



Designation: F3554 – 22

Standard Specification for Additive Manufacturing – Finished Part Properties – Grade 4340 (UNS G43400) via Laser Beam Powder Bed Fusion for Transportation Applications¹

This standard is issued under the fixed designation F3554; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This specification covers additive manufacturing of parts manufactured via laser beam powder bed fusion (PBF-LB) processing of Grade 4340 (UNS G43400) used in transportation applications, including automotive applications. Parts made using this processing method require heat treatment to achieve maximum strength and are typically used in applications that require mechanical properties similar to wrought Grade 4340 (UNS G43400) products. Products built to this specification may require additional post-processing in the form of machining, polishing etc. to meet necessary surface finish and dimensional tolerances.

1.2 This specification describes the required facility, training, equipment, and processing requirements necessary to support the production of parts with properties and associated quality metrics outlined in a part classification structure.

1.3 This specification is intended for the use of purchasers or producers, or both, of PBF-LB Grade 4340 (UNS G43400) parts for defining the requirements based on classification methodology. These requirements shall be agreed upon by the part supplier and purchaser.

1.4 Users are advised to use this specification as a basis for obtaining parts that will meet the minimum acceptance requirements established and revised by consensus of committee members.

1.5 User requirements considered more stringent may be met by additional requirements in the purchase order.

1.6 The values stated in SI units are to be regarded as standard. The values given in parentheses after SI units are provided for information only and are not considered standard.

1.7 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the*

Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.

2. Referenced Documents

2.1 ASTM Standards:²

- B822 Test Method for Particle Size Distribution of Metal Powders and Related Compounds by Light Scattering
- D3951 Practice for Commercial Packaging
- E3 Guide for Preparation of Metallographic Specimens
- E8/E8M Test Methods for Tension Testing of Metallic Materials
- E10 Test Method for Brinell Hardness of Metallic Materials
- E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications
- E407 Practice for Microetching Metals and Alloys
- E112 Test Methods for Determining Average Grain Size
- E1019 Test Methods for Determination of Carbon, Sulfur, Nitrogen, and Oxygen in Steel, Iron, Nickel, and Cobalt Alloys by Various Combustion and Inert Gas Fusion Techniques
- E1245 Practice for Determining the Inclusion or Second-Phase Constituent Content of Metals by Automatic Image Analysis
- E1417 Practice for Liquid Penetrant Testing
- E1479 Practice for Describing and Specifying Inductively Coupled Plasma Atomic Emission Spectrometers
- E1742 Practice for Radiographic Examination
- E2234 Practice for Sampling a Stream of Product by Attributes Indexed by AQL
- E2594 Test Method for Analysis of Nickel Alloys by Inductively Coupled Plasma Atomic Emission Spectrometry (Performance-Based)
- E2762 Practice for Sampling a Stream of Product by Variables Indexed by AQL
- F2971 Practice for Reporting Data for Test Specimens Prepared by Additive Manufacturing

¹ This specification is under the jurisdiction of ASTM Committee F42 on Additive Manufacturing Technologies and is the direct responsibility of Subcommittee F42.07 on Applications.

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² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

F3122 Guide for Evaluating Mechanical Properties of Metal Materials Made via Additive Manufacturing Processes
F3301 Additive Manufacturing – Post Processing Methods – Standard Specification for Thermal Post-Processing Metal Parts Made Via Powder Bed Fusion

2.2 ISO/ASTM Standards:²

52900 Additive manufacturing — General principles — Fundamentals and vocabulary
52901 Guide for Additive Manufacturing – General Principles – Requirements for Purchased AM Parts
52904 Additive Manufacturing – Process Characteristics and Performance: Practice for Metal Powder Bed Fusion Process to Meet Critical Applications
52921 Terminology for Additive Manufacturing-Coordinate Systems and Test Methodologies
52930 Additive manufacturing — Qualification principles — Installation, operation, and performance (IQ/OQ/PQ) of PBFLB equipment
52941 Additive Manufacturing — System performance and reliability — Acceptance Tests for laser metal powder bed fusion machines for metallic materials for aerospace application
52942 Additive Manufacturing — Qualification principles — Qualifying machine operators of metal laser powder bed fusion machines and equipment used in aerospace applications

2.3 ISO Standards:³

ISO 9001 Quality management system — Requirements
ISO 9044 Industrial woven wire cloth — Technical requirements and testing
ISO 9712 Non-destructive testing — Qualification and certification of NDT personnel
ISO 16949 Quality management systems — Particular requirements for the application of ISO 9001:2008 for automotive production and relevant service part organizations

2.4 SAE Standards:⁴

AS 9100 Quality Management Systems – Requirements for Aviation, Space and Defense Organizations
AMS 2175 Castings, Classification, and Inspection of

2.5 ASME Standards:⁵

ASME B46.1 Surface Texture

2.6 National Aerospace Standards:⁶

NAS410 National Aerospace Standard Certification & Qualification of Non-destructive Test Personnel

2.7 ANSI/ASNT:⁷

CP189 Standard for Qualification and Certification of Non-destructive Testing Personnel

3. Terminology

3.1 Definitions of Terms:

3.1.1 Terminology relating to additive manufacturing in Terminology ISO/ASTM **52900** shall apply.

3.1.2 Part positioning and orientation related to coordinate systems in ISO/ASTM **52921** shall apply.

4. Classification

4.1 All parts made to this specification shall be given a classification A, B, C, D, according to the annex.

5. Condition

5.1 All Conditions shall meet the requirements in each section of this standard and conform to Specification **F3301**.

5.1.1 Condition SR, parts shall be stress relieved.

5.1.2 Condition Q/T, parts shall be quenched and tempered.

5.1.3 Condition HIP, parts shall be processed by hot isostatic pressing.

5.2 The purchaser may specify multiple conditions on the purchase order such as Condition SR/HIP.

5.2.1 Class A parts shall be delivered in condition HIP and Q/T.

5.2.2 Class B parts shall be delivered in condition Q/T.

5.2.3 Class C parts shall be delivered in condition SR.

5.2.4 Class D parts shall be delivered in condition as agreed upon between supplier and purchaser.

6. Ordering Information

6.1 Parts shall be ordered in accordance with ISO/ASTM **52901** and include the specified condition(s) and classification in accordance with this specification.

6.2 Supplementary requirements shall be stated on the purchase order.

7. Manufacturing Plan

7.1 All classification of parts manufactured to this specification shall have a manufacturing plan in accordance with ISO/ASTM **52904**.

8. Feedstock and Powder Batches

8.1 Classifications A, B, C of parts manufactured to this specification shall use pre-alloyed powder and control powder batches in accordance with ISO/ASTM **52904**.

8.1.1 The part manufacturer shall flow-down powder specifications to their powder vendor and have receiving procedures that ensure the powder meets the requirements in ISO/ASTM **52904**.

⁷ Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, <http://www.ansi.org> and American Society for Nondestructive Testing (ASNT), P.O. Box 28518, 1711 Arlington Ln., Columbus, OH 43228-0518, <http://www.asnt.org>.

³ Available from International Organization for Standardization (ISO), ISO Central Secretariat, Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland, <https://www.iso.org>.

⁴ Available from SAE International (SAE), 400 Commonwealth Dr., Warrendale, PA 15096, <http://www.sae.org>.

⁵ Available from American Society of Mechanical Engineers (ASME), ASME International Headquarters, Two Park Ave., New York, NY 10016-5990, <http://www.asme.org>.

⁶ Available from Aerospace Industries Association (AIA), 1000 Wilson Blvd., Suite 1700, Arlington, VA 22209, <http://www.aia-aerospace.org>.