

## MET SERIES



**Metallurgical Microscopes**

# Metallurgical Microscopy

Metallography is the study of the physical structure and components of metals, by using microscopy. Many different microscopy techniques are used in metallographic analysis.

Prepared specimens should be examined with the unaided eye after etching to detect any visible areas that have responded to the etchant differently from the norm as a guide to where microscopical examination should be employed. Light optical microscopy (LOM) examination should always be performed prior to any electron metallographic (EM) technique, as these are more time-consuming to perform and the instruments are much more expensive.

Further, certain features can be best observed with the LOM, e.g., the natural color of a constituent can be seen with the LOM but not with EM systems. Also, image contrast of microstructures at relatively low magnifications, e.g.,  $<500\times$ , is far better with the LOM than with the scanning electron microscope (SEM), while transmission electron microscopes (TEM) generally cannot be utilized at magnifications below about 2000 to 3000 $\times$ . LOM examination is fast and can cover a large area. Thus, the analysis can determine if the more expensive, more time-consuming examination techniques using the SEM or the TEM are required and where on the specimen the work should be concentrated.

## Brightfield and darkfield microscopy

Most LOM observations are conducted using bright-field (BF) illumination, where the image of any flat feature perpendicular to the incident light path is bright, or appears to be white. But, other illumination methods can be used and, in some cases, may provide superior images with greater detail. Dark-field microscopy (DF), is an alternative method of observation that provides high-contrast images and actually greater resolution than bright-field. In dark-field illumination, the light from features perpendicular to the optical axis is blocked and appears dark while the light from features inclined to the surface, which look dark in BF, appear bright, or "self-luminous" in DF. Grain boundaries, for example, are more vivid in DF than BF.

## Polarized light microscopy

Polarized light (PL) is very useful when studying the structure of metals with non-cubic crystal structures (mainly metals with hexagonal close-packed (hcp) crystal structures). If the specimen is prepared with minimal damage to the surface, the structure can be seen vividly in cross-polarized light (the optic axis of the polarizer and analyzer are 90 degrees to each other, i.e., crossed). In some cases, an hcp metal can be chemically etched and then examined more effectively with PL. Tint etched surfaces, where a thin film (such as a sulfide, molybdate, chromate or elemental selenium film) is grown epitaxially on the surface to a depth where interference effects are created when examined with BF producing color images, can be improved with PL. If it is difficult to get a good interference film with good coloration, the colors can be improved by examination in PL using a sensitive tint (ST) filter.

## Differential interference contrast microscopy

Another useful imaging mode is differential interference contrast (DIC), which is usually obtained with a system designed by the Polish physicist Georges Nomarski. This system gives the best detail. DIC converts minor height differences on the plane-of-polish, invisible in BF, into visible detail. The detail in some cases can be quite striking and very useful. If an ST filter is used along with a Wollaston prism, color is introduced. The colors are controlled by the adjustment of the Wollaston prism, and have no specific physical meaning, per se. But, visibility may be better.



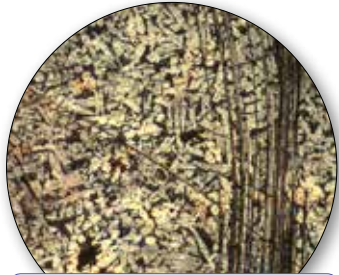
## Oblique illumination

DIC has largely replaced the older oblique illumination (OI) technique, which was available on reflected light microscopes prior to about 1975. In OI, the vertical illuminator is offset from perpendicular, producing shading effects that reveal height differences. This procedure reduces resolution and yields uneven illumination across the field of view. Nevertheless, OI was useful when people needed to know if a second phase particle was standing above or was recessed below the plane-of-polish, and is still available on a few microscopes. OI can be created on any microscope by placing a piece of paper under one corner of the mount so that the plane-of-polish is no longer perpendicular to the optical axis.

