INTERNATIONAL STANDARD

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Additive manufacturing — General principles —

Part 3: Main characteristics and corresponding test methods

Fabrication additive — Principes généraux —

Partie 3: Principales caractéristiques et méthodes d'essai correspondantes

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Contents

Page

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).

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

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 261, *Additive manufacturing*.

ISO 17296 consists of the following parts, under the general title *Additive manufacturing — General principles*:

— *Part 1: Terminology*

— *Part 2: Overview of process categories and feedstock*

— *Part 3: Main characteristics and corresponding test methods*

— *Part 4: Overview of data processing*

Introduction

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

This part of ISO 17296 aims to offer recommendations and advice to machine manufacturers, feedstock suppliers, machine users, part providers, and customers, to improve communication between these stakeholders concerning test methods.

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

The manufacturing of parts by additive manufacturing processes is subject to numerous variables. The processes described in ISO 17296-2 can be used to manufacture parts that meet technological requirements only if these factors are controlled, optimized and, if necessary, customized for each order. When assessing parts quality, comparison with the specific requirements is one of the most important aspects.

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 used and the process parameters. However, complete testing of all parts characteristics is neither cost-effective nor technologically feasible. Therefore, when formulating parts specifications, the nature and scope of testing is an important issue.

Additive manufacturing — General principles —

Part 3:
Main characteristics and corresponding test methods

1 Scope

This part of ISO 17296 covers the principal requirements applied to testing of parts manufactured by additive manufacturing processes.

This part of ISO 17296

— specifies main quality characteristics of parts,

— specifies appropriate test procedures, and

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

This part of ISO 17296 is aimed at machine manufacturers, feedstock suppliers, machine 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, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 17296-1[1)], *Additive manufacturing — General — Part 1: Terminology*

ISO/ASTM 52915, *Standard specification for additive manufacturing file format (AMF) Version 1.1*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 17296-1 and the following apply.

3.1
machine manufacturer
manufacturer of additive manufacturing equipment including machine

[SOURCE: ISO 17296-1[1)]]

3.2
feedstock supplier
provider of bulk raw material/consumable to be processed in additive manufacturing equipment

[SOURCE: ISO 17296-1[1)]]

1) To be published.

3.3
machine user
user of additive manufacturing equipment

[SOURCE: ISO 17296-1[2)]]

3.4
part provider
provider of parts manufactured by additive manufacturing equipment

[SOURCE: ISO 17296-1[2)]]

3.5
customer
end user of parts manufactured by additive manufacturing equipment

Note 1 to entry: One company can have several roles at the same time.

[SOURCE: ISO 17296-1[2)]]

4 Main characteristics and corresponding test methods

4.1 General

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 part of ISO 17296 develops the following main quality characteristics:

— feedstock:

  — bulk raw material requirements: powder particle size, morphology, surface and distribution, density (tap and apparent), flowability/pourability, ash content, and 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;

  — build material requirements: density and physical and physico-chemical properties [microstructure analyses (non-destructive testing)].

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 part of ISO 17296:

— build material requirements: 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);

2) To be published.

— 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 Tables 1 to 3 shall be applied to guide the relation between customer and part provider, applicable for metal parts, plastic parts, and ceramic parts. These testing categories define the level of criticality of the parts:

— H: tests for highly engineered parts (safety critical);

— M: tests for functional parts that are not safety critical;

— L: tests for design or prototype parts.

For each testing category, the characteristics indicated (+) shall be fulfilled, the characteristics indicated (o) are recommended, and the characteristics indicated (-) are not applicable. An agreement between the customer and the part provider may exclude some of them due to specific applications of the part.

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.

Table 1 — Metal parts

	Surface requirements			Geometric requirements		Mechanical requirements											Build material requirements	
	Appearance	Surface texture	Colour	Size, length and angle dimensions, dimensional tolerances	Geometrical tolerancing (deviations in shape and position)	Hardness	Tensile strength	Impact strength	Compressive strength	Flexural strength	Fatigue strength	Creep	Ageing	Frictional coefficient	Shear resistance	Crack extension	Density	Physical and physico-chemical properties
H	o	+	-	+	+	+	+	+	+	+	+	+	-	+	+	+	+	+
M	o	o	-	+	+	+	+	+	+	o	o	o	-	o	o	o	+	o
L	o	o	-	+	+	+	+	o	o	o	-	-	-	-	o	-	+	-

Table 2 — Plastic parts

	Surface requirements			Geometric requirements		Mechanical requirements											Build material requirements	
	Appearance	Surface texture	Colour	Size, length and angle dimensions, dimensional tolerances	Geometrical tolerancing (deviations in shape and position)	Hardness	Tensile strength	Impact strength	Compressive strength	Flexural strength	Fatigue strength	Creep	Ageing	Frictional coefficient	Shear resistance	Crack extension	Density	Physical and physico-chemical properties
H	o	+	o	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
M	o	o	o	+	+	+	+	+	+	o	o	o	o	o	o	o	+	o
L	o	o	o	+	+	+	+	o	o	o	-	-	-	-	o	-	+	-