BS ISO 19012-1:2013

BSI Standards Publication

Microscopes — Designation of microscope objectives

Part 1: Flatness of field/Plan

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National foreword

This British Standard is the UK implementation of ISO 19012-1:2013. It supersedes BS ISO 19012-1:2011 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee CPW/172, Optics and Photonics.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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INTERNATIONAL STANDARD

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Third edition
2013-05-15

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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Contents

Page

Foreword

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The committee responsible for this document is ISO/TC 172, *Optics and photonics*, Subcommittee SC 5, *Microscopes and endoscopes*.

This third edition cancels and replaces the second edition (ISO 19012-1:2011) by the addition of "Petzval curvature".

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*

The following parts are under preparation:

— *Part 3: Spectral transmittance*

INTERNATIONAL STANDARD ISO 19012-1:2013(E)

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 documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. 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 and the following apply.

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 and Petzval curvature

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 and Petzval curvature

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

3.9
Petzval curvature
curvature of the Petzval surface, which denotes the basic field curvature

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 Formula (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 Formula (2)], and the magnification of the eyepiece is 10 × .

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

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

Berek's formula is as follows:

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

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

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