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Additive manufacturing — General principles — Terminology

Fabrication additive — Principes généraux — Terminologie

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Foreword

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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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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*, 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 second edition of ISO/ASTM 52900 replaces first edition (ISO/ASTM 52900:2015), which has been technically revised.

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

— new and modified terms and definitions

— abbreviations added for seven process categories

— a normative guideline for specification of AM processes based on process categories and determining characteristics (Annex A)

Introduction

Additive manufacturing is the general term for those technologies that, based on a geometrical representation, create physical objects by successive addition of material. These technologies are presently used for various applications in engineering industry as well as other areas of society, such as medicine, education, architecture, cartography, toys and entertainment.

During the development of additive manufacturing technology there have been numerous different terms and definitions in use, often with reference to specific application areas and trademarks. This is often ambiguous and confusing which hampers communication and wider application of this technology.

It is the intention of this International Standard to provide a basic understanding of the fundamental principles for additive manufacturing processes, and based on this, to give clear definitions for terms and nomenclature associated with additive manufacturing technology. The objective of this standardization of terminology for additive manufacturing is to facilitate communication between people involved in this field of technology on a world-wide basis.

This International Standard has been developed by ISO/TC 261 and ASTM F42 in close cooperation 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.

Additive manufacturing — General principles — Terminology

1 Scope

This International Standard establishes and defines terms used in additive manufacturing (AM) technology, which applies the additive shaping principle and thereby builds physical three-dimensional (3D) geometries by successive addition of material.

The terms have been classified into specific fields of application.

New terms emerging from the future work within ISO/TC 261 and ASTM F42 will be included in upcoming amendments and overviews of this International Standard.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

3.1 General terms

3.1.1
3D printer
machine used for *3D printing* (3.3.1).

3.1.2
additive manufacturing
AM
process of joining materials to make *parts* (3.9.1) from 3D model data, usually *layer* (3.3.7) upon layer, as opposed to subtractive manufacturing and formative manufacturing methodologies

Note 1 to entry: Historical terms: additive fabrication, additive processes, additive techniques, additive layer manufacturing, layer manufacturing, solid freeform fabrication and freeform fabrication.

Note 2 to entry: The meaning of “additive-”, “subtractive-” and “formative-” manufacturing methodologies are further discussed in Annex A.

3.1.3
additive system
additive manufacturing system
additive manufacturing equipment
machine and auxiliary equipment used for *additive manufacturing* (3.1.2)

3.1.4
AM machine
section of the *additive manufacturing system* (3.1.3) including hardware, machine control software, required set-up software and peripheral accessories necessary to complete a *build cycle* (3.3.8) for producing *parts* (3.9.1)

3.1.5
AM machine user
operator of or entity using an *AM machine* (3.1.4)

3.1.6
AM system user
additive system user
operator of or entity using an entire *additive manufacturing system* (3.1.3) or any component of an *additive system* (3.1.3)

3.1.7
front
<of a machine; unless otherwise designated by the machine builder> side of the machine that the operator faces to access the user interface, or primary viewing window, or both

3.1.8
material supplier
provider of material/ *feedstock* (3.6.6) to be processed in *additive manufacturing system* (3.1.3)

3.1.9
multi-step process
type of *additive manufacturing* (3.1.2) process in which *parts* (3.9.1) are fabricated in two or more operations where the first typically provides the basic geometric shape and the following consolidates the part to the fundamental properties of the intended material (metallic, ceramic, polymer or composite)

Note 1 to entry: Removal of the support structure and cleaning may be necessary, however in this context not considered as a separate process step.

Note 2 to entry: The principle of *single-step* (3.1.10) and multi-step processes are further discussed in Annex A.

3.1.10
single-step process
type of *additive manufacturing* (3.1.2) process in which *parts* (3.9.1) are fabricated in a single operation where the basic geometric shape and basic material properties of the intended product are achieved simultaneously

Note 1 to entry: Removal of the support structure and cleaning may be necessary, however in this context not considered as a separate process step.

Note 2 to entry: The principle of single-step and *multi-step processes* (3.1.9) are further discussed in Annex A.

3.2 Process categories

3.2.1
binder jetting
BJT
additive manufacturing (3.1.2) process in which a liquid bonding agent is selectively deposited to join powder materials

3.2.2
directed energy deposition
DED
additive manufacturing (3.1.2) process in which focused thermal energy is used to fuse materials by melting as they are being deposited

Note 1 to entry: "Focused thermal energy" means that an energy source (for example: laser, electron beam, or plasma arc) is focused to melt the materials being deposited.

