# INTERNATIONAL STANDARD

ISO 19012-1

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# Optics and photonics — Designation of microscope objectives —

Part 1: Flatness of field/Plan

Optique et photonique — Désignation des objectifs de microscope —

iTeh STPartie 1: Planette du champ/Plan EW (standards.iteh.ai)



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ISO 19012-1:2007 https://standards.iteh.ai/catalog/standards/sist/c18ae20d-54a1-4f15-bff2-547a974dd86d/iso-19012-1-2007



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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 19012-1 was prepared by Technical Committee ISO/TC 172, *Optics and photonics*, Subcommittee SC 5, *Microscopes and endoscopes*.

ISO 19012 consists of the following parts, under the general title Optics and photonics — Designation of microscope objectives: (standards.iteh.ai)

— Part 1: Flatness of field/Plan

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# Optics and photonics — Designation of microscope objectives —

### Part 1:

### Flatness of field/Plan

### 1 Scope

This part of ISO 19012 specifies the use of the marking, "Plan", on microscope objectives, and defines the diameter of the sharp region of the primary image of a flat object surface. This part of ISO 19012 applies to visual observation using the combination of objective lens, tube lens and eyepiece as specified by the manufacturer.

This marking is consistent with ISO 8578.

NOTE The flatness of the image field does not imply any degree of correction for other aberrations (ISO 10934-1).

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## 2 Normative references (standards.iteh.ai)

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 6d/iso-19012-1-2007

ISO 10934-1:2002, Optics and optical instruments — Vocabulary for microscopy — Part 1: Light microscopy

#### 3 Terms and definitions

For the purposes of this document, the terms and definitions from ISO 10934-1 apply together with the following.

#### 3.1

#### tangential structured object

object containing short lines perpendicular to the radii of the object field

#### 3.2

#### tangential image surface

surface on which all tangential structured objects are focused and sharply imaged in the primary image space subject to no aberrations other than astigmatism

#### 3.3

#### sagittal structured object

object containing short lines parallel to the radii of the object field

#### 3.4

#### sagittal image surface

surface on which all sagittal structured objects are focused and sharply imaged in the primary image space subject to no aberrations other than astigmatism

#### 3.5

#### astigmatic difference

dimensional difference along optical axis in the tangential plane between the tangential and sagittal image surfaces

#### 3.6

#### plan field number

PFN

number which specifies the diameter, in millimetres, of the sharp region of the primary image of a flat object surface

#### 3.7

#### objective field number

**OFN** 

maximum field of view number of the eyepiece for which the objective is designed to be used

#### 3.8

#### plan field ratio

**PFR** 

ratio of the plan field number to the objective field number defined as PFR = PFN/OFN

#### 4 Requirements

# 4.1 Indication iTeh STANDARD PREVIEW

Objective lenses named Plan or with Plan as part of the name in the markings shall also indicate the objective field number on its body. If the words "flat field" are used in the name in the marking, then they shall also be marked Plan with the indication of the OFN on its body. The indication of objective field number does not apply to objective lenses sold before the year 2010[SO 19012-1:2007]

https://standards.iteh.ai/catalog/standards/sist/c18ae20d-54a1-4f15-bff2-

Objective field numbers shall be expressed as follows 86d/iso-19012-1-2007

18, 19, 20, 21, 22, 23, 24, 25, 26, 26.5, 27, 28, 29, 30 and so on

**EXAMPLE** 

In the case of the objective field number 25:

OFN25

#### 4.2 Definition of plan objectives

The plan field ratio of a plan objective lens shall be at least 0,85.

