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Additive manufacturing — General principles — Fundamentals and vocabulary

Fabrication additive — Principes généraux — Fondamentaux et vocabulaire

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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 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.

This document was prepared by 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).

This second edition of ISO/ASTM 52900 replaces the 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;

— new annex for the specification of AM processes based on process categories and determining characteristics (Annex A).

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.

Introduction

Additive manufacturing (AM) is the general term for those technologies that successively join material to create physical objects as specified by 3D model data. 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 document 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 worldwide basis.

Additive manufacturing — General principles — Fundamentals and vocabulary

1 Scope

This document 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.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

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/

3.1 General terms

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

3.1.2
additive manufacturing, noun
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 include: 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 is further discussed in Annex B.

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

3.1.4
AM machine, noun
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, noun
operator of or entity using an *AM machine* (3.1.4)

3.1.6
AM system user, noun
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, noun
<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, noun
provider of material/*feedstock* (3.6.6) to be processed in an *additive manufacturing system* (3.1.3)

3.1.9
multi-step process, noun
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

Note 1 to entry: Fundamental properties of the intended product material are typically metallic properties for intended metallic products, ceramic properties for intended ceramic products, polymer properties for intended polymer (plastic) products and composite material properties for products intended to be made of a composite material.

Note 2 to entry: Removal of the support structure and cleaning can many times be necessary; however, in this context, this operation is not considered as a separate process step.

Note 3 to entry: The principle of *single-step* (3.1.10) and multi-step processes is further discussed in Annex B.

3.1.10
single-step process, noun
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 can many times be necessary; however, in this context, this operation is not considered as a separate process step.

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

3.2 Process categories

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

Note 1 to entry: Identification of different binder jetting processes shall be consistent with the method described in Annex A.

3.2.2
directed energy deposition, noun
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.

Note 2 to entry: Identification of different directed energy deposition processes shall be consistent with the method described in Annex A.

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

Note 1 to entry: Identification of different material extrusion processes shall be consistent with the method described in Annex A.

3.2.4
material jetting, noun
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.

Note 2 to entry: Identification of different material jetting processes shall be consistent with the method described in Annex A.

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

Note 1 to entry: Identification of different powder bed fusion processes shall be consistent with the method described in Annex A.

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

Note 1 to entry: Identification of different sheet lamination processes shall be consistent with the method described in Annex A.

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

Note 1 to entry: Identification of different vat photopolymerization processes shall be consistent with the method described in Annex A.

3.3 Processing: general

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

Note 1 to entry: This term is often used in a non-technical context synonymously with *additive manufacturing* (3.1.2) and, in these cases, typically associated with machines used for non-industrial purposes including personal use.

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

3.3.3
build space, noun
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, noun
total usable volume available in the machine for building *parts* (3.9.1)

3.3.5
build platform, noun
<of a machine> base which provides a surface upon which the building of the *parts* (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 certain types of *powder bed* (3.8.5) systems, a direct mechanical fixture between the part and the build platform is not necessarily required.

3.3.6
build surface, noun
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 (are) variable, it may be defined relative to the build surface.

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

3.3.8
build cycle, noun
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, noun
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, noun
operating parameters and system settings used during a *build cycle* (3.3.8)

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

3.3.12
manufacturing lot, noun
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* (3.6.10) steps (if required) as recorded on a single manufacturing work order

Note 1 to entry: The additive manufacturing system can 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, noun
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 typically includes, but is not limited to, *process parameters* (3.3.10), preparation and *post-processing* (3.6.10) 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, noun
set of 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, noun
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 can 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[7] gives the standard specification of AMF.

3.4.2
AMF consumer, noun
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, noun
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 to convert all curved triangles to flat triangles or convert porous material specification into an explicit mesh surface.

3.4.4
AMF producer, noun
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, noun
standard for the exchange of product model data

Note 1 to entry: This is an International Standard that provides a representation of product information along with the necessary mechanisms and definitions to enable product data to be exchanged. ISO 10303[4] applies to the representation of product information, including components and assemblies, the exchange of product data, including storing, transferring, accessing and archiving.

Note 2 to entry: ISO 10303-238, commonly referred to as STEP-NC, specifies the slicing operation and other mechanical commands in the AM process.

3.4.6
STL, noun
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
PDES, noun
Product Data Exchange Specification
data exchange specification 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[4] STEP.

3.4.8
attribute, noun
<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 Extensible Markup Language (XML)[10], attributes are characteristics of *elements* (3.3.10).

Note 2 to entry: In the *AMF* (3.4.1)-file, attributes can, for example, be used to carry notices enabling backwards traceability to CAD components, or markers that allow track and trace mechanisms for the file.