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

**Part 1:
Feedstock materials**

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

Partie 1: Matières premières

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Contents

	Page
Foreword	iv
1 Scope	1
2 Normative references	1
3 Terms and definitions	1
4 Materials	2
4.1 Material classification	2
4.2 Manufactured feedstock	2
5 Certification	2
6 Material packaging and package marking	2
7 Quality assurance	3
Annex A (normative) Standard nomenclature of feedstock plastic materials	4
Bibliography	5

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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, *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.

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.

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

Part 1: Feedstock materials

1 Scope

This document describes a method for defining requirements for plastic materials used in extrusion-based additive manufacturing (AM) processes. Materials include unfilled, filled, and reinforced plastic materials suitable for processing into parts. These materials can also contain special additives (e.g. flame retardants, stabilizers, etc.). Processes include all material extrusion-based AM processes.

This document is intended for use by manufacturers of materials, feedstocks, plastic parts or any combination of the three using material extrusion-based AM.

NOTE In some cases, material manufacturers can also be feedstock manufacturers. In other cases, a material manufacturer can supply materials (example: pellets) to a feedstock manufacturer (example: converter of pellets into filaments).

This document does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health, and environmental practices and determine the applicability of regulatory limitations prior to use.

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*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/ASTM 52900 and the following 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/>

3.1

filament

feedstock characterized by extreme length relative to its uniform cross section

3.2

pellets

small mass of preformed feedstock material, having relative uniform dimensions in any given batch

Note 1 to entry: Pellets of smaller size can sometimes be referred to as micro-pellets.

4 Materials

4.1 Material classification

This document is intended to facilitate communication between material manufacturers, feedstock manufacturers, and purchasers. Required properties of the feedstock and test methods shall be included in the purchase order. Classification of plastic material types, compositions, and testing methodologies can be found in ASTM and ISO classification documents.

Both the feedstock and final test part can be referenced by the appropriate material classification.

One example of a general classification document is ASTM D4000 or ISO 1043-1. As ASTM D4000 or ISO 1043-1 recommends, the user should refer to specific material classification documents, if they exist.

Since the process of this document is referred to as extrusion, the letter E shall be used as code where required by the classification standard. See [Annex A](#) for further information and examples.

4.2 Manufactured feedstock

4.2.1 The composition, melt flow rate, thermal characteristics, and physical properties shall be acceptable for the material extrusion-based AM process as determined by the vendor, resin producer, or material supplier. The properties of the feedstock, including those of the spool and filament, should be determined by the feedstock manufacturer.

4.2.2 The characteristics of spool and the characteristics of the filament, for example cross section and length on spool of filament, shall be according to the specifications and tolerances of the AM machine manufacturer. If a specified maximum level of moisture is required, the spool shall be sold in sealed packaging. Also, the manufacturer shall supply recommended storage conditions.

4.2.3 If a feedstock of powder or pellets has a recommended moisture level, the powder or pellets can be additionally dried by the AM user, as recommended by the powder or pellet vendor, before being used in the AM machine.

4.2.4 To ensure consistency and quality, feedstock lots shall be supplied with documentation to include, at a minimum, feedstock vendor name, material identification, lot number, and date of manufacture. To facilitate traceability, the feedstock material, filament spool, or container shall have a unique alphanumeric identifier.

5 Certification

The material manufacturer shall, on request, furnish to the purchaser a certificate of conformance stating that each lot has been sampled, tested, and inspected in accordance with this document and has been found to meet the requirements. This certificate shall include all properties that the purchaser requests, including lot number and other information from original raw materials used, and those of the final feedstock (filament) to be used in the manufacture of a part and the standard used in reference for the classification (ASTM D 4000 or ISO 1043-1).

6 Material packaging and package marking

The material shall be packaged to provide adequate protection during normal handling and transportation.

[4.2.2](#) or [4.2.3](#) shall be followed to ensure moisture content, if moisture content is a requirement.

Each shipping container shall contain the purchaser's purchase order number and a detailed part list with quantities on a part manufacturer's supplied packing list.

7 Quality assurance

If a purchaser of a material, feedstock, or both requires data from standard AM samples, these samples shall be produced and tested according to the purchaser's specifications. Unless otherwise specified in the contract or purchase order, the supplier of the material, feedstock, or both to the purchaser is responsible for the execution of all inspection and testing specified. The supplier may use their own or any other suitable facilities for the performance of the sample manufacturing, inspection, and test requirements specified, unless requested differently by the purchaser in the order. The purchaser may have the right to perform any inspection and testing set forth in this document where such inspections are deemed necessary to assure that material conforms to prescribed requirements.