#### 4.3 Determination of plan field number

Let  $\tau_t$  and  $\tau_s$  be the distance of tangential and sagittal image surface calculated from the image plane, along optical axis in a tangential plane, respectively. Using  $\tau_t$  and  $\tau_s$ , the average image surface distance,  $\Delta$  is defined as shown in Equation 1:

$$\Delta = (\tau_t + \tau_s)/2 \tag{1}$$

The plan field number shall be specified by the maximum field of view of the primary image which satisfies the following conditions. When the absolute values of both  $\Delta$  and astigmatic difference  $(\tau_t - \tau_s)$  are less than or equal to the value  $\delta$  calculated by Berek's formula, and the magnification of the eyepiece is 10 ×.

$$\delta = \left[ \left( \omega / M_{\text{TOT VIS}} \right) \times \left( 250\ 000 / NA \right) + \lambda / 2NA^2 \right] \times M_0^2$$
 (2)

where

 $\delta$  is the depth of focus in image space in micrometres;

 $\omega$  is a physiological constant which describes the resolution of the human eye, taken to be the angle 5' [ $\omega$  is the arc of this angle (0,001 4)];

 $M_{\rm TOT, VIS}$  is the total visual magnification of the microscope;

NA is the numerical aperture of objective;

 $\lambda$  is the wavelength of the e-line in micrometres;

 $M_0$  is the magnification in the primary image plane.

The depth of field calculated by Berek's formula is expressed in Annex A.

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## Annex A

(informative)

# Depth of field in object space calculated by Berek's formula

$$\delta_{\text{ob}} = n \left( \omega I M_{\text{TOTVIS}} \times 250 \ 000 I NA + \lambda I 2 NA^2 \right)$$

$$\omega = 0,001 \ 4, \ \lambda = 0,55 \ \mu\text{m}$$

| Magnification of objective lens                                    | 4       | 4      | 4      | 4      | 5      | 5      | 5      |
|--|---------|--------|--------|--------|--------|--------|--------|
| NA of objective lens   | 0,10    | 0,13   | 0,16   | 0,20   | 0,12   | 0,15   | 0,16   |
| Magnification of eyepiece  | 10      | 10     | 10     | 10     | 10     | 10     | 10     |
| Depth of field at specimen: $\delta_{\rm ob}(\mu{\rm m})$          | 114,825 | 83,476 | 65,361 | 50,581 | 77,309 | 58,811 | 54,424 |
| Refractive index: $n$ (dry: $n = 1$ , oil immersion: $n = 1,515$ ) | 1       | 1      | 1      | 1      | 1      | 1      | 1      |

| Magnification of objective lens   | 10              | 10                               | 10             | 10                 | 10         | 10    |
|---|-----------------|----------------------------------|----------------|--------------------|------------|-------|
| NA of objective lens  | 0,22 <b>∆</b> ] | 770,25 R                         | 0,30           | 0,32               | 0,40       | 0,45  |
| Magnification of eyepiece   | 10              | 10                               | 10             | 10                 | 10         | 10    |
| Depth of field at specimen: $\delta_{\rm ob}(\mu{\rm m})$                         | 21,555          | 18,372<br>ISO 19012-1            | 14,703<br>2007 | 13,606             | 10,458     | 9,127 |
| Refractive index: $n$ https://stan (dry: $n = 1$ , oil immersion: $\mu = 1,515$ ) |                 | talog/standards<br>74dd86d/iso-1 |                | -54a1-4f15-bf<br>1 | <u>2</u> - | 1     |

| Magnification of objective lens                                    | 20    | 20    | 20    | 20    | 20    | 20    |
|--|-------|-------|-------|-------|-------|-------|
| NA of objective lens   | 0,40  | 0,45  | 0,50  | 0,60  | 0,70  | 0,75  |
| Magnification of eyepiece  | 10    | 10    | 10    | 10    | 10    | 10    |
| Depth of field at specimen: $\delta_{\rm ob}(\mu{\rm m})$          | 6,083 | 5,238 | 4,593 | 3,676 | 3,058 | 2,819 |
| Refractive index: $n$ (dry: $n = 1$ , oil immersion: $n = 1,515$ ) | 1     | 1     | 1     | 1     | 1     | 1     |

