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Surface chemical analysis — Auger electron spectroscopy and X-ray photoelectron spectroscopy — Guide to the use of experimentally determined relative sensitivity factors for the quantitative analysis of homogeneous materials

Analyse chimique des surfaces — Spectroscopie des électrons Auger et spectroscopie de photoélectrons — Lignes directrices pour l'utilisation de facteurs expérimentaux de sensibilité relative pour l'analyse quantitative de matériaux homogènes

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Foreword

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This document was prepared by Technical Committee ISO/TC 201, *Surface chemical analysis*, Subcommittee SC 7, *Electron spectroscopies*.

This ~~second~~third edition cancels and replaces the ~~first~~second edition (ISO 18118:~~2004~~2015), which has been technically revised.

The main changes are as follows:

— The main equation for the use of sensitivity factors for analysis have been moved from Annex A to the main text

— Defined symbols and abbreviated terms from the Annexes have been consolidated to Clause 4.

— Several terms have been modified for formatting purposes, and some have been removed due to no longer being required.

— Several formulae have been removed from Annex A and replaced by references and references to databases of parameters that are more accurate. Such databases are now the recommended source for the parameters previously calculated by these formulae.

— Annex A has been redefined as an informative Annex.

— Multiple small additions have been made to provide new and updated sources for information.

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— Multiple sections of textEditorial changes have been revised and/or removed to improve claritymade throughout.

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.

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Introduction

Auger electron spectroscopy (AES) and X-ray photoelectron spectroscopy (XPS) are surface-analytical techniques that are sensitive to the composition in the surface region of a material to depths of, typically, a few nanometres (nm). Both techniques yield a surface-weighted signal, averaged over the analysis volume. Most samples have compositional variations, both laterally and with depth, and quantification is often performed with approximate methods since it can be difficult to determine the magnitude of any compositional variations and the distance scale over which they can occur. The simplest sample for analysis is one that is homogeneous. Although this situation occurs infrequently, it is often assumed, for simplicity in the analysis, that the sample material of interest is homogeneous. This document provides guidance on the measurement and use of experimentally determined relative sensitivity factors for the quantitative analysis of homogeneous materials by AES and XPS.

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Surface chemical analysis — Auger electron spectroscopy and X-ray photoelectron spectroscopy — Guide to the use of experimentally determined relative sensitivity factors for the quantitative analysis of homogeneous materials

1 Scope

This document gives guidance on the measurement and use of experimentally-determined relative sensitivity factors for the quantitative analysis of homogeneous materials by Auger electron spectroscopy and X-ray photoelectron spectroscopy. The methods described only apply to polycrystalline and amorphous materials, as effects inherent to single-crystal samples are not addressed.

2 Normative references

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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 18115-1, *Surface chemical analysis — Vocabulary — Part 1: General terms and terms used in spectroscopy*

ISO 21270, *Surface chemical analysis — X-ray photoelectron and Auger electron spectrometers — Linearity of intensity scale*

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3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 18115-1 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
absolute elemental sensitivity factor
coefficient for an element by which the measured intensity for that element is divided to yield the atomic concentration or atomic fraction of the element present in the sample

Note 1 to entry: See *relative elemental sensitivity factor*.

Note 2 to entry: The choice of atomic concentration or atomic fraction should be made clear.

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Note 3 to entry: The type of sensitivity factor utilized should be appropriate for the formulae used in the quantification process and for the type of sample analysed, for example homogeneous samples or segregated layers.

Note 4 to entry: The source of sensitivity factors should be given to ensure that the correct *matrix factors* or other parameters are used.

Note 5 to entry: Sensitivity factors depend on parameters of the excitation source, the spectrometer, and the orientation of the sample to these parts of the instrument. Sensitivity factors also depend on the matrix being analysed, and in *SIMS* this has a dominating influence.

[SOURCE: ISO 18115-1]

3.2
elemental relative sensitivity factor
<AES, XPS> coefficient proportional to the *absolute elemental sensitivity factor* (3.1), where the constant of proportionality is chosen such that the value for a selected element and transition is unity

Note 1 to entry: Elements and transitions commonly used are C 1s or F 1s for *XPS* and Ag $M_{4,5}$VV for *AES*.

