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Surface chemical analysis — Auger electron spectroscopy — Description of selected instrumental performance parameters

Analyse chimique des surfaces — Spectroscopie d'électrons Auger — Description de certains paramètres relatifs à la performance instrumentale

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Foreword

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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 15471 was prepared by Technical Committee ISO/TC 201, *Surface chemical analysis*, Subcommittee SC 7, *X-ray photoelectron spectroscopy*.

Introduction

Auger electron spectrometers (AESs) and scanning Auger electron microscopes (SAMs) are produced by many manufacturers throughout the world. While the basic principles of the AES analytical method in each instrument are the same, the specific designs of the instruments and the way that performance specifications are provided differ widely. As a result, it is often difficult to compare the performance of instruments from one manufacturer with those from another. This International Standard provides a basic list of items devised to enable all Auger electron spectrometers to be described in a common manner. This International Standard is not intended to replace the manufacturer's specification, which may extend to 30 or more pages. It is intended that, where certain items are contained in that specification, there are agreed and defined meanings to those items.

Surface chemical analysis — Auger electron spectroscopy — Description of selected instrumental performance parameters

1 Scope

This International Standard describes the way in which specific aspects of the performance of an Auger electron spectrometer shall be described.

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 18115, *Surface chemical analysis — Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 18115 apply.

4 Symbols and abbreviations

AES Auger electron spectroscopy (also Auger electron spectrometer)

FWHM full width at half maximum

rms root mean square

SAM scanning Auger electron microscope (also scanning Auger electron microscopy)

SEM scanning electron microscope

FL Fermi level

VL vacuum level

NOTE Historically, the kinetic-energy scales of AES instruments have been referred to the VL whilst XPS or combined AES/XPS instruments have been referred to the FL. Conversion from FL to VL referencing is accomplished by subtracting the spectrometer work function from the electron kinetic energies; an approximate means for doing this, satisfactory for most practical AES and SAM applications, is to subtract 4,5 eV from kinetic energies referred to the FL.

5 Description of selected instrumental performance parameters

5.1 Method of analysis

A short description of the methods used to obtain information from the sample shall be given, and the availability (as an option) of other analytical techniques in the system under consideration shall be stated.

5.2 Samples

The size and shape of samples that may be analysed with the instrument performing to specification shall be given. If the size or shape is restricted for particular modes of analysis, e.g. angle-resolved measurements, measurements for insulators, etc., this shall be specified.

5.3 System configuration

The designed geometric configuration of the significant analytical components of the system and their tolerances shall be described.

EXAMPLE Tolerances for angles are often given as ± 1°.

5.4 Electron gun cathode

5.4.1 Cathode type

The cathode system shall be specified.

EXAMPLES Thermionic tungsten, lanthanum hexaboride (LaB_6), cold field emission tungsten (110), or Schottky.

5.4.2 Cathode lifetime

The expected lifetime of the cathode under the operating conditions specified in 5.5 shall be stated. The emission currents at chosen source potentials in 5.5 shall be stated. This would normally be a guarantee of lifetime operation but could, alternatively, be a mean historical lifetime. The type of lifetime shall be specified.

5.5 Spatial resolution and beam current

5.5.1 General

Spatial resolutions shall be specified for:

a) SEM at optimum conditions;

b) AES at specified conditions for each defined beam energy.

The measured value of the spatial resolution shall be obtained by one of the methods in 5.5.2, 5.5.3 or 5.5.4. Curves giving the typical spatial resolution as a function of beam current of 5 keV and/or 10 keV and any other appropriate beam energy shall be given.

NOTE If an instrument has a spatial resolution function that can be represented by a Gaussian function, then the FWHM of such a function corresponds to the distance over which the measured signal changes from 12 % to 88 % of its maximum value. In AES, the point spread function for the emitted Auger electrons is the Gaussian distribution of the beam superimposed on a backscattered halo. For this reason, it is convenient to define the spatial resolution as the distance corresponding to a 20 % to 80 % change in the Auger signal across the step edge, which is equivalent to 71,5 % of the Gaussian resolution function. Although there is no physical basis for this choice, it has been widely used.

5.5.2 Method 1

A sample shall be analysed which has an isolated feature whose size is smaller than 30 % of the instrument's stated spatial resolution. The measured FWHM of a line trace for an Auger electron signal characteristic of that feature defines the spatial resolution. The distance for the feature signal to rise from 50 % of the maximum to 100 % and then fall again to 50 % defines the measured spatial resolution.

NOTE 1 If the width of the isolated feature is greater than 30 % of the spatial resolution, the measured spatial resolution will be greater than the true spatial resolution.

NOTE 2 The use of a small sample allows easy confirmation of the system astigmatism.

5.5.3 Method 2

A sample shall be analysed which is comprised of two materials with their surfaces in the same plane and joined along a common straight edge. A line trace for an Auger electron intensity, characteristic of one of the two materials, measured at 90° to the edge, is used to define spatial resolution. The distance for the Auger electron intensity to change from 20 % to 80 % of the difference in the intensities in the plateau regions away from the edge defines the spatial resolution in the direction of the scan.

NOTE 1 If an instrument has a spatial resolution function that can be represented by a Gaussian function, then such an intensity:distance distribution is equivalent to 71,5 % of the FWHM of the spatial resolution function of the instrument.

NOTE 2 Close to the limit of resolution, astigmatism may be observed, and so the spatial resolution may need determination in more than one azimuth.

5.5.4 Method 3

A sample shall be analysed which is composed of a knife edge of one material, in the sample plane, over a hole with a depth more than five times its diameter. A line trace for an Auger electron intensity, characteristic of the knife edge material, measured at 90° to the edge, is used to define spatial resolution. The distance for the Auger electron intensity to change from 20 % to 80 % of the difference in the intensities in the plateau regions away from the edge defines the spatial resolution in the direction of the scan.

NOTE 1 If an instrument has a spatial resolution function that can be represented by a Gaussian function, then such an intensity:distance distribution is equivalent to 71,5 % of the FWHM of the spatial resolution function of the instrument.

NOTE 2 Close to the limit of resolution, astigmatism may be observed, and so the spatial resolution may need determination in more than one azimuth.

5.6 Spectrometer intensity performance and energy resolution

5.6.1 General

The spectrometer intensity performance is determined from the difference between the intensity (counting rate) of the Cu L_3VV peak at 918 eV and the background intensity (counting rate) at 950 eV (both measured in the direct mode). Performance shall be specified in pulse-counting systems as the difference in counting rates per nA of beam current or, alternatively, as the difference in counting rates at specified beam energy and beam current for (a) optimum energy resolution and (b) optimum sensitivity. If the spectrometer can be operated at different energy resolutions, the performance, the background intensity and the FWHM of the peak above background for each energy resolution shall be given at at least one beam energy. The beam current shall be given for each beam energy. The signal-to-noise ratio shall be defined as the ratio of the spectrometer intensity performance, obtained using data-acquisition time(s) of 1 s at 918 eV and 950 eV, to the noise obtained from 5.6.2 or 5.6.3. The method by which the noise is measured shall be stated.