BS ISO 23833:2013

BSI Standards Publication

Microbeam analysis — Electron probe microanalysis (EPMA) — Vocabulary

bsi.

...making excellence a habit.™

Document Sharing Hub

Full document details: BS ISO 23833:2013

National foreword

This British Standard is the UK implementation of ISO 23833:2013. It supersedes BS ISO 23833:2006 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee CII/9, Microbeam analysis.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

© The British Standards Institution 2013. Published by BSI Standards Limited 2013

ISBN 978 0 580 78774 4

ICS 01.040.71; 71.040.99

Compliance with a British Standard cannot confer immunity from legal obligations.

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 30 April 2013.

Amendments issued since publication

Date	Text affected

Documents
Document Sharing Hub

Full document details: BS ISO 23833:2013

INTERNATIONAL STANDARD

ISO 23833

Second edition
2013-04-15

Microbeam analysis — Electron probe microanalysis (EPMA) — Vocabulary

Analyse par microfaisceaux — Analyse par microsonde électronique (microsonde de Castaing) — Vocabulaire

Reference number
ISO 23833:2013(E)

Documents
Document Sharing Hub

© ISO 2013

Full document details: BS ISO 23833:2013

COPYRIGHT PROTECTED DOCUMENT

© ISO 2013

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
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

Published in Switzerland

© ISO 2013 – All rights reserved

Documents
Document Sharing Hub

Full document details: BS ISO 23833:2013

Contents

Page

Foreword ..... **iv**
Introduction ..... **v**
1 Scope **1**
2 Abbreviated terms **1**
3 Definitions of general terms used in electron probe microanalysis **1**
4 Definition of terms used to describe EPMA instrumentation **7**
5 Definitions of terms used in EPMA methodology **17**
Bibliography **27**

© ISO 2013 – All rights reserved

Documents
Document Sharing Hub
Full document details: BS ISO 23833:2013

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 23833 was prepared by Technical Committee ISO/TC 202, *Microbeam analysis*, Subcommittee SC 1, *Terminology*.

The European Microbeam Analysis Society (EMAS) made contributions to the preparation of the document.

This second edition of ISO 23833 cancels and replaces the first edition (ISO 23833:2006), of which it constitutes a minor revision.

This International Standard has a cross-reference relationship with the surface chemical analysis vocabulary prepared by ISO/TC 201 (ISO 18115-1:2010).

© ISO 2013 – All rights reserved
Documents
Document Sharing Hub
Full document details: BS ISO 23833:2013

Introduction

Electron probe X-ray microanalysis (EPMA) is a modern technique used to qualitatively determine and quantitatively measure the elemental composition of solid materials, including metal alloys, ceramics, glasses, minerals, polymers, powders, etc., on a spatial scale of approximately one micrometer laterally and in depth. EPMA is based on the physical mechanism of electron-stimulated X-ray emission and X-ray spectrometry.

As a major sub-field of microbeam analysis (MBA), the EPMA technique is widely applied in diverse business sectors (high-tech industries, basic industries, metallurgy and geology, biology and medicine, environmental protection, trade, etc.) and has a wide business environment for standardization.

Standardization of terminology in a technical field is one of the basic prerequisites for development of standards on other aspects of that field.

This International Standard is relevant to the need for an EPMA vocabulary that contains consistent definitions of terms as they are used in the practice of electron probe microanalysis by the international scientific and engineering communities that employ the technique.

© ISO 2013 – All rights reserved

Documents
Document Sharing Hub
Full document details: BS ISO 23833:2013

Documents
Document Sharing Hub

Full document details: BS ISO 23833:2013

INTERNATIONAL STANDARD ISO 23833:2013(E)

Microbeam analysis — Electron probe microanalysis (EPMA) — Vocabulary

1 Scope

This International Standard defines terms used in the practices of electron probe microanalysis (EPMA). It covers both general and specific concepts classified according to their hierarchy in a systematic order.