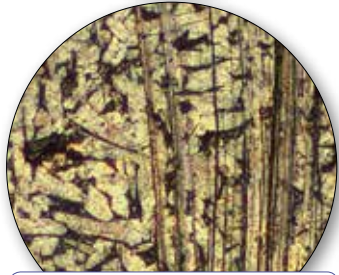
# B-383MET - Metallurgical Microscope

Brightfield upright microscope with IOS W-PLAN MET objectives and metallurgical attachment combining the exclusive **X-LED<sup>3</sup>** lighting source both for incident and transmitted illumination. The NCG (no cover glass) objectives are especially designed for microscopy use without a cover slip ideal for metallographic samples and other opaque specimens.

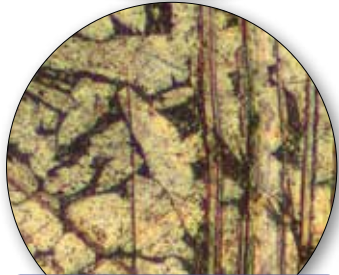
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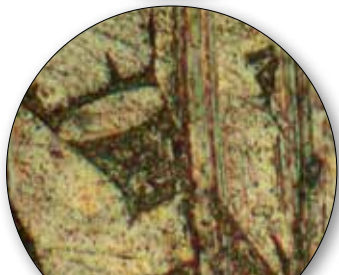
4x



10x



20x



50x









Part	Description
Observation mode:	Brightfield, incident polarized light.
Epi-illumination and polarizing filters:	X-LED <sup>3</sup> with white 3.6 W LED (6.300 K) with brightness control. Field and aperture diaphragms, polarizer & analyzer filters.
Head:	Trinocular (fixed 50/50), 30° inclined, 360° rotating.
Interpupillary distance:	Adjustable between 48 and 75 mm.
Dioptric adjustment:	On the left eyepiece tube.
Eyepieces:	WF10x/20 mm, high eye-point and secured by screw.
Nosepiece:	Quintuple revolving nosepiece, rotation on ball bearings.

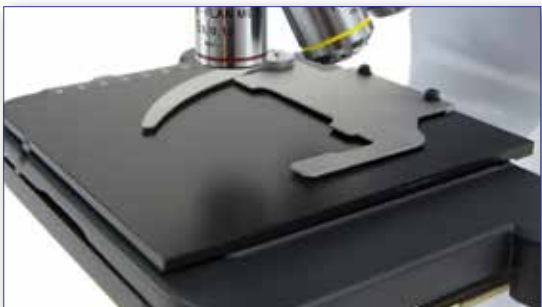
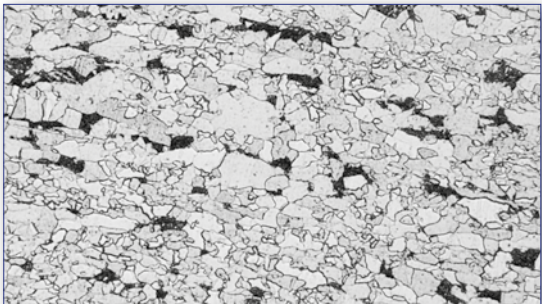
Part	Description
Objectives (strain-free):	IOS W-PLAN MET 4x/0.10    IOS W-PLAN MET 10x/0.25 IOS W-PLAN MET 20x/0.40    IOS W-PLAN MET 50x/0.75 All with anti-fungus treatment.
Specimen stage:	Double layer rackless mechanical stage, 233x147 mm, 78x54 mm X-Y range. With tempered glass plate.
Focusing:	Coaxial coarse (adjustable tension) and fine focusing mechanism with limit stop to prevent the contact between objective and specimen.
Condenser:	Abbe N.A. 1.25, with objective-coded iris diaphragm, focusable and centerable.
Transmitted illumination (Fixed Koehler type):	X-LED <sup>3</sup> with white 3.6 W LED (6.300 K) with brightness control. Multi-plug 100-240Vac/6Vdc external power supply.



# B-510MET - Metallurgical Microscope

Advanced routine laboratory microscope with IOS W-PLAN MET objectives and metallurgical attachment with the exclusive **X-LED<sup>3</sup>** lighting source for incident illumination only. The NCG (no cover glass) objectives are especially designed for microscopy use without a cover slip ideal for metallographic samples and other opaque specimens.