| Magnification of objective lens              | 40    | 40    | 40    | 40    | 40    | 40    | 40    | 40    | 40    | 40    |
|--|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| NA of objective lens                         | 0,55  | 0,60  | 0,65  | 0,70  | 0,75  | 0,85  | 0,95  | 1,00  | 1,25  | 1,30  |
| Magnification of eyepiece                    | 10    | 10    | 10    | 10    | 10    | 10    | 10    | 10    | 10    | 10    |
| Depth of field at specimen:                  | 2,494 | 2,217 | 1,993 | 1,808 | 1,652 | 1.408 | 1,224 | 1,740 | 1,325 | 1,265 |
| $\delta_{ m ob}(\mu{ m m})$                  | 2,434 | 2,217 | 1,990 | 1,000 | 1,002 | 1,400 | 1,224 | 1,740 | 1,020 | 1,200 |
| Refractive index: n                          | 1     | 1     | 1     | 1     | 1     | 1     | 1     | 1,515 | 1,515 | 1,515 |
| (dry: $n = 1$ , oil immersion: $n = 1,515$ ) |       | ı     |       | '     | '     |       | '     | 1,515 | 1,313 | 1,313 |

| Magnification of objective lens                                    | 60    | 60    | 60    | 60    | 60    | 60    | 60    |
|--|-------|-------|-------|-------|-------|-------|-------|
| NA of objective lens   | 0,70  | 0,85  | 0,90  | 0,95  | 1,25  | 1,30  | 1,40  |
| Magnification of eyepiece  | 10    | 10    | 10    | 10    | 10    | 10    | 10    |
| Depth of field at specimen: $\delta_{\rm ob}(\mu {\rm m})$         | 1,391 | 1,064 | 0,985 | 0,917 | 0,972 | 0,925 | 0,842 |
| Refractive index: $n$ (dry: $n = 1$ , oil immersion: $n = 1,515$ ) | 1     | 1     | 1     | 1     | 1,515 | 1,515 | 1,515 |

| Magnification of objective lens   | $A_{63}DA$  | $R_{63}$ P | R <sub>63</sub> V | E 63       | 63    | 63    | 63    |
|---|---|------------|-------------------|------------|-------|-------|-------|
| NA of objective lens  | andar   | dg,75te    | 0,80              | 0,95       | 1,25  | 1,32  | 1,40  |
| Magnification of eyepiece   | 10  | 10         | 10                | 10         | 10    | 10    | 10    |
| Depth of field at specimen: https://standards.iteh. $\delta_{\mathrm{ob}}(\mu\mathrm{m})$ | <u>ISO 19</u><br>ai/c <b>1t,35</b> g/stai<br>7a974dd86d |            |                   | -410,8882- | 0,938 | 0,875 | 0,812 |
| Refractive index: $n$ (dry: $n = 1$ , oil immersion: $n = 1,515$ )                        | 1   | 1          | 1                 | 1          | 1,515 | 1,515 | 1,515 |

| Magnification of objective lens              | 100   | 100   | 100   | 100   | 100   | 100   |
|--|-------|-------|-------|-------|-------|-------|
| NA of objective lens                         | 0,90  | 0,95  | 1,25  | 1,30  | 1,35  | 1,40  |
| Magnification of eyepiece                    | 10    | 10    | 10    | 10    | 10    | 10    |
| Depth of field at specimen:                  | 0.700 | 0.074 | 0.000 | 0.050 | 0.000 | 0.500 |
| $\delta_{\sf ob}(\mu{\sf m})$                | 0,726 | 0,671 | 0,689 | 0,653 | 0,620 | 0,590 |
| Refractive index: n                          | 4     | 1     | 1 515 | 1 515 | 1 515 | 1 515 |
| (dry: $n = 1$ , oil immersion: $n = 1,515$ ) | l     | l     | 1,515 | 1,515 | 1,515 | 1,515 |

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