International Standard

ISO/ASTM 52909

Additive manufacturing of metals — Finished part properties — Orientation and location dependence of mechanical properties for metal parts

Fabrication additive de métaux — Propriétés des pièces finies — Dépendance de l'orientation et de l'emplacement sur les propriétés mécaniques pour les pièces métalliques

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

The document was prepared by Technical Committee ISO/TC 261, *Additive manufacturing*, in cooperation with ASTM Committee F42, *Additive Manufacturing Technologies*, on the basis of a partnership agreement between ISO and ASTM International with the aim to create a common set of ISO/ASTM standards on Additive Manufacturing, and in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 438, *Additive manufacturing,* in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

Any feedback or questions on this document should be directed to the user’s national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

This second edition cancels and replaces the first edition (ISO/ASTM 52909:2022), of which it constitutes a minor revision.

The main changes are as follows:

— The third element of the title of the standard has been changed to “Orientation and location dependence of mechanical properties for metal parts”;

— The title for Figure A.6 b) has been corrected;

— Reference [12] in bibliography has been corrected.

Any feedback or questions on this document should be directed to the user’s national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

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Introduction

AM produced metallic parts are being intensively developed and used more widely today with an expected faster growth in near future. This document aims to support customers' needs to address specifics of the AM deposited parts – location and orientation dependent local properties and their variations over the part or deposition chamber.

This document provides a list of accurate terminologies and existing standards dedicated to mechanical testing of metallic materials, guidance on designation of coordinate systems and their application to AM specimens/parts designation, and recommendations on possibilities for local properties measurement.

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Additive manufacturing of metals — Finished part properties — Orientation and location dependence of mechanical properties for metal parts

1 Scope

This document covers supplementary guidelines for evaluation of mechanical properties including static/quasi-static and dynamic testing of metals made by additive manufacturing (AM) to provide guidance toward reporting when results from testing of as-built specimen or specimen cut out from AM parts made by this technique or both.

This document is provided to leverage already existing standards. Guidelines are provided for mechanical properties measurements and reporting for additively manufactured metallic specimen as well as those cut out from AM parts.

This document does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health and environmental practices and determine the applicability of regulatory limitations prior to use.

This document expands upon the nomenclature of ISO/ASTM 52900 and principles of ISO 17295 and extends them specifically to metal additive manufacturing. The application of this document is primarily intended to provide guidance on orientation designations in cases where meaningful orientation/direction for AM cannot be obtained from available test methods.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 1099, *Metallic materials — Fatigue testing — Axial force-controlled method*

ISO 4506, *Hardmetals — Compression test*

ISO 6892-1, *Metallic materials — Tensile testing — Part 1: Method of test at room temperature*

ISO 12106, *Metallic materials — Fatigue testing — Axial-strain-controlled method*

ISO 12108, *Metallic materials — Fatigue testing — Fatigue crack growth method*

ISO 12135, *Metallic materials — Unified method of test for the determination of quasistatic fracture toughness*

ISO 17295, *Additive manufacturing — General principles — Part positioning, coordinates and orientations*

ISO/ASTM 52900, *Additive manufacturing — General principles — Fundamentals and vocabulary*

ASTM E8/E8M, *Standard test methods for tension testing of metallic materials*

ASTM E9, *Standard test methods of compression testing of metallic materials at room temperature*

ASTM E399, *Standard test method for linear-elastic plane-strain fracture toughness kic of metallic materials*

ASTM E466, *Standard practice for conducting force-controlled constant amplitude axial fatigue tests of metallic materials*

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ASTM E561, *Standard test method for k-r curve determination*

ASTM E606/E606M, *Standard test method for strain-controlled fatigue testing*

ASTM E647, *Standard test method for measurement of fatigue crack growth rates*

ASTM E1820, *Standard test method for measurement of fracture toughness*

ASTM E1921, *Test Method for Determination of Reference Temperature, T_o, for Ferritic Steels in the Transition Range*

ASTM E2472, *Standard Test Method For Determination Of Resistance To Stable Crack Extension Under Low-Constraint Conditions*

ASTM E2899, *Standard test method for measurement of initiation toughness in surface cracks under tension and bending*

ASTM F2971, *Practice for Reporting Data for Test Specimens Prepared by Additive Manufacturing*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 17295 and ISO/ASTM 52900 and apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1 Definition

3.1.1
part location
location of the part/sample/specimen within the build volume

Note 1 to entry: The part location is normally specified by the *x*, *y*, *z* coordinates for the position of the geometric centre of the part´s bounding box with respect to the build volume origin.

3.2 Abbreviations

The abbreviations used in Figure A.4, are listed in Table 1.

Table 1 — Abbreviations

Abbreviation	Signification	Comment
S	Start	Any base of the specimen or part that provides a surface upon which deposition starts (see Annex A).
E	End	Any area of a specimen or part that provides a surface upon which the specimen or part deposition ends (see Annex A).
M	Middle	Mid-plane of a specimen or part between start and end (see Annex A).
B	Both	Crack growth captures both start and end of build (see Annex A).
RD	Scan direction	This may or may not be the same throughout the build (see Annex A).

3.3 Acronyms

The acronyms used in this document for illustrating crack growth directions with respect to the build direction are listed in Table 2 and illustrated in Figure A.4.

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