SLOVENSKI STANDARD
oSIST prEN ISO/ASTM 52948:2023

01-december-2023

Aditivna proizvodnja kovinskih izdelkov - Neporušitveno preskušanje in vrednotenje - Razvrstitev nepravilnosti v delih, izdelanih s spajanjem prahu v postelji (PBF) (ISO/ASTM DIS 52948:2023)

Additive manufacturing for metals - Non-destructive testing and evaluation - Imperfections classification in PBF parts (ISO/ASTM DIS 52948:2023)

Additive Fertigung für Metalle - Zerstörungsfreie Prüfung und Bewertung - Klassifizierung von Fehlern in PBF-Teilen (ISO/ASTM DIS 52948:2023)

Fabrication additive de métaux - Essais et évaluations non destructifs - Classification des imperfections dans les pièces PBF (ISO/ASTM DIS 52948:2023)

Ta slovenski standard je istoveten z: **prEN ISO/ASTM 52948**

ICS:

19.100	Neporušitveno preskušanje	Non-destructive testing
25.030	3D-tiskanje	Additive manufacturing

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Additive manufacturing for metals — Non-destructive testing and evaluation — Imperfections classification in PBF parts

Fabrication additive de métaux — Essais et évaluations non destructifs — Classification des imperfections dans les pièces PBF

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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).

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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).

Introduction

Metal laser powder bed fusion (PBF) additive manufacturing (AM) using a laser beam (PBF-LB) or an electron beam (PBF-EB) is in full development. It consists of depositing layers of powder on a tray and fusing each layer with a laser or electron beam. It is thus possible to produce parts of great geometric complexity.

The control of this process is the subject of numerous studies to attain the best possible quality. It is essential to supplement the approaches addressed by these studies with a standard describing observable imperfections to serve as a basis for non-destructive testing (NDT).

Knowledge of the imperfections generated by the manufacturing process and their standardised classification are preliminary and essential steps in defining and applying acceptance.

Additive manufacturing for metals — Non-destructive testing and evaluation — Imperfections classification in PBF parts

1 Scope

This document specifies the classification of imperfections likely to be generated during an additive manufacturing process by PBF-LB (laser beam powder bed fusion) or PBF-EB (electron beam powder bed fusion) for metallic parts.

This document also indicates the most probable causes of the formation of imperfections and includes illustrations.

This can be extended to other additive manufacturing process categories as long as no other related standard exists.

Acceptance criteria for imperfections are not included in this document.

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 version cited applies. For undated references, the latest version of the referenced document (including any amendments) applies.

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

ISO 3252, *Powder metallurgy — Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions of ISO 3252, ISO/ASTM 52900 and the following apply.

ISO and IEC maintain terminological databases for use in standardisation at the following addresses:

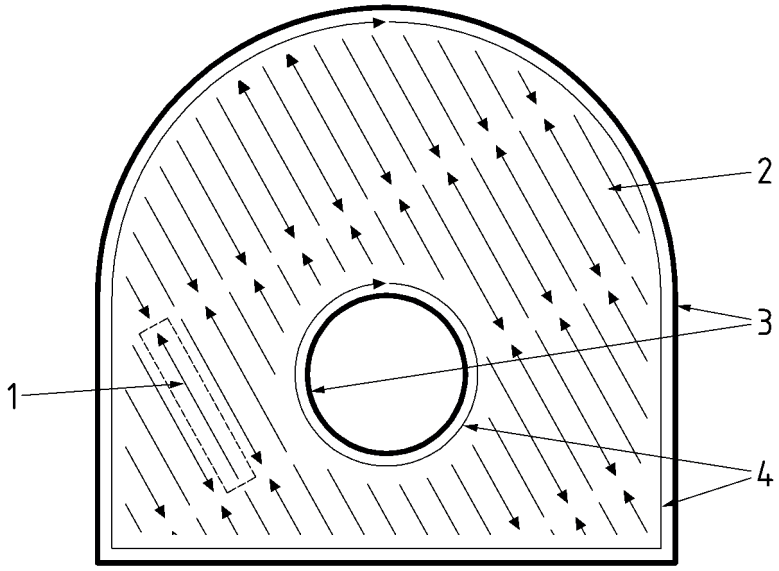
— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
contour
one or a set of scan trajectories following the edges of the layer

Note 1 to entry: Among scanning strategies, it is very common to use one or more contours, which consist of paths that follow the edges of the layer.

Note 2 to entry: See Figure 1.



