INTERNATIONAL STANDARD

ISO/ASTM 52924

First edition
2023-08

Additive manufacturing of polymers — Qualification principles — Classification of part properties

Fabrication additive des polymères — Principes de qualification — Classification des propriétés de la pièce

Reference number
ISO/ASTM 52924:2023(E)

© ISO/ASTM International 2023



COPYRIGHT PROTECTED DOCUMENT

© ISO/ASTM International 2023

All rights reserved. Unless otherwise specified, or required in the context of its implementation, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester. In the United States, such requests should be sent to ASTM International.

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11

Email: copyright@iso.org
Website: www.iso.org

ASTM International
100 Barr Harbor Drive, PO Box C700
West Conshohocken, PA 19428-2959, USA
Phone: +610 832 9634
Fax: +610 832 9635
Email: khooper@astm.org
Website: www.astm.org

Published in Switzerland

© ISO/ASTM International 2023 – All rights reserved

Contents

Page

Foreword ... **iv**

Introduction ... **v**

1 Scope ... **1**

2 Normative references ... **1**

3 Terms and definitions ... **1**

4 Symbols and abbreviations ... **2**
4.1 Symbols ... 2
4.2 Abbreviations ... 2

5 Classification system ... **3**
5.1 Definition of the classes of part property ... 3
5.2 Typical classification of important material classes and usage of the classification system for part properties ... 4

6 Test specimens for determining the characteristic values for the classification system ... **6**
6.1 General ... 6
6.2 Tensile properties ... 6
6.3 Dimensional accuracy ... 6
6.4 Density ... 6
6.5 Labelling ... 7
6.6 Orientation, grid arrangement, and distribution in the build space ... 7
6.6.1 General ... 7
6.6.2 Orientation and grid arrangement to be used ... 7
6.6.3 Distribution in the build space ... 7
6.7 Manufacturing ... 11

7 Determination of characteristic values and classification in the classification system ... **12**
7.1 General ... 12
7.2 Mechanical properties ... 12
7.2.1 General ... 12
7.2.2 Determination of characteristic values ... 12
7.2.3 Classification in the classification system ... 13
7.3 Dimensional accuracy ... 13
7.3.1 General ... 13
7.3.2 Determination of characteristic values ... 13
7.3.3 Classification in the classification system ... 14
7.4 Relative part density ... 14
7.4.1 General ... 14
7.4.2 Determination of characteristic values ... 14
7.4.3 Classification in the classification system ... 14
7.5 Classification in classes of part properties ... 14

8 Initial classification and regular checking of the classifications ... **15**
8.1 Standard classification procedure ... 15
8.2 Initial classification ... 15
8.3 Regular checking ... 15
8.4 Renewed determination of the classifications in case of replacement of relevant machine components ... 15

Annex A (informative) **Form for part property classification in accordance with this document** ... **17**

Bibliography ... **18**

© ISO/ASTM International 2023 – All rights reserved

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 Technical Committee 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).

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.

© ISO/ASTM International 2023 – All rights reserved

Introduction

The goal of this document is to improve the communication between providers and users of additive manufactured polymer parts in relation to the part quality to be supplied. For this purpose, quality criteria and part properties are categorised into a system of quality classes.

In the additive manufacturing processes relevant for polymers, the part properties depend very heavily on the machine systems, the material and the process control used. Typically, the process control can be optimised for productivity or quality. These goals are in principle contradictory in the context of the performance of a specific machine.

The property classes listed in this document help to make clear the differences in quality. The property classes enable the user to define part specifications for manufacturing.

Along with the specification of the property classes, this document states which property classes can be achieved with typical materials. Test specimens and their arrangement in the build space are specified (the related CAD data are included with this document as positioned STL data and AMF data and available on: https://standards.iso.org/iso/52924/ed-1/en/). The determination of the mechanical tensile properties, the dimensional accuracy and the part density with the aid of these test specimens is described to make possible the assignment to property classes for the related characteristic values.

This document refers to parts produced by PBF and MEX processes. Certain processes within these categories have also been known under different process names and trademarks. For example, (for PBF) laser sintering when the fusion is enabled by a laser, -trademarked as SLS®, (selective laser sintering)[1)]. Other thermoplastic PBF trademarks include multi jet fusion (MJF) or high speed sintering where the fusion is enabled by infra-red light. MEX processes for thermoplastic polymers are also known by names such as fused layer modelling (FLM), fused layer manufacturing or fused filament fabrication (FFF). FDM (fused deposition modelling) is an existing trademark for this type of process. The mentioning of trademarks in this document are only for informative reasons and does not intend any form of endorsement of the mentioned products.

Rather than comparing capabilities of hardware, material solutions based on common parameter set inputs, are compared based on part property outcomes. This document supplies a framework for comparison of those outcomes. The goal of such a comparison exercise is one of “what does it take to get to a particular class outcome". The benefit of this approach is to decouple the nuances of different hardware solution providers from the comparison process, allowing a focus on material property outcomes, which are much more impactful in terms of end user value.

1) SLS® is an example of a suitable product available commercially. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of this product.

© ISO/ASTM International 2023 – All rights reserved

Additive manufacturing of polymers — Qualification principles — Classification of part properties

1 Scope

This document establishes the required or the achievable classes of part properties for additive manufactured polymer parts in order to get a common understanding on part quality. It is aimed at providers of manufacturing services for polymer parts who use additive manufacturing machines and at the customers for these services. Designers of parts as well as buyers and providers of manufacturing services can specify, in a traceable manner, the required or the achievable level of part properties with the aid of this document. The classification is based on mechanical, physical and geometrical properties. Further properties can be defined between buyer and provider of manufacturing.

This document is applicable to parts that have been manufactured from a thermoplastic polymer by means of thermal reaction fusion of material typically applied by a powder bed fusion (PBF) or material extrusion (MEX) processes. This document is also applicable to thermoplastic parts made by other processes, provided that due consideration is given to process-specific topics.

The classification of part properties applies to parts in as-built condition, that have been unpacked from the build space, with all support structures removed, but prior to any post-processing operations.

Specific industries (e.g. aerospace and medical) typically specify additional requirements.

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 37, *Rubber, vulcanized or thermoplastic — Determination of tensile stress-strain properties*

ISO 291, *Plastics — Standard atmospheres for conditioning and testing*

ISO 527-1, *Plastics — Determination of tensile properties — Part 1: General principles*

ISO 527-2, *Plastics — Determination of tensile properties — Part 2: Test conditions for moulding and extrusion plastics*

ISO 10350-1, *Plastics — Acquisition and presentation of comparable single-point data — Part 1: Moulding materials*

ISO 17295[2)], *Additive manufacturing — General principles — Part positioning, coordinates and orientation*

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.

2) ISO 17295 cancels and replaces ISO/ASTM 52921-13 which is still available at https://www.astm.org/f2921-13r19.html.

© ISO/ASTM International 2023 – All rights reserved