This International Standard is applicable to all standardization documents relevant to the practices of EPMA. In addition, some parts of this International Standard are applicable to those documents relevant to the practices of related fields (SEM, AEM, EDX, etc.) for definition of those terms common to them.

2 Abbreviated terms

BSE	backscattered electron
CRM	certified reference material
EDS	energy-dispersive spectrometer
EDX	energy-dispersive X-ray spectrometry
EPMA	electron probe microanalysis or electron probe microanalyser
eV	electronvolt
keV	kiloelectronvolt
RM	reference material
SE	secondary electron
SEM	scanning electron microscope
WDS	wavelength-dispersive spectrometer
WDX	wavelength-dispersive X-ray spectrometry

3 Definitions of general terms used in electron probe microanalysis

3.1
electron probe microanalysis
EPMA
technique of spatially-resolved elemental analysis based upon electron-excited X-ray spectrometry with a focussed electron probe and an electron interaction volume with micrometer to sub-micrometer dimensions

3.1.1
qualitative EPMA
procedure in EPMA leading to the identification of the elements present in the electron-excited interaction volume by a systematic method for the recognition and assignment of X-ray spectral peaks to specific elements

© ISO 2013 – All rights reserved

Documents
Document Sharing Hub
Full document details: BS ISO 23833:2013

3.1.2
quantitative EPMA
procedure leading to the assignment of numerical values to represent the concentrations of elemental constituents that had been previously identified in the electron-excited interaction volume during the qualitative analysis phase in EPMA

Note 1 to entry: Quantitative analysis can be accomplished by comparing the unknown X-ray peak intensities to X-ray peak intensities measured under the same conditions using reference material(s) or by calculating the concentration from first principles (also known as standardless analysis).

3.2
electron probe microanalyser
instrument for carrying out electron-excited X-ray microanalysis

Note 1 to entry: This instrument is usually equipped with more than one wavelength spectrometer and an optical microscope for precise specimen placement.

3.3
electron scattering
deviation in trajectory and/or kinetic energy suffered by an impinging energetic beam electron as a result of an interaction with a specimen atom or electron

3.3.1
angle of scattering
scattering angle
angle between the direction of the incident particle or photon and the direction that the particle or photon is traveling after scattering

[ISO 18115-1:2010]

3.3.2
backscattering
escape of beam electrons from the specimen following sufficient scattering events to cause the trajectories to intersect the entrance surface of the specimen

3.3.2.1
backscatter coefficient
η
fraction of beam electrons that are backscattered, given by the equation

$$\eta = n(\mathrm{BS})/n(\mathrm{B})$$

where n(B) is the number of incident electrons and n(BS) is the number of backscattered electrons

3.3.2.2
backscattered electron
electron ejected from the entrance surface of the specimen by a backscattering process

3.3.2.3
backscattered electron angular distribution
distribution of backscattered electrons as a function of the angle relative to the surface normal

3.3.2.4
backscattered electron depth distribution
distribution of backscattered electrons as a function of the maximum depth into the specimen reached before travelling back to the entrance surface to exit the specimen

© ISO 2013 – All rights reserved
Documents
Document Sharing Hub
Full document details: BS ISO 23833:2013

3.3.3
continuous energy loss approximation
mathematical description of energy loss by fast electrons propagating through matter in which all of the discrete inelastic processes are approximated as a single continuous energy loss process

Note 1 to entry: Also known as the continuous slowing-down approximation (CSDA).

3.3.4
elastic scattering
interaction of an energetic electron from the impinging beam and a specimen atom during which the electron's energy remains essentially unaltered but its trajectory is changed by an angle from 0 up to π rad (180°) with an average of approximately 0,1 rad

3.3.5
inelastic scattering
interaction of an energetic electron from the impinging beam and a specimen atom or electron during which kinetic energy is lost to the specimen by various mechanisms (secondary electron generation, bremsstrahlung, inner shell ionization, plasmon and photon excitation)

Note 1 to entry: For inelastic scattering, the electron trajectory is modified by a small angle, generally less than 0,01 rad.

