

ICS 71.040.50

CCS N 33



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

GB/T 43610-2023

**Microbeam analysis - Analytical electron microscopy - Method
of determination for apparent growth direction of wirelike
crystals by transmission electron microscopy**

微束分析 分析电子显微术 线状晶体表观生长方向的透射电子显微术测定方法

(English Translation)

Issued on: December 28, 2023

Implemented on: July 1, 2024

**Issued by: State Administration for Market Regulation, China National
Standardization Administration**

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Foreword

This document complies with the provisions of GB/T 1.1-2020 "Standardization Work Guidelines Part 1: Structure and Drafting Rules of Standardization Documents" Drafting:

This document is modified using ISO 19214:2017 "Microbeam analysis of transmission electron microscopy of apparent growth direction of linear crystals" Microscopy measurement method:

Compared with ISO 19214:2017, this document has made the following structural adjustments:

---5:3:1 corresponds to 5:3:1:1 in ISO 19214:2017;

---5:3:2 corresponds to 5:3:1:2 in ISO 19214:2017;

---5:3:5 corresponds to 5:3:1:3 in ISO 19214:2017;

---Appendix D corresponds to Appendix C in ISO 19214:2017:

The technical differences between this document and ISO 19214:2017 and their reasons are as follows:

---The scope has been changed (see Chapter 1) to improve the operability of judgment and eliminate ambiguity;

---Replaced ISO 24173 (see Chapter 3) with the normatively quoted GB/T 30703-2014 to adapt to my country's technical conditions parts to increase operability;

---Changed the definition of the term linear crystal (see 3.1) to facilitate understanding of the text content and eliminate ambiguities;

---Added the terms reciprocal vector and diffraction spot vector (see 3.5 and 3.6) to facilitate understanding of text content and eliminate ambiguities;

---Deleted the simplified procedure requirements under special circumstances (see 5.3:2 in ISO 19214:2017) to improve the accuracy of the operation process Degree, avoid ambiguity;

---Added reference to GB/T 27418-2017 (Chapter 6) to adapt to my country's technical conditions and increase operability;

---Changed the influencing factors of uncertainty and added calculation formulas (see Chapter 6) to increase operability and facilitate the application of this document:

The following editorial changes have been made to this document:

---Changed part of the article to notes (see 5.1:4);

---Changed the incident beam direction to B1, added a note on the steps to obtain the diffraction pattern, and facilitated the calculation of the sample axis tilt angle [see 5.2:2:2a) and e)];

---Added the units of each parameter in formula (1) (see 5.2:3);

---Changed the expression of the diffraction pattern axis index to $[uvw]$ [see 5.2:4c)];

---Changed the expression of the crystal plane index to (hkl) and the expression of the crystal direction index to $[uvw]$ (see 5.2:5);

---Changed Figures 1 and 2, and deleted the note in Figure 1, the note in 5.3:1a) and "The particle is phosphorus with a hexagonal crystal structure" Chemical M2P" (see 5.3:1, 5.3:2);

---Added notes [see 5.2:4b), 5.3:2c)];

---Added an example of determination of the long axis direction of gold nanorods (see Appendix C):

Please note that some content in this document may be subject to patents: The publisher of this document assumes no responsibility for identifying patents:

Introduction

Linear crystals (including ribbon crystals) are the main components of some new materials, especially nanomaterials, and also exist in traditional materials, such as steel:

and needle-like precipitates in the alloy: When preparing these materials, controlling their microstructure is of great significance to improving material quality: In order to control in order to control the microstructure and improve the service performance of related materials, the apparent growth direction or long axis direction of linear crystals is a key feature: diameter the apparent growth direction of linear crystals (or thickness or width) in the range of more than ten nanometers to one hundred nanometers is usually determined by transmission electron microscopy:

Determination:

microbeam analysis analytical electron microscopy Transmission of apparent growth direction of linear crystals Electron microscopy measurement method

1 Scope

This document describes a method for determining the apparent growth direction of linear crystals using transmission electron microscopy:

This document applies to all types of linear crystalline materials prepared by various methods: It also applies to the determination of materials in steel, alloys and other materials:

The direction of one axis of the precipitated second phase particles resembles rod-like or polygonal shapes: By the acceleration voltage of transmission electron microscope (TEM) and Subject to the constraints of the sample itself and other conditions, this document is applicable to crystalline materials with a diameter (or thickness or width) ranging from tens of nanometers to about a hundred nanometers:

This document is not applicable to the determination of linear crystals in folded, twisted, or rotated states:

Note: In this document, linear crystals, ribbon crystals, needle-like second phase particles, etc: all belong to linear crystals in a broad sense:

2 Normative reference documents

The contents of the following documents constitute essential provisions of this document through normative references in the text: Among them, the dated quotations for undated

referenced documents, only the version corresponding to that date applies to this document; for undated referenced documents, the latest version (including all amendments) applies to this document:

GB/T 18907-2013 Microbeam analysis and analytical electron microscopy Transmission electron microscopy Selected electron diffraction analysis method (ISO 25498:2010, IDT)

GB/T 27418-2017 Evaluation and expression of measurement uncertainty (ISO/IEC Guide98-3:2008, MOD) GB/T 30703-2014 Guidelines for microbeam analysis electron backscattered diffraction orientation analysis method (ISO 24173:2009, IDT)

3 Terms and definitions

The terms and definitions defined in GB/T 30703-2014 and the following apply to this document:

wirelikecrystalwirelikecrystal A crystal whose length in one dimension is significantly larger than the other two dimensions:

The crystallographic direction parallel to the longest dimension of a single crystal:

Note: The apparent growth direction does not involve the phase interface migration mechanism:

Miller indexMiller notation an exponential system that describes the diffraction pattern of a crystal using a three-axis coordinate system:

Miller-Bravais notation an exponential system that describes the diffraction pattern of hexagonal crystals using a four-axis coordinate system: