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**NATIONAL STANDARD OF THE
PEOPLE'S REPUBLIC OF CHINA**

GB/T 45768-2025

**Surface chemical analysis - Secondary ion mass spectrometry -
Linearity of intensity scale in single ion counting time-of-flight
mass analysers**

表面化学分析 二次离子质谱 单离子计数飞行时间质谱分析器的强度标线性
(English Translation)

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Foreword

This document is in accordance with the provisions of GB/T 1.1-2020 "Guidelines for standardization work Part 1: Structure and drafting rules for standardization documents" Drafting.

This document is equivalent to ISO 17862:2022 "Surface chemical analysis - Secondary ion mass spectrometry - Single ion counting time-of-flight mass spectrometry" Strength Scaling of Devices.

The following minimal editorial changes have been made to this document.

--- ISO 17862:2022 does not have Annex D. In this document, in the flowchart of the calibration work in Figure 1, delete "Annex D Influence on Linearity" Factors" box;

--- In ISO 17862:2022, there is no 5.4.5 in the table of contents and the text. In 5.4.1, delete "(5.4.5)";

---CM in Figures 5 and 6 was changed to cM to be consistent with the text.

Introduction

In order to perform quantitative analysis of materials using secondary ion mass spectrometry (SIMS), it is necessary to measure the intensity of the mass spectrometry signal.

The nonlinearity of the intensity scale will directly lead to errors in the relative content of materials measured in surface and depth profiling.

It is linear at low count rates (or more precisely, at low counts per pulse), but becomes nonlinear as the count rate increases.

Intensity measurement relies on a measuring system that provides an intensity signal that is proportional to the intensity being measured. In a counting system, this ratio If this ratio changes with changes in signal level or count rate, the measurement system is said to be nonlinear.

The nonlinearity of the intensity scale may exceed 1% when the counting rate exceeds 5% of the maximum allowable counting rate[2].

For many instruments, as long as the detection system is set up correctly, the nonlinear behavior will not change significantly from month to month.

The count rate is corrected using a correlation relationship so that the correction strength is linear over a large part of the maximum achievable count rate range.

This intensity calibration may also be provided in the instrument data acquisition or processing computer.

The proposed method can be used to correct the intensity loss during time-to-digital conversion in a detection system consisting of a microchannel plate or a scintillator and a photomultiplier.

If this test proves valid, the appropriate instrument can be calibrated to extend the intensity scale by a factor of 50 or more.

Nonlinearity is unpredictable and cannot be described by any simple relationship. For these instruments, this document gives the nonlinearity that allows measurement.

The instrument settings can be adjusted to improve the situation in some cases.

The user can set the deviation from linearity limit appropriately according to the analysis requirements.

Although there are many factors that cause nonlinearity in time-of-flight secondary ion mass spectrometry (ToF-SIMS), the most significant factor affecting nonlinearity is the most notable is the intensity saturation caused by the effective dead time of the detector system. Because within the dead time interval τ , each primary ion pulse can only detect Unwanted background in the spectrum can also exacerbate the problem of secondary ion counts.

Linear.

This document only provides correction for dead time nonlinearity, which is applicable to some ideal situations, but not to all situations.

However, significantly increased dynamic range or operating rate may be very important. This document also proposes methods for optimizing the instrument to provide the best measurement performance.

The instrument provides recommendations for troubleshooting and diagnosing simple instrument problems such as low detector efficiency or detector failure where the detector is not providing single ion counts.

Poisson correction for instantaneous dead time corrects the measured counts within a certain range set by the analyst. This sets an upper limit for cM , i.e., or the count per pulse after correction. This upper limit usually applies to peaks whose signal distribution is constant in both time and space.

There is only one peak and the background intensity is negligible (these conditions are not always met in practice). Reference [2] provides a detailed description of this.

The results obtained by applying this paper are related to the "best case" situation. In actual situations, the linear equation obtained by using formula (1) may be in these cases, it is advisable to seek a more advanced dead time correction procedure.

The method in this document can be used to verify its effectiveness.

This document requires technical skills that may be beyond the scope of routine operation and should be used when evaluating new mass spectrometers to enable them to be used in appropriate After any substantial changes to the detection circuitry, replacement of the microchannel plate (MCP), or approximately every year Repeat the process specified in this document.

Surface chemical analysis secondary ion mass spectrometry Single ion counting time of flight Intensity scaling of mass spectrometers

1 Scope

This paper describes the measurement of polytetrafluoroethylene (PTFE)-based mass spectrometry in a single ion counting time-of-flight secondary ion mass spectrometer.

This document also includes a method for correcting the intensity nonlinearity by using the isotope ratios in the the linear method, the intensity nonlinearity is caused by the arrival of the microchannel plate (MCP) or scintillator and the subsequent entry of the photomultiplier during the dead time.

This correction increases the intensity range over which 95% linearity is achieved by a factor of 50 or more.

Therefore, for mass spectrometers for which the relevant correction formulas have been proven to be effective, a higher maximum count rate can be used.

2 Normative references

The contents of the following documents constitute the essential clauses of this document through normative references in this document.

For referenced documents without a date, only the version corresponding to that date applies to this document; for referenced documents without a date, the latest version (including all amendments) applies to this document.

ISO 13084 Surface chemical analysis secondary ion mass spectrometry time-of-flight secondary ion mass spectrometry mass standard calibration (Surface Note. GB/T 40129-2021 Surface chemical analysis secondary ion mass spectrometry time-of-flight secondary ion mass spectrometer mass standard calibration (ISO 13084.

2018, IDT)

3.1 Terms and Definitions

There are no terms or definitions that require definition in this document.

3.2 Notation

The following symbols apply to this document.

The term "intensity" is used below and elsewhere. Intensity refers to the peak area measured in a mass spectrum.

cM. Counts per pulse intensity measurement cP. Corrected counts per pulse intensity FM. abbreviation of FM(i,j) FP. FP(i,j) abbreviation FP(i,j). The corrected intensity ratio of the i-th $^{12}\text{C}_x\text{F}_y$ and $^{13}\text{C}_1^{12}\text{C}_x-1\text{F}_y$ secondary ions in Table 1 i. the serial number of the ion pair listed in Table 1 imax. Maximum primary ion beam current for saturation analysis IM.