3.2.3
material extrusion
MEX
additive manufacturing (3.1.2) process in which material is selectively dispensed through a nozzle or orifice

3.2.4
material jetting
MJT*additive manufacturing* (3.1.2) process in which droplets of feedstock material are selectively deposited

Note 1 to entry: Example feedstock materials for material jetting include photopolymer resin and wax.

3.2.5
powder bed fusion
PBF
additive manufacturing (3.1.2) process in which thermal energy selectively fuses regions of a *powder bed* (3.8.5)

3.2.6
sheet lamination
SHL
additive manufacturing (3.1.2) process in which sheets of material are bonded to form a *part* (3.9.1)

3.2.7
vat photopolymerization
VPP
additive manufacturing (3.1.2) process in which liquid photopolymer in a vat is selectively cured by light-activated polymerization

3.3 Processing: General

3.3.1
3D printing
fabrication of objects through the deposition of a material using a print head, nozzle, or another printer technology

Note 1 to entry: Term often used in a non-technical context synonymously with *additive manufacturing* (3.1.2); until present times this term has in particular been associated with machines that are low end in price and/or overall capability.

3.3.2
build chamber
enclosed location within the *additive manufacturing system* (3.1.3) where the *parts* (3.9.1) are fabricated

3.3.3
build space
location where it is possible for *parts* (3.9.1) to be fabricated, typically within the *build chamber* (3.3.2) or on a *build platform* (3.3.5)

3.3.4
build volume
total usable volume available in the machine for building *parts* (3.9.1)

3.3.5
build platform
<of a machine> base which provides a surface upon which the building of the *part/s* (3.9.1) is started and supported throughout the build process

Note 1 to entry: In some systems, the *parts* (3.9.1) are built attached to the build platform, either directly or through a *support* (3.3.9) structure. In other systems, such as *powder bed* (3.8.5) systems, no direct mechanical fixture between the build and the platform may be required.

3.3.6
build surface
area where material is added, normally on the last deposited *layer* (3.3.7), which becomes the foundation upon which the next layer is formed

Note 1 to entry: For the first layer, the build surface is often the *build platform* (3.3.5).

Note 2 to entry: In the case of *directed energy deposition* (3.2.2) processes, the build surface can be an existing part onto which material is added.

Note 3 to entry: If the orientation of the material deposition or consolidation means, or both, is variable, it may be defined relative to the build surface.

3.3.7
layer
<matter> material laid out, or spread, to create a surface

3.3.8
build cycle
single process cycle in which one or more components are built by successive joining of material within the *build space* (3.3.3) of the *additive manufacturing system* (3.1.3)

3.3.9
support
structure separate from the *part* (3.9.1) geometry that is created to provide a base and anchor for the part during the building process

Note 1 to entry: Supports are typically removed from the part prior to use.

Note 2 to entry: For certain processes such as *material extrusion* (3.2.3) and *material jetting* (3.2.4) the support material can be different from the part material and deposited from a separate nozzle or print head.

Note 3 to entry: For certain processes such as metal *powder bed fusion* (3.2.5) processes, auxiliary supports can be added to serve as an additional heat sink for the part during the building process.

3.3.10
process parameters
set of operating parameters and system settings used during a *build cycle* (3.3.8)

3.3.11
system set-up
configuration of the *additive manufacturing system* (3.1.3) for a build

3.3.12
manufacturing lot
set of manufactured *parts* (3.9.1) having commonality between *feedstock* (3.6.6), *production run* (3.3.14), *additive manufacturing system* (3.1.3) and *post-processing* (3.6.11) steps (if required) as recorded on a single manufacturing work order

Note 1 to entry: The additive manufacturing system could include one or several *AM machines* (3.1.4) and/or post-processing machine units as agreed by *AM* (3.1.2) provider and customer.

3.3.13
manufacturing plan
document setting out the specific manufacturing practices, technical resources and sequences of activities relevant to the production of a particular product including any specified acceptance criteria at each stage

Note 1 to entry: For *additive manufacturing* (3.1.2), the manufacturing plan would typically include, but not be limited to *process parameters* (3.3.10), pre-, and *post processing* (3.6.11) operations as well as relevant verification methods.

