

# SVENSK STANDARD

## SS-ISO 13947:2011

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### **Provningsmetod för bestämning av ickemetalliska inneslutningar i metalliska pulver genom användning av pulversmidda provkroppar (ISO 13947:2011, IDT)**

**Metallic powders – Test method for the determination of non-  
metallic inclusions in metal powders using a powder-forged  
specimen (ISO 13947:2011, IDT)**

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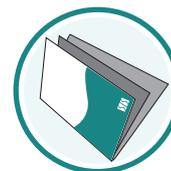
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Den internationella standarden ISO 13947:2011 gäller som svensk standard. Detta dokument innehåller den officiella engelska versionen av ISO 13947:2011.

Denna standard ersätter SS-ISO 13947:2010, utgåva 1.

The International Standard ISO 13947:2011 has the status of a Swedish Standard. This document contains the official version of ISO 13947:2011.

This standard supersedes the Swedish Standard SS-ISO 13947:2010, edition 1.

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Denna standard är framtagen av kommittén för Pulvermetallurgi, SIS/TK 133.

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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.

ISO 13947 was prepared by Technical Committee ISO/TC 119, *Powder metallurgy*, Subcommittee SC 2, *Sampling and testing methods for powders (including powders for hardmetals)*.

This second edition cancels and replaces the first edition (ISO 13947:2007), of which it constitutes a minor revision.



# Metallic powders — Test method for the determination of non-metallic inclusions in metal powders using a powder-forged specimen

**SAFETY PRECAUTIONS** — This International Standard does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user of this International Standard to establish appropriate safety and health practices and to determine the applicability of regulatory limitations prior to use.

## 1 Scope

This International Standard specifies a metallographic method for determining the non-metallic inclusion level in metal powders using a powder-forged specimen. The test method covers repress powder-forged test specimens in which there has been minimal lateral flow (<1 %). The core region of the powder-forged test specimen contains no porosity detectable at 100× magnification.

This test method can also be used to determine the non-metallic inclusion content of powder-forged steel parts. However, in parts where there has been a significant amount of material flow, the near-neighbour separation distance needs to be changed, or the inclusion sizes agreed between the parties need to be adjusted.

This test method is not suitable for determining the non-metallic inclusion level of parts that have been forged such that the core region contains porosity. At the magnification used for this test method, residual porosity is hard to distinguish from inclusions. Too much residual porosity makes a meaningful assessment of the inclusion population impossible.

This test method can be applied to materials that contain manganese sulfide (admixed or prealloyed), provided the near-neighbour separation distance is changed from 30 µm to 15 µm.

## 2 Normative references

The following referenced documents are indispensable for the application 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/TR 14321:1997, *Sintered metal materials, excluding hardmetals — Metallographic preparation and examination*

ASTM B796, *Standard test method for nonmetallic inclusion content of powders intended for powder forging (P/F) applications*

ASTM E3, *Standard guide for preparation of metallographic specimens*

ASTM E768, *Standard guide for preparing and evaluating specimens for automatic inclusion assessment of steel*

## 3 Principles

A section representing the core region of the test specimen (part) is cut from the test piece (part) prior to metallographic grinding and polishing (mounting the section is optional but strongly recommended).

The polished sample is examined microscopically at a magnification of 100× and a note is made of inclusions greater than a predetermined size.

The maximum Feret's diameter is used to determine inclusion size. A Feret's diameter is a caliper diameter, as illustrated in Figure 1.

The fragmented nature of some inclusions means that their size determination is somewhat complicated. The concept of near-neighbour separation shall be used in determining inclusion size. According to this concept, if an inclusion is within a certain distance of its neighbouring particles, it is considered a member of an inclusion cluster or agglomerate. Detected features within 30 µm of one another are considered part of the same inclusion. The concept is illustrated schematically in Figure 2.

The non-metallic inclusion level of the test specimen (part) is reported as the number of inclusions, per 100 mm<sup>2</sup>, greater than or equal to the predetermined size.

## 4 Significance and use

**4.1** The non-metallic inclusion level of ferrous powders is an indication of powder cleanliness. In pressed and sintered ferrous powder metallurgy (PM) materials, the extensive porosity present masks the effect of inclusions on mechanical properties. In contrast, the properties of a PM material processed to near pore-free density are strongly influenced by the composition, size, size distribution, and location of non-metallic inclusions.

**4.2** The test for non-metallic inclusions in fully dense steel parts is useful as

- a characteristic to classify or differentiate one grade of powder or batch of parts from another, and
- a lot-to-lot quality comparison of powders intended for powder forging.

**4.3** A significant amount of variation in non-metallic inclusion content will occur

- if the powder used to form the test specimen (part) does not meet the required quality standards for non-metallic inclusion content, or
- processing of the test specimen (part) has been carried out under conditions that do not permit oxide reduction or allow oxidation of the test specimen (part), or both.

**4.4** The use of the near-neighbour concept offers a more conservative estimate of the inclusions: it will overestimate rather than underestimate them.

## 5 Apparatus

**5.1 Equipment**, for the metallographic preparation of test specimens.

**5.2 Metallographic microscope**, permitting observation and measurement up to a magnification of 100× using light with a wavelength of 544 nm (green filter), an objective lens with a magnification ranging from 8× to 12,5×, and a numerical aperture between 0,16 and 0,20.

**NOTE** Defining the light optics used is important because this determines the features that will be resolved, and all detected features are included in the assessment of inclusion size.

## 6 Test piece

**6.1** For the evaluation of the non-metallic inclusion content of a powder that is intended for use in powder-forging applications, the powder shall be mixed with an appropriate amount of graphite and lubricant and compacted to a specified green density. The test method covers repress powder-forged test specimens in which there has been minimal lateral flow (<1 %) so the diameter of the green compact shall be such, relative to the diameter of the forging die, that this requirement is met.