
**Additive manufacturing —
Material extrusion-based additive
manufacturing of plastic materials —**

**Part 2:
Process equipment**

*Fabrication additive — Fabrication additive de matériaux plastiques
à base d'extrusion de matière —*

Partie 2: Équipement de processus

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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.

This document was prepared by ISO/TC 261, *Additive manufacturing*, in cooperation with ASTM F 42, 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 first edition of ISO/ASTM 52903-2 cancels and replaces ASTM 20196-2.

A list of all parts in the ISO/ASTM 52903 series can be found on the ISO website.

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

The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system are not necessarily exact equivalents; therefore, each system needs to be used independently of the other. Combining values from the two systems can result in non-conformance with this document.

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Additive manufacturing — Material extrusion-based additive manufacturing of plastic materials —

Part 2: Process equipment

1 Scope

This document describes a method for defining requirements and assuring component integrity for plastic parts created using material extrusion based additive manufacturing processes. It relates to the process, equipment and operational parameters. Processes include all material extrusion based additive manufacturing processes.

This document is intended for use by AM users and customers procuring such parts.

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:—¹⁾, *Additive manufacturing — General principles — Fundamentals and vocabulary*

ISO/ASTM 52903-1, *Additive manufacturing — Material extrusion-based additive manufacturing of plastic materials — Part 1: Feedstock materials*

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

ASTM F3091/F3091M, *Standard Specification for Powder Bed Fusion of Plastic Materials*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/ASTM 52900 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 <http://www.electropedia.org/>

4 Process specification

4.1 General

According to the final quality of the part, the process may be classified under the following classes:

1) Under preparation. Current stage: ISO/ASTM FDIS 52900:2020.

4.2 Class I

Process specification: most rigorous process specification intended for use in producing the highest quality parts with the highest degree of confidence through detailed traceability required in quality documents.

4.3 Class II

Process specification: a rigorous process specification intended for use in producing high quality parts with less traceability than Class I.

4.4 Class III

Process specification: a general process specification intended for use as a guideline in processing quality parts using best practice with minimum traceability.

NOTE These classes are referenced from the powder bed fusion document ASTM F3091.

5 Materials

Materials shall be in accordance with ISO/ASTM 52903-1.

6 Fabrication of test specimens

6.1 General

Unless otherwise specified by the customer, all test specimens shall be additive manufactured parts which are not post-processed, with the exception of removing support material.

Since post-processing can affect some final part properties, the customer should consider evaluating test specimens with the same post processing as the one that the final parts have or are expected to have.

6.2 Direction-independent properties

Test specimens used to assess direction-independent properties may be built with associated parts anywhere in the build envelope at the part manufacturer's discretion. Unless otherwise specified by the customer or the specific test method to be employed, a minimum of three test specimens for each property per build shall be evaluated. The specimens may be aligned to any directional axis (X, Y, or Z) chosen by the part manufacturer.

6.3 Non-mechanical direction-dependent properties

Unless otherwise specified by the customer, test specimens used to assess non-mechanical, potentially direction-dependent properties such as electrical resistance shall be built in a location and direction deemed by the part manufacturer to be the least favourable orientation (ISO/ASTM 52921) within the master bounding box (ISO/ASTM 52900) for measurement of the property in question. Unless otherwise specified by the customer or the specific test method to be employed, a minimum of three test specimens per build shall be evaluated.

6.4 Mechanical direction-dependent properties

6.4.1 All mechanical property testing except tension testing

Unless otherwise specified by the customer, test specimens other than tension testing specimens used to assess mechanical properties such as flexural modulus, impact strength and shear modulus shall be built in a location and direction deemed by the part manufacturer to be the least favourable

orientation (ISO/ASTM 52921) within the master bounding box (ISO/ASTM 52900) for measurement of the property in question. Unless otherwise specified by the customer or the specific test method to be employed, three test specimens per build shall be evaluated.

6.4.2 Tension testing

Unless otherwise specified by the customer, the number, orientation and location of test specimens for evaluation of tensile mechanical properties shall be as specified in [Table 1](#).

