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**Microbeam analysis — Analytical  
electron microscopy — Calibration  
procedure of energy scale for  
elemental analysis by electron energy  
loss spectroscopy**

*Analyse par microfaisceaux — Microscope électronique analytique  
— Procédure d'étalonnage de l'échelle d'énergie pour l'analyse  
élémentaire par spectroscopie de perte d'énergie des électrons*





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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](http://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](http://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](http://www.iso.org/iso/foreword.html).

This document was prepared by Technical Committee ISO/TC 202, *Microbeam analysis*, Subcommittee SC 3, *Analytical 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](http://www.iso.org/members.html).

## Introduction

The electron energy loss spectroscopy (EELS) is an effective method for elemental analysis with high spatial resolution. In a transmission electron microscope (TEM) or a scanning TEM (STEM), incident electrons irradiating a sufficiently electron transparent sample, such as thin foil samples, are scattered by the atoms in the sample. Inelastically scattered electrons are analysed to identify elements in the sample by a spectrometer. All elements from hydrogen to uranium are identified based upon comparisons of the peak energies and shapes of the core-loss edges, with table of peak energies and spectra in handbooks for the different elements. To identify specific element core-loss peaks, calibration of the EEL spectrometer to an uncertainty of  $\pm 3$  % is generally adequate for energy range 0 eV to 3 000 eV. This document details the procedure for the energy calibration intended for work at that level of accuracy.

Determination of a sample to be suitably electron transparent can be established by the EELS log ratio technique ( $t/\lambda$ ) for specimen thickness. For further details on the determination of relative specimen thickness using the EELS log ratio technique ( $t/\lambda$ ), see Reference [1].



# Microbeam analysis — Analytical electron microscopy — Calibration procedure of energy scale for elemental analysis by electron energy loss spectroscopy

## 1 Scope

This document specifies a calibration procedure of the energy step and the energy scale for electron energy loss spectroscopy in (scanning) transmission electron microscopes to an uncertainty of  $\pm 3\%$  for the energy range 0 eV to 3 000 eV.

This document is intended for electron energy loss spectroscopy with transmitted electrons through sufficiently electron transparent samples, such as a thin foil sample, and is not designed for backscattered electrons from a bulk sample.

## 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 15932, *Microbeam analysis — Analytical electron microscopy — Vocabulary*

## 3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 15932 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 acceptance angle

$\gamma$

half of the angle formed by an entrance aperture to the EEL spectrometer

Note 1 to entry: See [Figure 1](#).

### 3.2 channel

range of one pixel in the *parallel detector* ([3.13](#))

### 3.3 collection angle

$\beta$

half of the angle formed by an objective aperture in a transmission electron microscope

Note 1 to entry: See [Figure 1](#).