Key

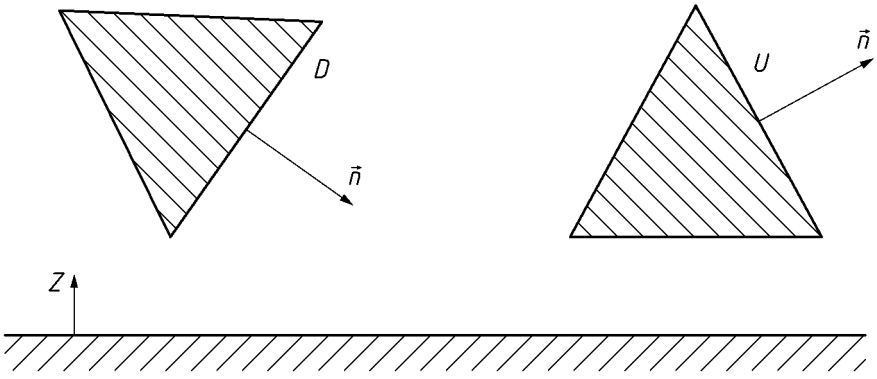
1 weld bead
2 core scanning strategy
3 geometric edge
4 contour

Figure 1 — Example of a manufacturing strategy using a contour

3.2
downskin area
D
(sub-)area where the normal vector projection on the z-axis is negative

Note 1 to entry: See Figure 2.

[SOURCE: ISO/ASTM 52911-1, 3.2 modified — reference to Figure 2 instead of Figure 1]



Key

$\vec{n}$ normal vector
D downskin area (left)
U upskin area (right)

Figure 2 — Upskin and downskin areas *U* and *D* (extracted from Figure 1 of ISO/ASTM 52911-1)

3.3
imperfection
any discontinuity or deviation observed from a specification (geometrical, material integrity)

3.4
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).

[SOURCE: ISO/TR ASTM 52905, 3.2]

3.5
powder spreading device
layering device
powder supply mechanism, which distributes and evenly spreads the powder on the build surface

[SOURCE: ISO/ASTM 52941, 3.4 modified — addition of accepted term layering device]

3.6
scanning strategy
concept that describes the laser or electron beam path at each layer

Note 1 to entry: The scanning strategy is automatically generated by the machine or by upstream software. There is a wide variety of scanning strategies.

Note 2 to entry: See Figure 3 where each arrow represents a weld bead.

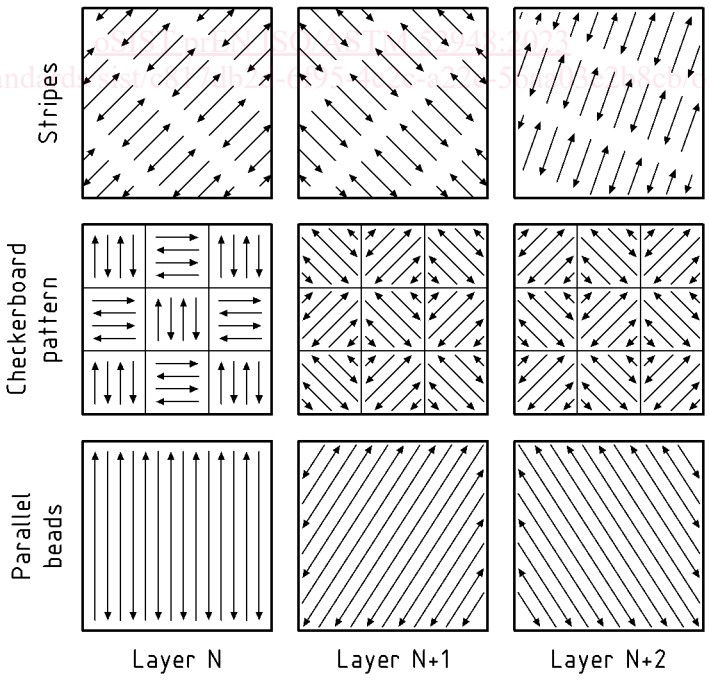


Figure 3 — Different types of scanning strategy

3.7
upskin area
U
(sub-)area where the normal vector n projection on the z-axis is positive

Note 1 to entry: See Figure 2.

[SOURCE: ISO/ASTM 52911-1, 3.4 modified — reference to Figure 2 instead of Figure 1]

3.8
bead
continuous line of fused metal

4 Classification of imperfections

4.1 General

The principle of the classification (or numbering) system is based on six groups of imperfections according to Table 1.

Table 1 — Classification of imperfection by type

Class	Imperfection type
1	Crack
2	Porosity
3	Solid inclusion
4	Lack of fusion[a]
5	Shape imperfection and dimensional imperfection[b]
6	Other imperfection type

[a] Also defined as cross-layer or layer on ISO/ASTM TR 52905 and vertical LoF or Horizontal LoF in ASTM E3166.

[b] Equivalent to layer shift in ISO/ASTM TR 52905 and ASTM E3166.

The occurrence of imperfections can be related to issues in the process or the machine (see Annex B), the powder (see Annex C), or issues arising during stages subsequent to the manufacturing process (see Annex D).

4.2 Designation

In this document, the imperfection class (or numbering) shall be preceded by the prefix PBF which corresponds to PBF processes using a laser or electron beam.

When a designation is required for an imperfection, it shall have the following structure:
ISO/ASTM 52948-PBF-[nnn].

With

ISO/ASTM 52948 for reference to this document

PBF indicating powder bed fusion (with laser or electron beam)

nnn classification index according to the type of imperfection (see 4.3)

EXAMPLE The designation ISO/ASTM 52948-PBF-112 according to this document refers to a crack within a part produced using powder bed fusion.

To simplify reading, in the following imperfections are designated PBF- [nnn].