SLOVENSKI STANDARD
SIST-TP CEN ISO/ASTM TR 52905:2023

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Dodajalna izdelava kovinskih izdelkov - Neporušitveno preskušanje in vrednotenje - Detekcija napak v delih (ISO/ASTM TR 52905:2023)

Additive manufacturing of metals - Non-destructive testing and evaluation - Defect detection in parts (ISO/ASTM TR 52905:2023)

Additive Fertigung von Metallen - Zerstörungsfreie Prüfung und Bewertung - Erkennung von Fehlstellen in Bauteilen (ISO/ASTM TR 52905:2023)

Fabrication additive de métaux - Essais et évaluation non destructifs - Détection de défauts dans les pièces (ISO/ASTM TR 52905:2023)

Ta slovenski standard je istoveten z: **CEN ISO/ASTM TR 52905:2023**

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SIST-TP CEN ISO/ASTM TR 52905:2023 **en**

TECHNICAL REPORT

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CEN ISO/ASTM TR 52905

June 2023

ICS 77.040.20; 25.030

English Version

Additive manufacturing of metals - Non-destructive testing and evaluation - Defect detection in parts (ISO/ASTM TR 52905:2023)

Fabrication additive de métaux - Essais et évaluation non destructifs - Détection de défauts dans les pièces (ISO/ASTM TR 52905:2023)

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European foreword

This document (CEN ISO/ASTM TR 52905:2023) has been prepared by Technical Committee ISO/TC 261 "Additive manufacturing" in collaboration with Technical Committee CEN/TC 438 “Additive Manufacturing” the secretariat of which is held by AFNOR.

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The text of ISO/ASTM TR 52905:2023 has been approved by CEN as CEN ISO/ASTM TR 52905:2023 without any modification.

TECHNICAL REPORT

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First edition
2023-06

Additive manufacturing of metals — Non-destructive testing and evaluation — Defect detection in parts

Fabrication additive de métaux — Essais et évaluation non destructifs — Détection de défauts dans les pièces

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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).

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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.

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, 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.

Introduction

In response to the urgent need for standards for Additive Manufacturing (AM), this document initially indicates Non-Destructive Testing (NDT) methods with potential to detect defects and determine residual strain distribution that are generated in AM processes. A number of these methods were verified. The strategy adopted was to review existing NDT standards for matured manufacturing processes which are similar to AM, namely casting and welding. This potentially reduces the number of standards required to comprehensively cover the defects in AM. For identified AM unique defects, this document proposes a two-level NDT approach: a star artefact as an Initial Quality Indicator (IQI) and *à la carte* artefact where an example shows the specific steps to follow for the very specific unique AM part to be built, paving the way for a structured and comprehensive framework.

Most metal inspection methods in NDT use ultrasound or X-rays, but these techniques cannot always cope with the complicated shapes typically produced by AM. In most circumstances X-ray computed tomography (CT) is a more suitable method, but it also has limitations and room for improvement or adaptation to AM, on top of being a costly method both in time and money.

This document includes post-process non-destructive testing of additive manufacturing (AM) of metallic parts with a comprehensive approach. It covers several sectors and a similar framework can be applied to other materials (e.g. ceramics, polymers, etc.). In-process NDT and metrology standards are referenced as they are being developed. This document presents current standards capability to detect which of the Additive Manufacturing (AM) flaw types and which flaws require new standards, using a standard selection tool. NDT methods with the highest potential will be tested.

Additive manufacturing of metals — Non-destructive testing and evaluation — Defect detection in parts

1 Scope

This document categorises additive manufacturing (AM) defects in DED and PBF laser and electron beam category of processes, provides a review of relevant current NDT standards, details NDT methods that are specific to AM and complex 3D geometries and outlines existing non-destructive testing techniques that are applicable to some AM types of defects.

This document is aimed at users and producers of AM processes and it applies, in particular, to the following:

— safety critical AM applications;

— assured confidence in AM;

— reverse engineered products manufactured by AM;

— test bodies wishing to compare requested and actual geometries.

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 11484, *Steel products — Employer's qualification system for non-destructive testing (NDT) personnel*

ISO/ASTM 52900, *Additive manufacturing — General principles — Fundamentals and vocabulary*

ASTM E1316, *Terminology for Nondestructive Testing*

EN 1330-2, *Non-destructive testing — Terminology — Part 2: Terms common to the non-destructive testing methods*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/ASTM 52900, ASTM E1316, EN 1330-2, ISO 11484, 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 https://www.electropedia.org/

3.1
flaw type
identifiable features that defines a specific flaw

Note 1 to entry: defect term, this word is used when a flaw that does not meet specified acceptance criteria and is rejectable.

Note 2 to entry: Flaw term, an imperfection or discontinuity that is not necessarily rejectable

3.2
lack of fusion
LOF
type of process-induced porosity, in which the powder or wire feedstock is not fully melted or fused onto the previously deposited substrate

Note 1 to entry: In PBF, this type of flaw can be an empty cavity, or contain unmelted or partially fused powder, referred to as unconsolidated powder.

Note 2 to entry: LOF typically occurs in the bulk, making its detection difficult.

Note 3 to entry: Like voids, LOF can occur on the build layer plane (layer/horizontal LOF) or across multiple build layers (cross layer/vertical LOF).

3.3
unconsolidated powder
unmelted powder that due to process failure was not melted and became trapped internally

3.4
layer shift
<E beam> when it is disturbed by a magnetic field a layer or a number of layers are shifted away from the other build layers

Note 1 to entry: see stop/start for PBF laser/E beam.

3.5
trapped powder
unmelted powder that is not intended for the part but is trapped within internal part cavities

3.6
porosity
presence of small voids in a part making it less than fully dense

Note 1 to entry: Porosity may be quantified as a ratio, expressed as a percentage of the volume of voids to the total volume of the part.

[SOURCE: ISO/ASTM 52900:2019, 3.11.8]

4 NDT potential for authentication and/or identification

Some of the NDT methods in this technical report have the additional potential to extract authentication and/or identification apparatus or design embedded in the design of the AM part. Such a potential clearly depends on the material(s), geometry and process selected to fabricate the part, however the design information and AM data file can embed in its geometry or texture ad-hoc devices that potentially could be extracted by NDT techniques. ISO/TC 292 specifies and maintains a number of standards supporting such devices within the ISO referential, and are fully applicable to AM digital information. The specific requirements of design techniques, materials, processes, NDT modalities and applications, however, still require careful evaluation, selection and classification.