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X-LED<sup>3</sup>
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IOS
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W-PLAN
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MET
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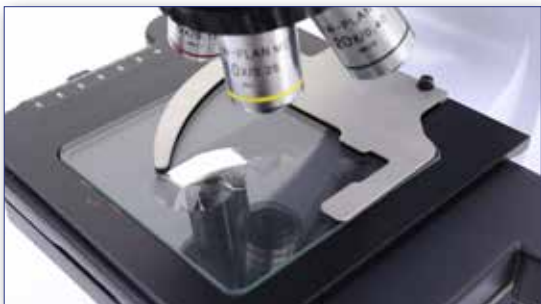
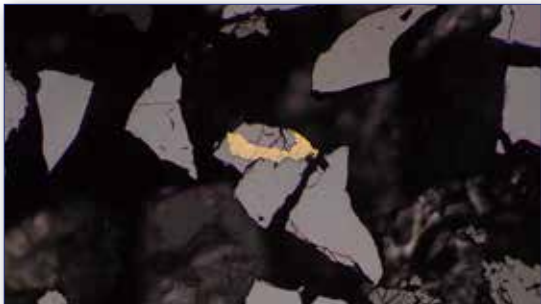


Part	Description
Observation mode:	Brightfield, simple polarized light, oblique illumination on incident light.
Epi-illumination and polarizing filters:	X-LED <sup>3</sup> with white 8 W LED (6.300 K) with brightness control. With aperture and field diaphragms, and oblique illumination system. With polarizer and analyzer. Multi-plug 100-240Vac/6Vdc external power supply.
Head:	Trinocular (fixed 50/50), 30° inclined, 360° rotating.
Interpupillary distance:	Adjustable between 50 and 75 mm.
Dioptric adjustment:	On the left eyepiece tube.
Eyepieces:	WF10x/22 mm, high eye-point and with rubber cups.
Nosepiece:	Quintuple revolving nosepiece, rotation on ball bearings.

Part	Description
Objectives (strain-free):	IOS W-PLAN MET 5x/0.12 IOS W-PLAN MET 10x/0.25 IOS W-PLAN MET 20x/0.40 IOS W-PLAN MET 50x/0.75 All with anti-fungus treatment.
Specimen stage:	Double layer rackless mechanical stage, 233x147 mm, 78x54 mm X-Y range.
Focusing:	Coaxial coarse (adjustable tension) and fine focusing mechanism with limit stop to prevent the contact between objective and specimen.

# B-510METR - Metallurgical Microscope

Advanced routine laboratory microscope with IOS W-PLAN MET objectives and metallurgical attachment with the exclusive **X-LED<sup>3</sup>** lighting source for both transmitted and incident illumination. The NCG (no cover glass) objectives are especially designed for microscopy use without a cover slip ideal for metallographic samples and other opaque specimens.

