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**Microbeam analysis — Selected  
instrumental performance parameters for  
the specification and checking of energy-  
dispersive X-ray spectrometers for use in  
electron probe microanalysis**

*Analyse par microfaisceaux — Paramètres de performance  
instrumentale sélectionnés pour la spécification et le contrôle des  
spectromètres X à sélection d'énergie utilisés en microanalyse par  
sonde à électrons*



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ISO copyright office  
Case postale 56 • CH-1211 Geneva 20  
Tel. + 41 22 749 01 11  
Fax + 41 22 749 09 47  
E-mail [copyright@iso.org](mailto:copyright@iso.org)  
Web [www.iso.org](http://www.iso.org)

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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.

ISO 15632 was prepared by Technical Committee ISO/TC 202, *Microbeam analysis*.

This second edition cancels and replaces the first edition (ISO 15632:2002), which has been technically revised (see the Introduction, first paragraph, for details).

## Introduction

Recent progress in energy-dispersive X-ray spectrometry (EDS) by means of improved manufacturing technologies for detector crystals and the application of advanced pulse-processing techniques have increased the general performance of spectrometers, in particular at high count rates and at low energies (below 1 keV). A revision of this International Standard became necessary because silicon drift detector (SDD) technology was not included. SDDs provide performance comparable to Si-Li detectors, even at considerably higher count rates. In addition, a larger detector active area results in the capability of measuring even higher count rates. This International Standard has therefore been updated with criteria for the evaluation of the performance of such modern spectrometers.

In the past, a spectrometer was commonly specified by its energy resolution at high energies defined as the full peak width at half maximum (FWHM) of the manganese  $K\alpha$  line. To specify the properties in the low energy range, values for the FWHM of carbon K, fluorine K or the zero peak are given by the manufacturers. Some manufacturers also specify a peak-to-background ratio, which may be defined as a peak-to-shelf ratio in a spectrum from an  $^{55}\text{Fe}$  source or as a peak-to-valley ratio in a boron spectrum. Differing definitions of the same quantity have sometimes been employed. The sensitivity of the spectrometer at low energies related to that at high energies depends strongly on the construction of the detector crystal and the X-ray entrance window used. Although high sensitivity at low energies is important for the application of the spectrometer in the analysis of light-element compounds, normally the manufacturers do not specify an energy dependence for spectrometer efficiency.

This International Standard was developed in response to a worldwide demand for minimum specifications of an energy-dispersive X-ray spectrometer. EDS is one of the most applied methods used to analyse the chemical composition of solids and thin films. This International Standard should permit comparison of the performance of different spectrometer designs on the basis of a uniform specification and help to find the optimum spectrometer for a particular task. In addition, this International Standard contributes to the equalization of performances in separate test laboratories. In accordance with ISO/IEC 17025<sup>[1]</sup>, such laboratories have to periodically check the calibration status of their equipment according to a defined procedure. This International Standard may serve as a guide for similar procedures in all relevant test laboratories.



# Microbeam analysis — Selected instrumental performance parameters for the specification and checking of energy-dispersive X-ray spectrometers for use in electron probe microanalysis

## 1 Scope

This International Standard defines the most important quantities that characterize an energy-dispersive X-ray spectrometer consisting of a semiconductor detector, a pre-amplifier and a signal-processing unit as the essential parts. This International Standard is only applicable to spectrometers with semiconductor detectors operating on the principle of solid-state ionization. This International Standard specifies minimum requirements and how relevant instrumental performance parameters are to be checked for such spectrometers attached to a scanning electron microscope (SEM) or an electron probe microanalyser (EPMA). The procedure used for the actual analysis is outlined in ISO 22309<sup>[2]</sup> and ASTM E1508<sup>[3]</sup> and is outside the scope of this International Standard.

## 2 Normative references

The following referenced documents are indispensable for the application 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 23833, *Microbeam analysis — Electron probe microanalysis (EPMA) — Vocabulary*

## 3 Terms and definitions

For the purposes of this International Standard, the terms and definitions given in ISO 23833 and the following apply.

NOTE With the exception of 3.1, 3.2, 3.2.1, 3.2.2, 3.11, 3.12 and 3.13, these definitions are given in the same or analogous form in ISO 22309<sup>[2]</sup>, ISO 18115-1<sup>[4]</sup> and ISO 23833.

### 3.1

#### **energy-dispersive X-ray spectrometer**

device for determining X-ray intensity as a function of the energy of the radiation by recording the whole X-ray spectrum simultaneously

NOTE The spectrometer consists of a solid-state detector, a preamplifier, and a pulse processor. The detector converts X-ray photon energy into electrical current pulses which are amplified by the preamplifier. The pulse processor then sorts the pulses by amplitude so as to form a histogram distribution of X-ray intensity vs energy.

### 3.2

#### **count rate**

number of X-ray photons per second

#### 3.2.1

##### **input count rate**

##### **ICR**

number of X-ray photons absorbed in the detector per second