Note 2 to entry: Manufacturing plans are typically required under a quality management system such as ISO 9001 and ASQ C1.

3.3.14
production run
all *parts* (3.9.1) produced in one *build cycle* (3.3.8) or sequential series of build cycles using the same *feedstock* (3.6.6) batch and process conditions

3.3.15
process chain
sequence of operations necessary for the *part* (3.9.1) to achieve desired functionality and properties

3.4 Processing: Data

3.4.1
Additive Manufacturing File Format, noun
AMF
file format for communicating *additive manufacturing* (3.1.2) model data including a description of the 3D surface geometry with native support for colour, materials, lattices, textures, constellations and metadata

Note 1 to entry: Additive Manufacturing File Format (AMF) can represent one of multiple objects arranged in a constellation. Similar to *STL* (3.4.6), the surface geometry is represented by a triangular mesh, but in AMF the triangles may also be curved. AMF can also specify the material and colour of each volume and the colour of each triangle in the mesh. ISO/ASTM 52915[5] gives the standard specification of AMF.

3.4.2
AMF consumer
software reading (parsing) the *AMF* (3.4.1) file for fabrication, visualization or analysis

Note 1 to entry: AMF files are typically imported by *additive manufacturing equipment* (3.1.3), as well as viewing, analysis and verification software

3.4.3
AMF editor
software reading and rewriting the *AMF* (3.4.1) file for conversion

Note 1 to entry: AMF editor applications are used to convert an AMF from one form to another, for example, convert all curved triangles to flat triangles or convert porous material specification into an explicit mesh surface.

3.4.4
AMF producer
software writing (generating) the *AMF* (3.4.1) file from original geometric data

Note 1 to entry: AMF files are typically exported by CAD software, scanning software, or directly from computational geometry algorithms.

3.4.5
STEP
standard for the exchange of product model data

Note 1 to entry: ISO standard that provides a representation of product information along with the necessary mechanisms and definitions to enable product data to be exchanged. ISO 10303[3] applies to the representation of product information, including components and assemblies, the exchange of product data, including storing, transferring, accessing and archiving.

3.4.6
STL
file format for model data describing the surface geometry of an object as a tessellation of triangles used to communicate 3D geometries to machines in order to build physical *parts* (3.9.1)

Note 1 to entry: The STL file format was originally developed as part of the CAD package for the early STereoLithography Apparatus, thus referring to that process. It is sometimes also described as "Standard Triangulation Language" or "Standard Tessellation Language", though it has never been recognized as an official standard by any standards developing organization.

3.4.7
IGES
initial graphics exchange specification
platform neutral CAD data exchange format intended for exchange of product geometry and geometry annotation information

Note 1 to entry: IGES is the common name for a United States National Bureau of Standards standard NBSIR 80–1978, Digital Representation for Communication of Product Definition Data, which was approved by ANSI first as ANS Y14.26M-1981 and later as ANS USPRO/IPO-100–1996. IGES version 5.3 was superseded by ISO 10303[3] *STEP* (3.4.5) in 2006.

3.4.8
PDES
Product Data Exchange Specification or Product Data Exchange using *STEP* (3.4.5)

Note 1 to entry: Originally, a product data exchange specification developed in the 1980s by the IGES/PDES Organization, a program of US Product Data Association (USPRO). It was adopted as the basis for and subsequently superseded by ISO 10303[3] STEP.

3.4.9
extensible markup language
XML

standard from the WorldWideWeb Consortium (W3C) that provides for tagging of information content within documents offering means for representation of content in a format that is both human and machine readable

Note 1 to entry: Through the use of customizable style sheets and schemas, information can be represented in a uniform way, allowing for interchange of both content (data) and format (metadata).

3.4.10
attribute
<data> characteristic representing one or more aspects, descriptors, or elements of the data

Note 1 to entry: In object-oriented systems, attributes are characteristics of objects. In *XML* (3.4.9), attributes are characteristics of elements.

3.4.11
comment
<data> remark in source code which does not affect the behaviour of the program

Note 1 to entry: Comments are used for enhancing human readability of the file and for debugging purposes.

3.4.12
element
information unit within an *XML* (3.4.9) document consisting of a start tag, an end tag, the content between the tags, and any *attributes* (3.4.10).

Note 1 to entry: In the XML framework, an element can contain data, attributes, and other elements.