



BSI Standards Publication

Steel — Rating and classifying nonmetallic inclusions using the scanning electron microscope

National foreword

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A list of organizations represented on this committee can be obtained on request to its committee manager.

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nonmetallic inclusions using the
scanning electron microscope**

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métalliques à l'aide du microscope électronique à balayage*

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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 document 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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This document was prepared by Technical Committee ISO/TC 17, *Steel*, Subcommittee SC 7, *Methods of testing (other than mechanical tests and chemical analysis)*.

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.

Steel — Rating and classifying nonmetallic inclusions using the scanning electron microscope

1 Scope

This document specifies procedures for the rating and statistical analysis of non-metallic inclusions (referred to as inclusions hereafter) using a scanning electron microscope (SEM) with an energy dispersive X-ray spectrometer (EDS), a backscattered detector (BSD) and automatic image analysis capabilities.

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 4967, *Steel — Determination of content of non-metallic inclusions — Micrographic method using standard diagrams*

ISO 15632, *Microbeam analysis — Selected instrumental performance parameters for the specification and checking of energy-dispersive X-ray spectrometers (EDS) for use with a scanning electron microscope (SEM) or an electron probe microanalyser (EPMA)*

ISO 16700, *Microbeam analysis — Scanning electron microscopy — Guidelines for calibrating image magnification*

ISO 22309, *Microbeam analysis — Quantitative analysis using energy-dispersive spectrometry (EDS) for elements with an atomic number of 11 (Na) or above*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 16700, ISO 22309 and the following apply.

ISO and IEC maintain terminology 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

maximum Feret's diameter

maximum distance between the two parallel lines tangent to outer boundary of the particle measured in all directions, as shown in [Figure 1](#)

Note 1 to entry: It is a parameter used to describe the size of irregular particles.

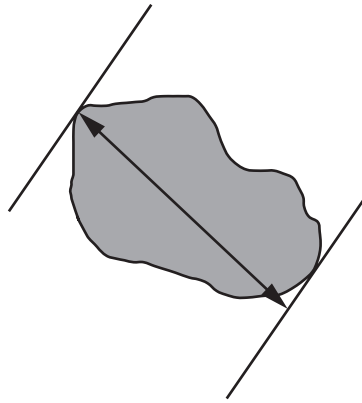


Figure 1 — Schematic of maximum Feret's diameter

3.2

equivalent circle diameter

ECD

diameter of the circle with an area equivalent to the particle

3.3

length

l

dimension of a particle or an inclusion in the main deformation direction, usually larger than the width

3.4

width

w

largest local dimension of a particle or an inclusion perpendicular to the main deformation direction ("calliper width")

3.5

aspect ratio

AR

ratio of length to width

3.6

analysis area

certain region of the specimen used to detect inclusions

3.7

rating area

square field of 0,5 mm²

Note 1 to entry: It is the specified area of rating inclusions in ISO 4967.

4 Principles

4.1 This document specifies two methods: rating method and statistical analysis method.

4.2 Rating method can use morphology or chemistry as the primary basis for sorting particles into types. When morphology is mainly used to sort inclusions with chemistry as auxiliary means, it produces the same ratings as ISO 4967, as illustrated in [Figure 2](#). However, the rating is performed using a fully automated SEM image analysis system. When agreed by mutual parties, it is also allowed to sort inclusions mainly according to chemistry, but use morphology as auxiliary means, as illustrated in [Figure 3](#). In this case, it might produce different ratings from ISO 4967. The two rating methods are called morphology rating method and chemistry rating method, respectively. The rating method is intended for inclusions with a width larger than 2 µm in