
**Microbeam analysis — Scanning
electron microscopy — Qualification
of the scanning electron microscope
for quantitative measurements**



This document is a preview generated by EKO



COPYRIGHT PROTECTED DOCUMENT

© ISO 2021

All rights reserved. Unless otherwise specified, or required in the context of its implementation, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

Contents

Page

Foreword	v
Introduction	vi
1 Scope	1
2 Normative references	1
3 Terms and definitions	1
4 Symbols and abbreviated terms	3
5 General principles	5
5.1 Condition setting	5
5.2 Contrast/brightness setting	5
5.3 Sample preparation	6
6 Measurement of image sharpness	7
7 Measurement of drift and drift-related distortions (imaging repeatability)	8
7.1 Measurement of image drifts within specified time intervals	9
7.1.1 One-minute drift measurement	10
7.1.2 Ten-minute drift measurement	10
7.1.3 One-hour drift measurement	10
7.1.4 Long-term larger than one-hour drift measurement	10
7.2 Evaluation of the drift and the drift-related distortions by using image overlay	11
7.3 Evaluation of the drift and the drift-related distortions by using cross-correlation function (CCF)	13
7.3.1 Measurement of the drifts by using the CCF	13
7.3.2 Measurement of the distortions by using the CCF	15
8 Measurement of electron-beam-induced contamination	15
8.1 Cleaning of the sample surface	16
8.2 Cleaning of the inner surfaces of the sample chamber	16
8.3 Measurement method of the contamination	17
8.3.1 Measurement of the height of the contamination growth	17
8.3.2 Measurement of relative carbon concentration of the contamination by the X-ray analysis	18
8.3.3 Measurement of the surface contamination by the change of SEM signal intensities	18
9 Measurement of the image magnification and linearity	19
9.1 Measurement of the image magnification	20
9.2 Measurement of the image linearity	21
10 Measurement of background noise	22
10.1 Evaluation methods by using noise profiles and processed images	22
10.2 Evaluation methods by calculating numerical image properties	28
11 Measurement of the primary electron beam current	30
11.1 Ten-minute primary electron beam current measurement	30
11.2 Long-term primary electron beam current measurement	30
12 Reporting Form	32
Annex A (informative) Measurement of image sharpness	34
Annex B (informative) Measurement of image drift and distortions caused by unintended motions	36
Annex C (informative) Measurement of electron beam-induced contamination	47
Annex D (informative) Measurement of the image magnification and linearity	53
Annex E (informative) Measurement of the primary electron beam current	56

Bibliography	58
---------------------------	-----------

This document is a preview generated by EVS

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).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

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 Technical Committee ISO/TC 202, *Microbeam analysis*, Subcommittee SC 4, *Scanning electron microscopy*.

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

The scanning electron microscope (SEM) is a very versatile instrument, which is widely used in production, development and scientific research across the world. While they are easy to operate and provide results quickly, there are a number of notorious problems, which hinder operating them at their best performance. These are the reasons for lack of excellent repeatability in SEM imaging and measurements. The most bothersome ones among these are unintended motions of the sample stage and the primary electron beam, geometry distortions, wrong image magnification, image blur (lack of sharp focus), noise and electron beam-induced contamination. Quantification of these essential performance parameters is very useful to ensure that all SEMs perform at manufacturers specifications and at users' own purpose. Quantified knowledge helps in the evaluation of measurement uncertainties, and necessary repairs.

This document pertains to measurement methods for the following SEM performance parameters:

- Image sharpness (spatial resolution, primary electron beam focusing ability).
- Drifts (the sample stage, the electron beam and the electron-optical column).
- Cleanliness (lack of beam-induced contamination).
- Image magnification and linearity (both in X and Y directions).
- Background noise.
- Primary electron beam current.

These parameters will also be influenced by the SEM conditions such as the lifetime of source (emitter conditions), lifetime of liner tube and apertures (contamination of the electron optical parts), time and intensity of last cleaning of vacuum chamber by the plasma cleaning or Ultra Violet irradiation, the sample preparation and final surface cleaning.

Microbeam analysis — Scanning electron microscopy — Qualification of the scanning electron microscope for quantitative measurements

1 Scope

This document describes methods to qualify the scanning electron microscope with the digital imaging system for quantitative and qualitative SEM measurements by evaluating essential scanning electron microscope performance parameters to maintain the performance after installation of the instruments. The items and evaluating methods of the performance parameters are selected by users for their own purposes.

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 16700:2016, *Microbeam analysis — Scanning electron microscopy — Guidelines for calibrating image magnification*

ISO/IEC 17025:2017, *General requirements for the competence of testing and calibration laboratories*

ISO 22493, *Microbeam analysis — Scanning electron microscopy — Vocabulary*

ISO/TS 24597:2011, *Microbeam analysis — Scanning electron microscopy — Methods of evaluating image sharpness*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 22493 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 <http://www.electropedia.org/>

3.1

scanning electron microscope SEM

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

[SOURCE: ISO 16700, 3.1]

3.2

image

two-dimensional representation of the specimen surface generated by SEM

[SOURCE: ISO 16700, 3.2]