SLOVENSKI STANDARD
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Aditivna proizvodnja - Osnovna načela - Glavne karakteristike in ustrezne preskusne metode (ISO/ASTM DIS 52927:2022)

Additive manufacturing - General principles - Main characteristics and corresponding test methods (ISO/ASTM DIS 52927:2022)

Additive Fertigung - Grundlagen - Hauptmerkmale und entsprechende Prüfverfahren (ISO/ASTM DIS 52927:2022)

Fabrication additive - Principes généraux - Principales caractéristiques et méthodes d'essai correspondantes (ISO/ASTM DIS 52927:2022)

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Additive manufacturing — General principles — Main characteristics and corresponding test methods

Fabrication additive — Principe généraux — Principales caractéristiques et méthodes d'essai correspondantes

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ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11

Email: copyright@iso.org
Website: www.iso.org

ASTM International
100 Barr Harbor Drive, PO Box C700
West Conshohocken, PA 19428-2959, USA
Phone: +610 832 9634
Fax: +610 832 9635
Email: khooper@astm.org
Website: www.astm.org

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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 documents 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).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

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 committee responsible for this document is 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.

This document cancels and replaces the first edition (ISO 17296-3:2014), which has been technically revised and merged with document ASTM F3122-14 *Standard Guide for Evaluating Mechanical Properties of Metal Materials Made via Additive Manufacturing Processes* and therefore re-designated and renamed to ISO/ASTM 52927 *Additive manufacturing — General principles — Main characteristics and corresponding test methods*

The main changes compared to the previous edition are as follows:

— The main types of materials (metallic, polymers and ceramics) are separated in specific Annexes following the main part containing general requirements,

— This version includes the contents of *ASTM F3122-14 Standard Guide for Evaluating Mechanical Properties of Metal Materials Made via Additive Manufacturing Processes* and merges them with (formerly) ISO 17296-3.

Introduction

Additive manufacturing is a process of joining materials to make parts from 3D model data, usually layer upon layer, as opposed to subtractive manufacturing and formative methodologies. It is used to manufacture prototypes and production parts.

This document aims to offer recommendations and advice to machine manufacturers, feedstock suppliers, AM system users, part providers, and customers, to improve communication between these stakeholders concerning test methods.

This document has been developed within a set of consistent documents from terminology to test methods and data exchange.

Additive manufacturing processes require the selective application of thermo-physical and/or chemical mechanisms to generate the part. Thus, it is possible to produce parts with different characteristics, depending on the method and the process parameters used. However, complete testing of all characteristics for every part is neither cost-effective nor technologically feasible. Therefore, when formulating parts specifications, the nature and scope of testing is an important issue.

This document provides an overview of test methods for the characterization of the mechanical properties of metals, ceramics and polymers. It lists all the applicable standards based on specimens manufactured in a traditional process and gives the complement applicable when these specimens are manufactured by additive manufacturing.

At the time of publication of this document, the state of the art does not allow to describe all these specificities related to additive manufacturing. This document will therefore be regularly revised in order to incorporate the knowledge acquired in the field of additive manufacturing.

Additive manufacturing — General principles — Main characteristics and corresponding test methods

1 Scope

This document covers the principal requirements applied to testing of parts manufactured by additive manufacturing processes.

This document:

— provides the list of quality characteristics of parts and the appropriate test procedures,

— provides the specific procedures to build samples using additive manufacturing process,

— recommends the scope and content of test and supply agreements.

This document is aimed at machine manufacturers, feedstock suppliers, AM system users, part providers, and customers to facilitate the communication on main quality characteristics. It applies wherever additive manufacturing processes are used.

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

ISO/ASTM 52901, *Additive manufacturing — General principles — Requirements for purchased AM parts*

ISO/ASTM 52909, *Additive manufacturing — Finished part properties — Orientation and location dependence of mechanical properties for metal powder bed fusion*

ISO/ASTM 52915, *Specification for additive manufacturing file format (AMF) Version 1.2*

ISO/ASTM 52921, *Standard terminology for additive manufacturing — Coordinate systems and test methodologies*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/ASTM 52900 and ISO/ASTM 52901 apply.

ISO and IEC maintain terminological 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/

4 Main characteristics and corresponding test methods

4.1 General

This Clause contains the general requirements and recommendations for the relevant tests, regardless of the material type.

For specific requirements and recommendations regarding tests and methods on samples made of metallic materials, see Annex A.