Note 2 to entry: The type of sensitivity factor used should be appropriate for the type of sample analysed, for example homogeneous samples or segregated layers.

Note 3 to entry: The source of sensitivity factors should be given to ensure that the correct *matrix factors* or other parameters are used.

Note 4 to entry: Sensitivity factors depend on parameters of the excitation source, the spectrometer, and the orientation of the sample to these parts of the instrument. Sensitivity factors also depend on the matrix being analysed, and in *SIMS* this has a dominating influence.

[SOURCE: ISO 18115-1]

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3.3
average matrix relative sensitivity factor
AMRSF
<AES, XPS> coefficient, proportional to the intensity, calculated for an element in an average matrix, by which the measured intensity for that element is divided in calculations to yield the atomic concentration or atomic fraction of the element present in the sample

Note 1 to entry: See sensitivity factor, *elemental relative sensitivity factor* (3.2) and *pure element relative sensitivity factor* (3.4).

Note 2 to entry: The choice of atomic concentration or atomic fraction should be made clear.

Note 3 to entry: The type of sensitivity factor utilized should be appropriate for the formulae used in the quantification process and for the type of sample analysed, for example homogeneous samples or segregated layers.

Note 4 to entry: The source of sensitivity factors should be given. *Matrix factors* are taken to be unity for average matrix relative sensitivity factors.

Note 5 to entry: Sensitivity factors depend on parameters of the excitation source, the spectrometer, and the orientation of the sample to these parts of the instrument. The numerical values of the sensitivity factors can also depend on the method used to measure the peak intensities.

[SOURCE: ISO 18115-1]

3.4
pure-element relative sensitivity factor

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PERSF
<AES, XPS> coefficient, proportional to the intensity measured for a pure sample of an element, by which the measured intensity for that element is divided in calculations to yield the atomic concentration or atomic fraction of the element present in the sample

Note 1 to entry: See sensitivity factor, *elemental relative sensitivity factor* (3.2), and *average matrix relative sensitivity factor* (3.3).

Note 2 to entry: The choice of atomic concentration or atomic fraction should be made clear.

Note 3 to entry: The type of sensitivity factor used should be appropriate for the formulae used in the quantification process and for the type of sample analysed, for example homogeneous samples or segregated layers.

Note 4 to entry: The source of sensitivity factors should be given to ensure that the correct *matrix factors* or other parameters are used. Matrix factors are significant and should be used with pure-element relative sensitivity factors.

Note 5 to entry: Sensitivity factors depend on parameters of the excitation source, the spectrometer, and the orientation of the sample to these parts of the instrument. The numerical values of the sensitivity factors can also depend on the method used to measure the peak intensities.

[SOURCE: ISO 18115-1]

3.5
spectrometer response function
quotient of the number of particles detected with a spectrometer by the number of such particles per solid angle and per interval of the dispersing parameter available for measurement as a function of the dispersing parameter

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Note 1 to entry: See *spectrometer étendue*.

Note 2 to entry: The dispersing parameter is commonly energy, mass, or wavelength.

Note 3 to entry: The units of the spectrometer response function can be sr·eV, sr·amu, or sr·m.

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Note 4 to entry: The spectrometer response function is similar to the *spectrometer transmission function* (3.6) or étendue but includes the efficiencies of all other components of the measurement chain, such as detectors and the electronic processing and recording equipment.

Note 5 to entry: For some methods of *quantitative analysis*, the energy dependence of the response function is needed in order to use *relative sensitivity factors*. For these cases, a function is determined which is proportional to the absolute response function, where the proportionality constant is not necessarily important.

[SOURCE: ISO 18115-1]

3.6
spectrometer transmission function
analyser transmission function
quotient of the number of particles transmitted by the analyser by the number of such particles per solid angle and per interval of the dispersing parameter (e.g. energy, mass, or wavelength) available for measurement as a function of the dispersing parameter

Note 1 to entry: See *spectrometer response function* (3.5).

Note 2 to entry: The units of transmission can be sr·eV, sr·amu, or sr·m.

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