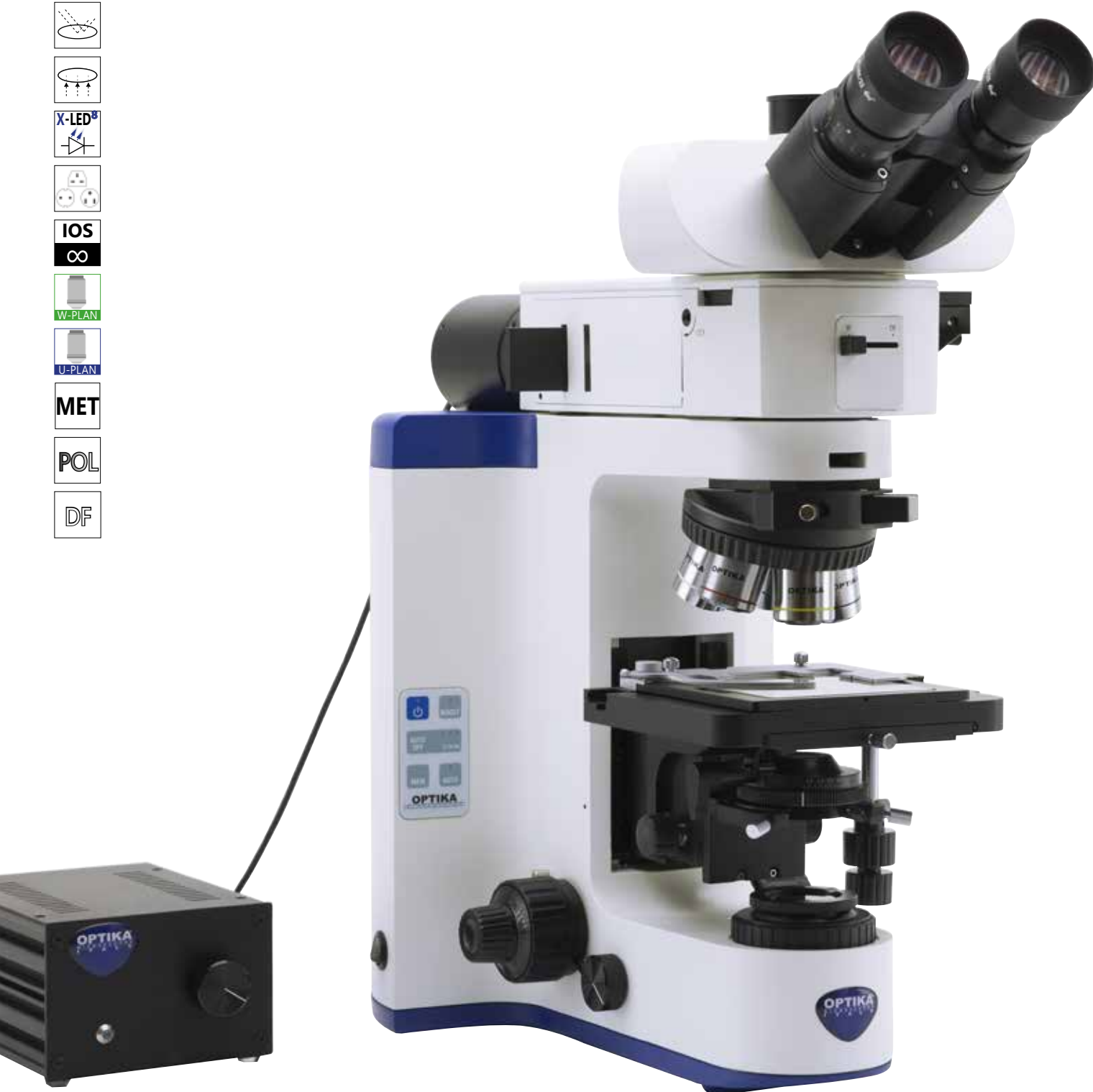


Part	Description
<b>Observation mode:</b>	Brightfield on transmitted light. Brightfield, simple polarized light, oblique illumination on incident light.
<b>Epi-illumination and polarizing filters:</b>	X-LED <sup>3</sup> with white 8 W LED (6.300 K) with brightness control. With aperture and field diaphragms, and oblique illumination system. With polarizer and analyzer.
<b>Head:</b>	Trinocular (fixed 50/50), 30° inclined, 360° rotating.
<b>Interpupillary distance:</b>	Adjustable between 50 and 75 mm.
<b>Dioptric adjustment:</b>	On the left eyepiece tube.
<b>Eyepieces:</b>	WF10x/22 mm, high eye-point and with rubber cups.
<b>Nosepiece:</b>	Quintuple revolving nosepiece, rotation on ball bearings.

Part	Description
<b>Objectives (strain-free):</b>	IOS W-PLAN MET 5x/0.12 IOS W-PLAN MET 10x/0.25 IOS W-PLAN MET 20x/0.40 IOS W-PLAN MET 50x/0.75 All with anti-fungus treatment.
<b>Specimen stage:</b>	Double layer rackless mechanical stage, 233x147 mm, 78x54 mm X-Y range. With tempered glass plate.
<b>Focusing:</b>	Coaxial coarse (adjustable tension) and fine focusing mechanism with limit stop to prevent the contact between objective and specimen.
<b>Condenser:</b>	Swing-out N.A. 0.2/0.9, with iris diaphragm, focusable and centerable.
<b>Transmitted illumination (Full Koehler type):</b>	X-LED <sup>3</sup> with white 3.6 W LED (6.300 K) with brightness control. Multi-plug 100-240Vac/6Vdc external power supply.