For specific requirements and recommendations regarding tests and methods on samples made of polymer materials, see Annex B.

For specific requirements and recommendations regarding tests and methods on samples made of ceramic materials, see Annex C.

Each development and fabrication phase of a part has a specific purpose. The performance criteria determine the type of part and the choice of additive manufacturing process. This document develops the following main quality characteristics:

— feedstock:

  — size and shape: powder particle size distribution, mean particle size, surface area, morphology, filament diameter, ovality;

  — packing and transport properties within the AM system: apparent and tap density, flowability, pourability, filament cast and helix;

  — chemistry: chemical composition, ash/carbon content.

— parts:

  — surface requirements: appearance, surface texture, and colour;

  — geometric requirements: size, length and angle dimensions, dimensional tolerances, and geometrical tolerancing (deviations in shape and position);

  — mechanical requirements: hardness, tensile strength, impact strength, compressive strength, flexural strength, fatigue strength, creep, ageing, frictional coefficient, shear resistance, and crack extension;

  — physical and chemical properties: density, chemical composition, grain size, imperfections (e.g. porosity, cracks).

NOTE The following other characteristics of parts have been identified but, due to the specificity of additive manufacturing, will be provided in a future version of this document:

— formed material requirements(e.g. ductility);

— thermal properties (e.g. operating temperature range, dimensional stability in heat, softening temperatures, melting point, specific heat, thermal conductivity, and coefficient of linear thermal expansion);

— electrical requirements (e.g. disruptive strength, dielectric properties, magnetic properties, and electrical conductivity);

— physical and physico-chemical properties (e.g. internal defaults, flammability, toxicity, chemical composition, chemical resistance, water absorption, crystalline structure, suitability for food, biocompatibility, sterility, photostability, translucence, solidification point, glass transition, and corrosion).

4.2 Selection criteria

Testing categories given in Table A.1, Table B.1 and Table C.1 shall be applied to guide the relation between customer and part provider, applicable for metallic parts, polymer parts, and ceramic parts.

The choice of a testing category shall be subject to agreement between customer and part provider.

NOTE Test categories are defined according to the application and the type of material.

5 Part and process testing — Specifications and quality criteria

5.1 General

The quality of a part is determined by comparing its characteristics against an agreed set of requirements. The requirements shall be precisely defined within the purchase specification and include suitability for the intended application in conjunction with any specified geometric, material or performance requirements. Inspection and testing of the part and associated test specimens are performed to demonstrate compliance with the requirements.

NOTE 1 ISO/ASTM 52901 gives guidance for requirements about purchase specifications.

NOTE 2 A definition or discussion that lacks clarity can result in considerable additional costs and delays and/or inferior quality.

The form of specifications depends on the application, the nature of the features being tested, and the materials used. Specifications may also vary within one part (e.g. critical mass). Some intrinsic properties depend on the choice of material and the technology used. Relevant test procedures shall be stipulated and adhered to.

5.2 Testing the feedstocks

The condition of the feedstock can have a significant impact on the part properties. Significant variations can arise due to storage and reutilization of the feedstock and variations between batches. Essential data relating to the feedstock shall be provided by the feedstock supplier.

5.3 Monitoring the process

All additive manufacturing processes are computer-assisted. Therefore, it is possible to record and statistically analyse important process-related data, such as process parameters and environmental conditions, which can be recorded at specified time intervals. The need to monitor the process depends on the required or anticipated reproducibility of the process and part quality for each application. Process monitoring might also be required by customer.

Where the process stability is assessed, at different intervals, consideration shall be given to selecting monitoring points where variables are consistent (e.g. constant geometry) such that any identified variations are indicative of process instability (e.g. mechanical properties, geometric features, chemical composition).

Test specimens for process monitoring should be as representative as possible compared to the part. Complementary test specimens can be used to improve the testing of dimensional accuracy, reproduction accuracy and process stability. The shape of test specimen and the nature and frequency of testing shall be defined in agreement between the customer and part provider for each application in accordance with applicable standards.

5.4 Testing the part

Relevant testing standards are given in Table A.5 for metallic parts, Table B.5 for polymer parts and Table C.5 for ceramic parts.

Tests and their acceptance criteria shall be set out in the contract specification or agreement between customer and part provider prior to manufacturing.

NOTE 1 ISO/ATSM 52909 gives information on the sizing of metallic specimens.

NOTE 2 ASTM D 1708 gives information for specimens made of polymers.