INTERNATIONAL STANDARD

ISO 16700

Second edition
2016-08-01

Microbeam analysis — Scanning electron microscopy — Guidelines for calibrating image magnification

Analyse par microfaisceaux — Microscopie électronique à balayage — Lignes directrices pour l'étalonnage du grandissement d'image

Reference number
ISO 16700:2016(E)

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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 on 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 the following URL: www.iso.org/iso/foreword.html.

The committee responsible for this document is ISO/TC 202, *Microbeam analysis*, Subcommittee SC 4, *Scanning electron microscopy (SEM)*.

This second edition cancels and replaces the first edition (ISO 16700:2004), which has been technically revised.

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Introduction

The scanning electron microscope is widely used to investigate the surface structure of a range of important materials such as semiconductors, metals, polymers, glass, food and biological materials, and this International Standard is relevant to the need for magnification calibration of the images. It describes the requirements for calibration of the image magnification in the scanning electron microscope using a reference material or a certified reference material.

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Microbeam analysis — Scanning electron microscopy — Guidelines for calibrating image magnification

1 Scope

This International Standard specifies a method for calibrating the magnification of images generated by a scanning electron microscope (SEM) using an appropriate reference material. This method is limited to magnifications determined by the available size range of structures in the calibrating reference material. This International Standard does not apply to the dedicated critical dimension measurement SEM.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/IEC 17025:2005, *General requirements for the competence of testing and calibration laboratories*

ISO Guide 30, *Reference materials — Selected terms and definitions*

ISO Guide 34, *General requirements for the competence of reference material producers*

ISO Guide 35, *Reference materials — General and statistical principles for certification*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
scanning electron microscope
SEM
instrument that produces magnified images of a specimen by scanning its surface with an electron beam

3.2
image
two-dimensional representation of the specimen surface generated by *SEM* (3.1)

Note 1 to entry: A photograph of a specimen taken using an SEM is a good example of an image.

3.3
image magnification
ratio of the linear dimension of the scan display to the corresponding linear dimension of the specimen scan field

3.4
scale marker
line/generated line (intervals) on the *image* (3.2) representing a designated actual length in the specimen

3.5
reference material
RM
material, sufficiently homogeneous and stable with respect to one or more specified properties, which has been established to be fit for its intended use in a measurement process

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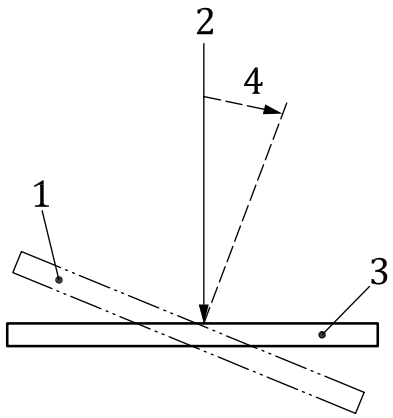
3.6
certified reference material
CRM
reference material (3.5) characterized by a metrologically valid procedure for one or more specified properties, accompanied by a certificate that provides the value of the specified property, its associated uncertainty, and a statement of metrological traceability

Note 1 to entry: For the purposes of this International Standard, an RM/CRM possesses pitch pattern(s) with the desired range of pitch size(s) and accuracy, to be used for the calibration of the *image magnification* (3.3).

3.7
calibration
set of operations which establish, under specified conditions, the relationship between the magnification indicated by the *SEM* (3.1) and the corresponding magnification determined by examination of an *RM* (3.5) or a *CRM* (3.6)

3.8
tilt angle
angle of the inclined specimen surface from the plane perpendicular to the electron beam axis

Note 1 to entry: See Figure 1.



Key
1 tilted specimen
2 electron beam
3 specimen
4 tilt angle

Figure 1 — Tilt angle

3.9
display
analog or digital device used for visualization of *images* (3.2)

Note 1 to entry: Examples of display are a cathode ray tube, plasma display panel, liquid crystal display, etc.

3.10
working distance
distance between the specimen surface and the bottom plane of the objective lens of the *SEM* (3.1)

3.11
pitch
closest separation of two similar features on a specimen which are equivalent points on a repeat pattern

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3.12
accuracy
closeness of agreement between a test result and the accepted reference value

Note 1 to entry: A "test result" constitutes the observed values of a *pitch* (3.11) of a *CRM* (3.6) obtained by the procedure outlined in this International Standard.

Note 2 to entry: The term "accepted reference value" is a value certified by a national or an international calibrating laboratory. There will be an uncertainty associated with this value which should also appear on the certificate.

Note 3 to entry: Accuracy and precision are different. Precision is defined as the closeness of agreement between independent test results obtained under stipulated conditions. See ISO 5725-1.

4 Image magnification

4.1 Scale marker

To indicate magnification, superimpose on the image a scale marker and the corresponding length, in SI units, that it actually represents on the specimen. An example is shown in Figure 2.



NOTE In Figure 2, the length indicated by the arrows corresponds to 500 nm after the calibration.

Figure 2 — Scale marker and its length

4.2 Expressing magnification

Magnification of an image is given by a number representing the number of times the object has been magnified and it is accompanied by the symbol "×" (e.g. 100 ×, 10 000 ×, 10k × or × 100, × 10 000, × 10k, where 100, 10 000 and 10k are magnitude numbers).

NOTE 1 It is not always necessary to show the magnification when the scale marker is shown on the image.

NOTE 2 The magnification shown on the image corresponds to a chosen output device, which can be a display monitor or a printer or a photographing device. The scale marker shown on the image is independent from the output device chosen by the operator of the SEM. The magnification shown corresponds to the scale marker only when the image is displayed or printed on the operator-chosen output device.

5 Reference material

5.1 General

See ISO Guide 30.

For calibrating the magnification of an image, wherever possible, choose a CRM that is produced in accordance with ISO Guide 34 and certified in accordance with ISO Guide 35.

When a suitable CRM is not available, an RM produced in accordance with ISO Guide 34 may be used.

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