## B-1000MET - Metallurgical Microscope

The modular OPTIKA B-1000 is available with brightfield and darkfield incident light, helping you working in a comfortable way during extended periods of use and performing reliable, accurate and rapid diagnosis benefiting from modularity, which gives the chance to create customized configurations tailored on customer needs. Versatile, robust, durable and sturdy, B-1000 offers premium quality optics, the state-of-the-art, exclusive **X-LED<sup>®</sup>** (8 W) illumination system, designed by OPTIKA and the Koehler diaphragm. Incident light through 100 W halogen lamp or 18 W LED illumination. B-1000 gives multiple options as manual or motorized configuration.



# B-1000MET - Configuration Chart

Build the microscope that suites your needs by choosing among the components

## M-781

PL10x/22 eyepiece, high eyepoint, with micrometric scale (10mm/100um) & rubber cup (retractable)



## M-1001

PL10x/22 eyepieces (pair), high eyepoint, with rubber cup (retractable)



## M-1003

PL15x/16 eyepieces (pair), high eyepoint



## M-1011

Trinocular head, three positions (100/0, 50/50, 0/100)



## M-1012

Binocular ERGO head



## M-1035

Metallurgical attachment, 100 W Halogen



## M-1036

Metallurgical attachment, 18 W LED



## M-1021M

Main body with focus system and X-LED<sup>®</sup> illumination, for metallurgical model



## M-1021M+M-1156\*+M-1149

Main body with motorized focus system and X-LED<sup>®</sup> illumination, for metallurgical model



## M-1022M

Main body with focus system, for metallurgical model with incident light only



## M-1022M+M-1156\*+M-1149

Main body with motorized focus system, for metallurgical model with incident light only



## M-1042

Sextuple reversed nosepiece, for RMS objectives with DIC slot



## M-1043+M-1156\*

Sextuple motorized reversed nosepiece, for RMS objectives with DIC slot



## M-1045

Quintuple reversed nosepiece for darkfield MET objectives, with 3 adater rings for RMS objectives



## M-1046+M-1156\*

Quintuple motorized reversed nosepiece for darkfield MET objectives, with 3 adater rings for RMS objectives