Table 1 — Specifications for mechanical tension testing of material extrusion based additive manufacturing for plastics

Specification ^{ab}	Class I	Class II	Class III
Build certification	A minimum of three XY or YX tension specimens, and a minimum of three ZX or ZY tension specimens	A minimum of three XY or YX tension specimens	No tension specimens needed unless requested by customer
<p>^a For part orientation notation, see ISO/ASTM 52921.</p> <p>^b For ASTM D638 or ISO 527-1, smaller tension specimens may be used for ZX or ZY samples for build heights less than 57 mm (2,25 in).</p>			

7 Responsibility for quality assurance (inspection and test)

Unless otherwise specified in the contract or purchase order, the part manufacturer is responsible for the execution of all inspection and testing specified herein. Unless otherwise directed by the customer in the order, the part manufacturer may use their own or any other suitable facilities for the performance of the inspection and test requirements specified herein. The customer shall have the right to perform any inspection and testing set forth in the specification where such inspections are deemed necessary to assure that material conforms to prescribed requirements.

8 Tolerances and surface roughness

Tolerances, given in absolute or relative format, and surface roughness shall be defined by the customer in consultation with the part manufacturer.

9 Material processing

9.1 Maintenance

9.1.1 The additive manufacturing equipment shall be cleaned in accordance with the original equipment manufacturer's instructions and/or recommendations along with the part manufacturer's best practice prior to each build.

9.1.2 Special consideration shall be given to cleaning and maintaining the extrusion nozzle tip according to the manufacturer's specifications.

9.1.3 Mechanical and electronic adjustments shall be made to the additive manufacturing equipment according to the equipment manufacturer's specifications.

9.1.4 The building platform shall be clean and flat, in accordance with the original equipment manufacturer (OEM) requirements, prior to each build.

9.2 Raw material

Raw material shall be conditioned in accordance with the material manufacturer's specifications and in accordance with material specification ISO/ASTM 52903-1.

9.3 Process parameters

The part manufacturer should record parameters affecting the part production and reproducibility. For example, the following parameters for each build should be recorded, as applicable:

- temperature of liquefier (heat source)/extrusion screw temperature;
- nominal feed rate of feedstock;
- extrusion nozzle nominal tip diameter;
- nominal layer thickness;
- contour and infill specifics;
- build envelope temperature;
- build platform temperature;
- manufacturing time.

NOTE In some filament processes, the feed rate of the filament is automatically calculated by the software based on the nozzle tip and layer thickness and cannot be changed. For such cases, the "as applicable" language means it need not be recorded.

9.4 Production runs

If applicable, production runs shall comply with all customer specified requirements. Customer specifications may supersede the requirements listed in this document.

9.5 Post processing

9.5.1 Support material shall be removed from the test specimens and parts in accordance with the material manufacturer's recommendations.

9.5.2 If applicable, additional post processing methods for test specimens and parts shall comply with all customer specified requirements. The following subclauses ([9.5.3](#) to [9.5.5](#)) describe some post processing methods. Customer specifications may supersede the methods listed.

9.5.3 Parts may be finished (e.g. drilled, holes reamed, deburred, or hand sanded) to remove excess material from the part to meet requirements. A tumbler may also be used if the part geometry allows.

9.5.4 Parts may be visually examined for defects and anomalies (e.g. curl, growth, nodules, discoloration, distortion, layer lines, etc.) according to the customer's requirements and part supplier's standard practice. Parts may be scrapped if visual defects are present.

9.5.5 High intensity light can be required to check internal features. Light source shall be sufficient to yield penetration of the part structure requiring inspection. Care should be taken so the light source does not damage the plastic part.

10 Qualification

10.1 Additive manufacturing equipment qualification

Equipment qualification shall comply with the OEM recommended performance. The customer may require additional equipment performance characteristics.

10.2 Build qualification

The part manufacturer shall use OEM parameters for the material being used or modified parameters based on best practice.

10.3 Additive manufacturing equipment requalification

Systems that are not currently under an active maintenance contract shall follow OEM's recertification process.

11 Report

If requested, a report shall be provided by the part manufacturer to the customer at the time of shipment stating that the parts were manufactured in accordance with this document.

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