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Annex A (normative)

Standard nomenclature of feedstock plastic materials

The standard nomenclature for polymers allows incorporation of additional property categories as described in the classification system of ASTM D4000 and ISO 1043-1, including color, fluid resistance, melting point, electrical properties, flammability, specific gravity, heat resistance, hardness, tensile strength, tensile modulus, elongation, moisture resistance or content or both, flexural strength, impact resistance, compressive strength, volatile loss and gas permeability, oxidative stability, shear modulus, transmission haze, flexural modulus, viscosity, weather resistance, humidity aging, and deflection temperature. The standard nomenclature allows conformance with either ASTM International or ISO standards.

In this annex, an example for the appropriate nomenclature for ABS is provided following ISO 19062-1 (equivalent to the classification system of ASTM D4673) in which up to five blocks can be described such as:

- identification of the plastic according to ISO 1043-1 and information relative to composition (Block 1),
- filler or reinforcement and nominal content (Block 2),
- application or process or both, letter E for extrusion (Block 3),
- properties (Vicat temperature, flow index, charpy impact, and tensile strength) (Block 4), and
- additional information (Block 5).

EXAMPLE ISO 19062-ABS-1, E, 125-04-16-25

where

ISO 19062 is the standard

Block 1: ABS is the plastic identification

Block 2: empty (,)

Block 3: E (extrusion)

Block 4: Vicat temperature (125°C), flow index (4 g/10 min), Charpy impact (16 kJ/m²), tensile modulus 2 500 MPa (classified under the group 25)

Block 5: empty (,)

Bibliography

[1] ASTM D149, *Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies*

[2] ASTM D150, *Test Methods for AC Loss Characteristics and Permittivity (Dielectric Constant) of Solid Electrical Insulation*

[3] ASTM D256, *Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics*

[4] ASTM D257, *Test Methods for DC Resistance or Conductance of Insulating Materials*

[5] ASTM D638, *Test Method for Tensile Properties of Plastics*

[6] ASTM D648, *Test Method for Deflection Temperature of Plastics Under Flexural Load in the Edgewise Position*

[7] ASTM D696, *Test Method for Coefficient of Linear Thermal Expansion of Plastics Between -30 °C and 30 °C with a Vitreous Silica Dilatometer*

[8] ASTM D785, *Test Method for Rockwell Hardness of Plastics and Electrical Insulating Materials*

[9] ASTM D790, *Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials*

[10] ASTM D1238, *Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer*

[11] ASTM D1525, *Test Method for Vicat Softening Temperature of Plastics*

[12] ASTM D1895, *Test Methods for Apparent Density, Bulk Factor, and Pourability of Plastic Materials*

[13] ASTM D1921, *Test Methods for Particle Size (Sieve Analysis) of Plastic Materials*

[14] ASTM D3935, *Classification System and Basis for Specification for Polycarbonate (PC) Unfilled and Reinforced Material*

[15] ASTM D4000, *Classification System for Specifying Plastic Materials*

[16] ASTM D4673, *Classification System and Basis for Specification for Acrylonitrile-Butadiene-Styrene(ABS) Plastics and Alloys Molding and Extrusion Materials*

[17] ASTM D5205, *Classification System and Basis for Specification for Polyetherimide (PEI) Materials*

[18] ASTM E11, *Specification for Woven Wire Test Sieve Cloth and Test Sieves*

[19] ASTM E831, *Test Method for Linear Thermal Expansion of Solid Materials by Thermomechanical Analysis*

[20] ISO 62, *Plastics — Determination of water absorption*

[21] ISO 75-2, *Plastics — Determination of temperature of deflection under load — Part 2: Plastics and ebonite*

[22] ISO 178, *Plastics — Determination of flexural properties*

[23] ISO 179-1, *Plastics — Determination of Charpy impact properties — Part 1: Non-instrumented impact test*

[24] ISO 179-2, *Plastics — Determination of Charpy impact properties — Part 2: Instrumented impact test*

[25] ISO 306, *Plastics — Thermoplastic materials — Determination of Vicat softening temperature (VST)*