## IOS LWD W-PLAN MET



M-1099 2.5x

## IOS LWD U-PLAN MET



M-1100 5x  
M-1101 10x  
M-1102 20x  
M-1103 50x  
M-1104 100x

## IOS LWD U-PLAN F MET



M-1171 5x  
M-1172 10x  
M-1173 20x  
M-1174 50x  
M-1175 100x

## IOS LWD W-PLAN MET BD



M-1109 5x  
M-1110 10x  
M-1111 20x  
M-1112 40x  
M-1113 50x  
M-1114 100x

## IOS LWD U-PLAN MET BD



M-1094 5x  
M-1095 10x  
M-1096 20x  
M-1097 50x  
M-1098 100x

## IOS LWD U-PLAN F MET BD



M-1180 5x  
M-1181 10x  
M-1182 20x  
M-1183 50x  
M-1184 100x

## M-1148

Mechanical stage with glass, for metallurgical model



## M-1147+M-1156\*

Motorized mechanical stage



## M-1154

0.70 N.A. swing-out MET condenser

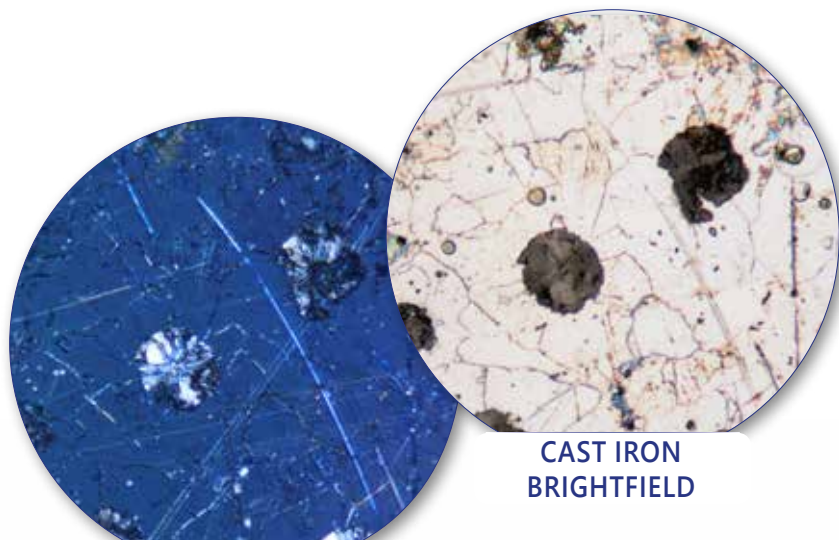


\* Code M-1156 must be added only **once** for any motorized configuration



# IM-3MET- Metallurgical Microscope

Routine inverted microscope with IOS LWD U-PLAN MET objectives for material science and metallographic applications, combining a sturdy yet compact structure with dedicated components required in this field, like the NCG (no cover glass) objectives working without cover slide ideal for metallographic samples and other opaque specimens. A particularly simple and ingenious optical design allows stable alignments and smooth and accurate movements.



CAST IRON  
POLARIZED LIGHT

CAST IRON  
BRIGHTFIELD





# IM-3 Series - Specifications



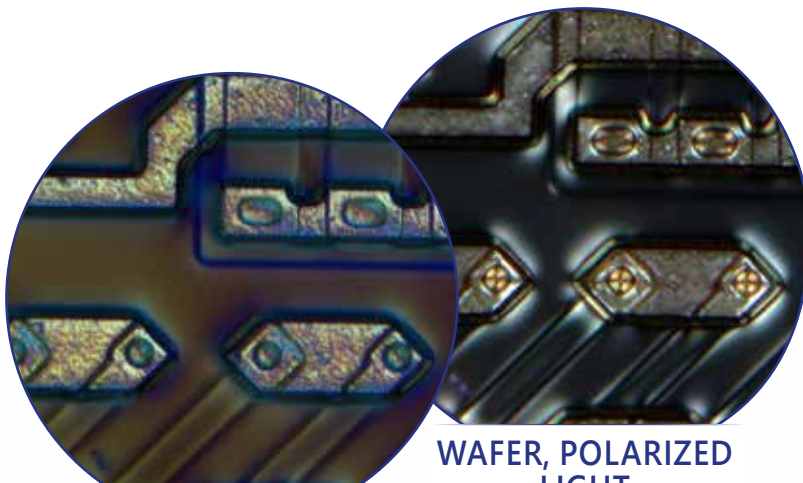
Part	Description
<b>Observation mode:</b>	Brightfield, simple polarized light on incident light.
<b>Epi-illumination and polarizing filters:</b>	Halogen 12 V/50 W with brightness control. With aperture and field (centrable) diaphragms. With polarizer and analyzer.
<b>Head:</b>	Trinocular (2-position 100/0, 50/50), 45° inclined.
<b>Interpupillary distance:</b>	Adjustable between 50 and 75 mm.
<b>Dioptric adjustment:</b>	On the left eyepiece tube.
<b>Eyepieces:</b>	WF10x/22 mm, high eye-point and with rubber cups.
<b>Nosepiece:</b>	Quintuple revolving nosepiece, rotation on ball bearings.
<b>Objectives</b>	IOS LWD U-PLAN MET 5x/0.15 IOS LWD U-PLAN MET 10x/0.30 IOS LWD U-PLAN MET 20x/0.45 IOS LWD U-PLAN MET 50x/0.55 All with anti-fungus treatment.
<b>Specimen stage:</b>	Fixed stage, 250x160 mm, with metal stage insert.
<b>Focusing:</b>	Coaxial coarse (adjustable tension) and fine focusing mechanism with limit stop to prevent the contact between objective and specimen.

## IM-3 Series - Optical performance

Eyepiece		10x (M-780)			15x (M-601)	
Field number (mm)		22			16	
Objective	N.A.	W.D. (mm)	Total magnification	Field of view (mm)	Total magnification	Field of view (mm)
5x	0.15	10.80	50x	4.40	75x	3.20
10x	0.30	10	100x	2.20	150x	1.60
20x	0.45	4	200x	1.10	300x	0.80
50x	0.55	7.90	500x	0.44	750x	0.32
100x	0.80	2.10	1000x	0.22	1500x	0.16

# 3 IM-5MET - Metallurgical Microscope

OPTIKA IM-5MET is a new inverted research microscope for metallography providing a high-end solution in the field of material science. Brightfield, darkfield, polarized light and DIC - Nomarski technique all-in-one for an extremely valuable instrument able to provide ergonomic handy controls and significant unique features, such as the highest F.O.V. available on an inverted microscope.



