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

GB/T 46223-2025

**Microbeam analysis - Analytical electron microscopy - Method
for the determination of energy resolution for electron energy
loss spectrum analysis**

(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 modified to adopt ISO 23420:2021 "Measurement of energy resolution of electron energy loss spectroscopy for microbeam analysis electron microscopy" Methods for Determination.

The technical differences between this document and ISO 23420:2021 and their reasons are as follows.

--- Added requirements for XPS spectrometer calibration (see 5.3 and 6.2.2) to adapt to the actual situation of the use of Chinese standards;

--- Added recommended values for relative thickness checking during electron energy loss spectrum acquisition (see 6.4.3 and 6.5.1) to enhance operability;

--- Deleted the "collection time t " which is not used in the text, and changed the symbol for the sample thickness from d to t (see Chapter 4) to match in line with the common usage in this field;

--- The term "geometric factor" which is not used in this text has been deleted to comply with the relevant provisions of GB/T 1.1-2020;

--- Deleted abbreviations such as CCD, CFE, CMOS, CRM, EEL, GUM, S/TEM, etc. that are not used or used only once in the text Symbols such as t representing the collection time and the cumulative number n are used to comply with the relevant provisions of GB/T 1.1-2020.

This document has been restructured as follows.

--- The relevant content of Chapter 5 of ISO 23420:2021 has been adjusted to Appendix A to make the structure clearer and more in line with Chinese reading habits;

--- The order of the appendices has been changed, and the original Appendix A has been moved to Appendix C to make the structure clearer and more in line with Chinese reading habits.

The following editorial changes have been made to this document.

--- Replaced the energy resolution determination program example in Appendix A (now Appendix C), and added the energy resolution determination program example for electron energy loss spectrum acquisition.

The steps for relative thickness checking are provided to increase the usability of the standard.

Introduction

Electron Energy Loss Spectroscopy (EELS) is often used with a Scanning Transmission Electron Microscope (STEM) or a Transmission Electron Microscope (TEM).

In the process, the chemical composition, atomic bonding and electronic structure of the material can be analyzed by analyzing the energy loss of the incident electrons.

Electron energy loss spectroscopy is used to determine the incident electrons' excitation, inter-band and intra-band transitions, and inner-sphere ionization due to photons and plasmons.

Energy loss caused by inelastic interactions. Among them, the energy loss caused by the ionization of inner electrons is particularly useful, which can give the material Accurate energy loss spectrum analysis needs to be based on the determination of peak decomposition and energy shift. To this end, the determination of electron energy loss the energy resolution of the spectrum is crucial, and therefore, the determination method of its energy resolution needs to be standardized.

This document provides procedures for calibrating the energy step size and determining the energy resolution for use in electron microscopes equipped with EELS.

Energy loss spectrum analysis was performed in.

Microbeam analysis electron microscopy Method for determining energy resolution of electron energy loss spectroscopy

1 Scope

This document describes a transmission electron microscope (TEM) or scanning electron microscope equipped with an electron energy loss spectrometer (EELS).

Procedure for determining the energy resolution of electron energy loss spectroscopy (EELS) in transmission electron microscopy (STEM).

This document applies to both built-in and post-detection EELS, including spectrometers using parallel and serial detection systems.

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.

GB/T 22571-2017 Calibration of the energy scale of X-ray photoelectron spectrometers for surface chemical analysis (ISO 15472.

2010, IDT)

GB/T 40300-2021 Microbeam analysis - Analytical electron microscopy - Terminology (ISO 15932:2013, MOD)

3 Terms and Definitions

The terms and definitions defined in GB/T 40300-2021 and the following apply to this document.

Beam diameter beam diameter the full width at half maximum (FWHM) of the incident electron beam intensity curve during scanning transmission electron microscopy (STEM) observation.

Boersch effect

The energy dispersion of the electron beam is caused by the Coulomb interaction (3.5) between the electrons in the electron beam.

channel

The range of one pixel on the detector of a parallel detection energy loss spectrometer.

collection angle

The angle between the entrance aperture diameter of the energy loss spectrometer or energy filter and the sample.

Note: In practical applications, the collection half angle is usually used to express it, that is, half of the collection angle.

Coulomb interaction

The repulsion between electrons due to their electric charges.