a single heat-treat load. Feedstock and substrate shall conform to [3.2](#) and [3.3](#), respectively.

PROLONGATION: Additional metallic material deposited on a substrate as agreed upon by the producer and the CEO to allow subsequent testing without destroying the preform. Prolongation must be deposited using the same deposition procedure parameters and thermal-process parameters as the preforms it serves. Specific characteristics of the prolongation shall be indicated on the PCD.

SUBSTRATE: Represents the base metal utilized to initiate the deposition of PA-DED material. This material may remain a portion of the preform.

TECHNICAL DATA PACKAGE (TDP): A technical description of an item adequate for supporting 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, drawings, associated lists, specifications, standards, performance requirements, QAP, software documentation, and packaging details.

3. TECHNICAL REQUIREMENTS

3.1 Composition

Final deposited material 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 or ASTM E2371. Other analytical methods may be used if acceptable to the CEO.