WAFER, DIC

WAFER, POLARIZED LIGHT



# IM-5MET - Specifications



Part	Description
<b>Observation mode:</b>	Brightfield, simple polarized light on incident light. DIC as optional.
<b>Epi-illumination and polarizing filters:</b>	Halogen 12 V/100 W with brightness control. Brightfield and darkfield lever. With polarizer and analyzer. With aperture and field diaphragms, both centrable.
<b>Head:</b>	Trinocular (2-position 100/0, 0/100), 45° inclined.
<b>Interpupillary distance:</b>	Adjustable between 50 and 75 mm.
<b>Dioptric adjustment:</b>	On both eyepieces.
<b>Eyepieces:</b>	PL10x/24 mm, with dioptric adjustment, high eye-point and rubber cups.
<b>Nosepiece:</b>	Quintuple revolving nosepiece, rotation on ball bearings, with DIC slot. M26 thread holes (and adapter rings for RMS objectives).
<b>Objectives:</b>	Selectable according to customer's preferences. Usable objective series for DIC: IOS LWD U-PLAN F MET, IOS LWD U-PLAN F MET BD
<b>Specimen stage:</b>	Fixed stage, 250x215 mm, with glass and metal inserts. Mechanical rackless stage, 250x240 mm, 50x50 mm X-Y range.
<b>Focusing:</b>	Coaxial coarse (adjustable tension) and fine focusing mechanism with limit stop to prevent the contact between objective and specimen.

## IM-5MET is freely configurable in terms of objectives, by choosing among:

Included ■ Optional □

MET Infinity-corrected Plan-Achromatic, Long Working Distance objectives, field flatness up to F.N. 25:		
M-1100	IOS LWD U-PLAN MET objective 5x/0.15	□
M-1101	IOS LWD U-PLAN MET objective 10x/0.30	□
M-1102	IOS LWD U-PLAN MET objective 20x/0.45	□
M-1103	IOS LWD U-PLAN MET objective 50x/0.55	□
M-1104	IOS LWD U-PLAN MET objective 100x/0.80 (dry)	□

MET Infinity-corrected Semi-Apochromatic, Long Working Distance objectives, field flatness up to F.N. 25:		
M-1171	IOS LWD U-PLAN F MET objective 5x/0.15	□
M-1172	IOS LWD U-PLAN F MET objective 10x/0.30	□
M-1173	IOS LWD U-PLAN F MET objective 20x/0.50	□
M-1174	IOS LWD U-PLAN F MET objective 50x/0.80	□
M-1175	IOS LWD U-PLAN F MET objective 100x/0.90 (dry)	□

MET Infinity-corrected Plan-Achromatic, Long Working Distance objectives, for brightfield and darkfield, field flatness up to F.N. 25:		
M-1094	IOS LWD U-PLAN MET BD objective 5x/0.15	□
M-1095	IOS LWD U-PLAN MET BD objective 10x/0.30	□
M-1096	IOS LWD U-PLAN MET BD objective 20x/0.45	□
M-1097	IOS LWD U-PLAN MET BD objective 50x/0.55	□
M-1098	IOS LWD U-PLAN MET BD objective 100x/0.80 (dry)	□

MET Infinity-corrected Semi-Apochromatic, Long Working Distance objectives, for brightfield and darkfield, field flatness up to F.N. 25:		
M-1180	IOS LWD U-PLAN F MET BD objective 5x/0.15	□
M-1181	IOS LWD U-PLAN F MET BD objective 10x/0.30	□
M-1182	IOS LWD U-PLAN F MET BD objective 20x/0.50	□
M-1183	IOS LWD U-PLAN F MET BD objective 50x/0.80	□
M-1184	IOS LWD U-PLAN F MET BD objective 100x/0.90 (dry)	□



v 1.4.0 - OPTIKA reserves the right to make corrections, modifications, enhancements, improvements and other changes to its products at any time without notice.

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## Headquarters and Manufacturing Facilities

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