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

*Analyse par microfaisceaux — Microscopie électronique analytique  
— Méthode de détermination de la direction apparente de croissance  
des cristaux filiformes par microscopie électronique en transmission*

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## Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see [www.iso.org/directives](http://www.iso.org/directives)).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see [www.iso.org/patents](http://www.iso.org/patents)).

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For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: [www.iso.org/iso/foreword.html](http://www.iso.org/iso/foreword.html).

This document was prepared by Technical Committee ISO/TC 202, *Microbeam analysis*, Subcommittee SC 3, *Analytical electron microscopy*.

## Introduction

Wirelike crystals (including beltlike crystals) are a main component in some advanced materials, especially nanomaterials, and also appear in traditional materials, such as needle-shaped precipitates in steels and alloys. Controlling the microstructure of these materials during fabrication is very important for quality control considerations. To control the microstructure and thereby improve the service properties of the relevant materials, the apparent growth direction or the longest axis of the wires is one of the essential parameters. This direction is generally determined for wirelike crystals whose diameter or thickness and width is ranged from tens to hundreds of nanometres by transmission electron microscopy (TEM).

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

## 1 Scope

This document prescribes a method for the determination of apparent growth direction by transmission electron microscopy. It is applicable to all kinds of wirelike crystalline materials fabricated by various methods. This document can also guide in ascertaining an axis direction of the second-phase particles with a rod-like or polygonal shape in steels, alloys or other materials. The applicable diameter or width of the crystals to be tested is in the range of tens to hundreds of nanometres, depending on the accelerating voltage of the TEM and the material itself.

**NOTE** In the present document, wirelike crystals, beltlike crystals, needle-shaped second-phase particles, etc. are all subsumed by the broad category of wirelike crystals.

## 2 Normative references

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 24173, *Microbeam analysis — Guidelines for orientation measurement using electron backscatter diffraction*

ISO 25498:2010, *Microbeam analysis — Analytical electron microscopy — Selected-area electron diffraction analysis using a transmission electron microscope*

## 3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 24173 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

### 3.1

#### **wirelike crystal**

crystal resembling a thread with a diameter or width measuring in nanometres

### 3.2

#### **apparent growth direction**

crystalline direction which is parallel to the longest dimension of a single crystal

Note 1 to entry: Apparent growth direction does not involve mechanisms of the phase interface migration.

### 3.3

#### **Miller notation**

indexing system for diffraction patterns, which describes a crystal lattice by three axes coordinate