3.3.6
scattering cross-section
number of scattering events per unit area
mathematical description of the probability of a scattering event (elastic or inelastic)

Note 1 to entry: See *ionization cross-section* (3.4.4).

Note 2 to entry: Scattering cross-section is usually expressed simply as an area, in cm^2. The number of scattering events per unit area is expressed in events/(atoms/cm^2).

3.3.7
scattering effect
measurable physical phenomenon, such as electron backscattering or loss of X-ray generation, that results from modification of the trajectory and/or kinetic energy of an impinging energetic beam electron by scattering processes in the specimen

3.3.8
secondary electron
Electron emitted from the specimen as a result of inelastic scattering of the primary beam electron by loosely bound valence-level electrons of the specimen

Note 1 to entry: Secondary electrons have conventionally an energy less than 50 eV.

3.4
X-ray
photon of electromagnetic radiation created by fluorescence of an inner shell electron vacancy or by deceleration of an energetic electron in the Coulombic field of an atom

3.4.1
characteristic X-ray
photon of electromagnetic radiation created by the relaxation of an excited atomic state created by inner shell ionization following inelastic scattering of an energetic electron or ion, or by absorption of an X-ray photon

3.4.2
continuous X-ray
photon of electromagnetic radiation created by deceleration (an inelastic scattering mechanism) of an energetic electron in the Coulombic field of an atom

© ISO 2013 – All rights reserved

Documents
Document Sharing Hub
Full document details: BS ISO 23833:2013

3.4.3
fluorescence yield
ω
fraction of inner shell ionization events that give rise to characteristic X-ray emission during subsequent de-excitation

Note 1 to entry: The fluorescence yield is independent of the method of ionization.

3.4.4
ionization cross-section
number of ionization events per unit area
mathematical description of the probability of ionizing an atom by removing an atomic electron from a particular bound electron shell into the unbound vacuum, or continuum, energy level or state

Note 1 to entry: See *scattering cross-section* (3.3.6).

Note 2 to entry: Ionization cross-section is usually expressed simply as an area, in cm^2 or in barns (10^{-24} cm^2). Ionization event probability is expressed in events/(atoms/cm^2).

Note 3 to entry: Ionization cross-section is usually denoted by Q, which is defined by the mathematical expression $dn = Q(N\rho/A)dx$ where dn is the number of ionization events which occur in each increment dx of electron path and $N\rho/A$ is the number of atoms per unit volume.

3.4.5
ionization energy
critical excitation energy
edge energy
minimum energy required to ionize an atomic electron, i.e. to remove a bound electron from a shell (K, L, etc.) to (as a minimum) the continuum of energy states in a solid

Note 1 to entry: Ionization energy units are eV or keV.

3.4.6
J-value
mean ionization energy, a critical parameter in mathematical descriptions of the continuous energy loss approximation

3.4.7
stopping power
dE/ds
rate of energy loss experienced by a primary electron (from all inelastic scattering processes) with distance travelled in the specimen

Note 1 to entry: Stopping power is expressed as energy loss/unit distance (e.g. eV/nm).

3.4.8
X-ray fluorescence effect
secondary fluorescence
photoelectric absorption of an X-ray (characteristic or bremsstrahlung) by an atom, resulting in an excited atomic state which will de-excite with electron shell transitions and subsequent emission of an Auger electron or the characteristic X-ray of the absorbing atom

3.4.9
X-ray generation
generation of X-rays in the specimen under the stimulation of an incident beam of radiation (electrons, ions or photons)

Note 1 to entry: X-rays can be generated through the ionization of inner atomic shells (characteristic X-rays) or through the "braking radiation" (bremsstrahlung) process (continuum or white radiation).

© ISO 2013 – All rights reserved
Documents
Document Sharing Hub
Full document details: BS ISO 23833:2013