

This is a preview of "ISO 29301:2017". [Click here to purchase the full version from the ANSI store.](#)

Second edition
2017-12

Microbeam analysis — Analytical electron microscopy — Methods for calibrating image magnification by using reference materials with periodic structures

*Analyse par microfaisceaux — Microscopie électronique analytique
— Méthodes d'étalonnage du grandissement d'image au moyen de
matériaux de référence de structures périodiques*



Reference number
ISO 29301:2017(E)

© ISO 2017

This is a preview of "ISO 29301:2017". [Click here to purchase the full version from the ANSI store.](#)



COPYRIGHT PROTECTED DOCUMENT

© ISO 2017, Published in Switzerland

All rights reserved. Unless otherwise specified, 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
Ch. de Blandonnet 8 • CP 401
CH-1214 Vernier, Geneva, Switzerland
Tel. +41 22 749 01 11
Fax +41 22 749 09 47
copyright@iso.org
www.iso.org

This is a preview of "ISO 29301:2017". Click here to purchase the full version from the ANSI store.

Contents

	Page
Foreword	iv
Introduction	vi
1 Scope	1
2 Normative references	1
3 Terms and definitions	1
4 Image magnification	5
4.1 Definition of the image magnification.....	5
4.2 Expressing magnification.....	6
5 Reference materials	6
5.1 General.....	6
5.2 Requirements for CRM/RM.....	7
5.3 Storage and handling.....	7
6 Calibration procedures	7
6.1 General.....	7
6.2 Mounting CRM/RM.....	8
6.3 Setting TEM operating conditions for calibration.....	8
6.4 Capturing digitized image.....	9
6.5 Digitizing the image recorded on photographic film.....	10
6.5.1 General.....	10
6.5.2 How to decide the pixel-resolution for digitization.....	10
6.6 Measurement of the angle-corrected distance, D_t , from the digitized image.....	12
6.6.1 General.....	12
6.6.2 Measurement procedure.....	13
6.7 Digitization of reference scale for pixel size calibration.....	16
6.8 Calibration of image magnification.....	17
6.8.1 General.....	17
6.8.2 Calibration of scale unit (= pixel size), S	17
6.8.3 Calculating image magnification.....	19
6.9 Calibration of scale bar.....	20
6.9.1 General.....	20
6.9.2 Basic scale size corresponding to one pixel on the digitized image.....	20
6.9.3 Calibration of scale bar.....	20
6.10 Calibration procedure for length measurements using photographic film only.....	21
7 Accuracy of image magnification	22
8 Uncertainty of measurement result	22
9 Calibration report	24
9.1 General.....	24
9.2 Contents of calibration report.....	24
Annex A (informative) Parameters that influence the resultant magnification of a TEM	26
Annex B (informative) Flowchart of image-magnification calibration procedure	27
Annex C (informative) How to decide the number of lines for averaging	28
Annex D (informative) Reference materials for magnification calibration	31
Annex E (informative) Example of test report for calibration of TEM magnification	35
Bibliography	44

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

This document was prepared by Technical Committee ISO/TC 202, *Microbeam analysis*, Subcommittee SC 3, *Analytical electron microscopy*.

This second edition cancels and replaces the first edition (ISO 29301:2010), which has been technically revised.

The main changes compared to the previous edition are as follows:

- [Annexes B](#) and [C](#) have been changed to informative;
- the Foreword has been revised;
- the Introduction has been revised;
- [Clause 1](#) has been revised;
- [Clause 2](#) has been updated;
- ISO 5725-1 and ISO/IEC Guide 98-3 have been added to the Bibliography;
- the heading and first paragraph of [Clause 3](#) have been updated;
- the terms “accuracy” ([3.1](#)) and “under focus” ([3.35](#)) have been added to [Clause 3](#);
- the terms “beam damage”, “goniometer” and “lattice spacing” have been deleted from [Clause 3](#);
- the term “just focus” has been replaced by the term “focus” ([3.10](#)) in [Clause 3](#);
- the term “image file format” has been replaced by the term “image file” ([3.14](#)) in [Clause 3](#);
- the terms “image scanner” ([3.17](#)) and “ROI: region of interest” ([3.26](#)) have been revised;
- the term “standard excitation condition” ([3.32](#)) has been updated;

This is a preview of "ISO 29301:2017". [Click here to purchase the full version from the ANSI store.](#)

- the keys 11 and 15 in [Figure 1](#) have been updated;
- [6.1](#), [6.2](#), [6.3](#) g), i), l), m), p) and q), [6.4](#), [6.5.1](#), [6.5.2](#), [Formula \(1\)](#), [6.6.1](#), [6.6.2](#) b), d), e) and f), [6.7](#) a), [6.8.2](#), [6.8.3](#), [6.9.2](#) and [6.9.3](#) have been revised and updated;
- [Clause 7](#) has been revised;
- [Clause 8](#) has been revised;
- [Formulae \(18\)](#), [\(19\)](#), and [\(20\)](#) have been revised;
- the first paragraph and e) in [9.2](#) have been revised;
- [D.1](#) has been revised;
- URLs have been added to [D.2.2](#), [D.2.3](#) and [D.2.4](#);
- [D.2.4](#) and [D.5](#) have been added;
- the first paragraph in [Annex E](#) has been revised;
- in [Annex E](#), Calibration Results (For photographic film or imaging plate use) and Calibration Results (For digital camera use) have been revised;
- the figures have been modified;
- the Bibliography has been updated.

Introduction

The transmission electron microscope (TEM) is widely used to investigate the micro/nano-structure of a range of important materials such as semiconductors, metals, nano-particles, polymers, ceramics, glass, food and biological materials. The technique used involves the transmission of electrons through an ultra-thin specimen, interacting with the specimen as they pass through. This interaction results in a magnified image which is focused onto an imaging device, such as a photographic film, an imaging plate, or an image sensor built into a digital camera. A TEM is capable of imaging at significantly higher resolutions than ordinary (light) microscopes. It can be used to examine fine details as small as a single atomic column in a given specimen. This document addresses the need for magnification calibration of the images. It describes the requirements for calibration of the image magnification in the transmission electron microscope using a certified reference material or a reference material with periodic structures.