INTERNATIONAL STANDARD

ISO 19012-1

Second edition
2011-07-01

Microscopes — Designation of microscope objectives —

Part 1: Flatness of field/Plan

Microscopes — Désignation des objectifs de microscope —

Partie 1: Planéité du champ/Plan

Reference number
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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*.

This second edition cancels and replaces the first edition (ISO 19012-1:2007), which has undergone a minor revision to amend the transition period specified in 4.1.

ISO 19012 consists of the following parts, under the general title *Microscopes — Designation of microscope objectives*:

— *Part 1: Flatness of field/Plan*

— *Part 2: Chromatic correction*

Microscopes — 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).

2 Normative references

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.

ISO 10934-1, *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 given in 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 the 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

Objective lenses named Plan or with Plan as part of the name in the markings shall also indicate the objective field number on the body of the lens. If the words “flat field” are used in the name in the marking, then the lenses shall also be marked “Plan” with an indication of the OFN on the body of the lens. The indication of objective field number does not apply to objective lenses sold before the year 2014.

Objective field numbers shall be expressed as follows:

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 τ_t and τ_s be the respective distances of the tangential and sagittal image surfaces from the image plane, along the optical axis in a tangential plane. Using τ_t and τ_s, the average image surface distance, Δ, is defined as shown in Equation (1):

$$\Delta = (\tau_t + \tau_s)/2 \quad (1)$$

The plan field number shall be specified by the maximum field of view of the primary image which satisfies the following conditions: the absolute values of both Δ and astigmatic difference $(\tau_t - \tau_s)$ are less than or equal to the value δ calculated by Berek's formula [see Equation (2)], and the magnification of the eyepiece is 10 ×.

$$\delta = \left(\frac{\omega}{M_{\text{TOT VIS}}} \cdot \frac{250\ 000}{NA} + \frac{\lambda}{2 \cdot NA^2} \right) \cdot M_0{}^2 \qquad (2)$$

where

δ is the depth of focus in image space, in micrometres;

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

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

NA is the numerical aperture of objective;

λ 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.

Annex A
(informative)

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

$$\delta_{ob} = n \cdot \left(\frac{\omega}{M_{TOT\ VIS}} \cdot \frac{250\ 000}{NA} + \frac{\lambda}{2 \cdot NA^2} \right)$$

ω = 0,001 4, λ = 0,55 µm

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: δ_{ob} (µm)	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	0,25	0,30	0,32	0,40	0,45
Magnification of eyepiece	10	10	10	10	10	10
Depth of field at specimen: δ_{ob} (µm)	21,555	18,372	14,703	13,606	10,458	9,127
Refractive index: n (dry: n = 1, oil immersion: n = 1,515)	1	1	1	1	1	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: δ_{ob} (µm)	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: δ_{ob} (µm)	2,494	2,217	1,993	1,808	1,652	1,408	1,224	1,740	1,325	1,265
Refractive index: n (dry: n = 1, oil immersion: n = 1,515)	1	1	1	1	1	1	1	1,515	1,515	1,515

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: δ_{ob} (µm)	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	63	63	63	63	63	63	63
NA of objective lens	0,70	0,75	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: δ_{ob} (µm)	1,351	1,227	1,121	0,888	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: δ_{ob} (µm)	0,726	0,671	0,689	0,653	0,620	0,590
Refractive index: n (dry: n = 1, oil immersion: n = 1,515)	1	1	1,515	1,515	1,515	1,515