MICROSCOPE UNITS AND OBJECTIVE LENSES

Microscope viewing units and objective lenses for UV, NUV, VISIBLE & NIR REGION
Many of today’s ultra-microscopic manufacturing technologies require sub-micron accuracy. Mitutoyo produces microscope systems with advanced features that combine optical and precision measurement technologies developed by us over a long period of time. Mitutoyo microscopes can be integrated into manufacturing systems, research and development equipment, and product inspection lines. Contact your nearest Mitutoyo Sales Office for further details on standard product specifications as well as custom-designed microscopes to best fit your application.
By installing a digital camera on a microscope the VMU provides a simple and compact system which allows microphotography and simultaneous external monitor observations. The VMU can be used in vertical and inverted positions according to your application requirements.

- Microphotography and observation of metallic, resinous and printed surfaces
- Micro-fluid analysis
- Cell and microorganism observation/analysis

Dual-camera systems featuring high and low magnification and differential interference observation are also available.

**Systems for laser applications**

Microscope unit and objectives compatible with YAG lasers (1064nm, 532nm, 355nm and 266nm) allow high precision and quality working.

- Peeling off protective films and organic thin-films
- Cutting of IC wiring (Au, Al) and exposure of lower layer pattern
- FPD defects repair
- Photomask repair
- Marking, trimming, patterning, spot annealing and scribing

**System with digital camera**

Digital microscopic system using VMU-V

**System for IR analysis/inspection**

Optical systems using Mitutoyo M Plan Apo NIR objectives that cover a wide range of wavelength from visible to infrared are providing solutions on the production line and in the laboratory. Nondestructive inspection is made possible by using an infrared source.

- Micro-fluid analysis
- Thickness measurement of LCD thin film and silicon board film
- Internal inspection/analysis and 3D evaluation of MEMS devices
- Internal observation of IC packages, void inspection/evaluation of wafer junctions, spectral characteristics analysis using infrared
- Femtosecond laser applications

**System for dual-camera (high & low magnification) observation**

By mounting two cameras on VMU-L you can observe the same area at different magnifications simultaneously.

**System for analysis**

The Mitutoyo M Plan Apo objectives provide a long working distance. This allows you to design an optical system for defects evaluation of semiconductor integrated circuits and precise repair with YAG lasers. The optical system for direct observation is also available.
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Features

> Small, lightweight microscope unit designed for a camera observation system
  Suitable for observing a wide range of objects: metal, resin, printed surfaces, minute mechanisms, etc.

> Compatible with YAG lasers (1064 nm, 532 nm, 355 nm and 266 nm)
  Suitable for cutting, trimming, repair and marking of IC wiring (Au, Al), removing and processing thin film (insulating film) and repair of color filters (defects repair).

> Compatible with infrared optical system
  Available for internal observation of IC packages and spectral characteristics analysis using an infrared source and camera.

> Standard of telecentric reflective illumination system with aperture diaphragm
  This is the best illumination system for image processing applications (e.g. dimension measurement, form inspection and positioning) which require even lighting.

> Extending the VMU series with high rigidity/performance VMU-LB and VMU-L4B models.

Specifications

<table>
<thead>
<tr>
<th>Model No.</th>
<th>VMU-V</th>
<th>VMU-H</th>
<th>VMU-L</th>
<th>VMU-L4</th>
<th>VMU-LB</th>
<th>VMU-L4B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Camera mounting orientation</td>
<td>Vertical</td>
<td>Horizontal</td>
<td>Vertical</td>
<td>Vertical (rotatable)</td>
<td>Vertical (rotatable)</td>
<td></td>
</tr>
<tr>
<td>Observation</td>
<td>Bf; erect image</td>
<td>8f; inverting image</td>
<td>Bf; erect image</td>
<td>Bf; erect image</td>
<td>8f; erect image</td>
<td>Bf; erect image</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Optical features</th>
<th>Magnification: 1X; Wavelength (λ): visible radiation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mount</td>
<td>C-mount (centering and parfocal adjustment)</td>
</tr>
<tr>
<td>Tube lens (correction range)</td>
<td>1X (visible - NIR)</td>
</tr>
<tr>
<td>Laser port</td>
<td>C-mount with centering and parfocal adjustment</td>
</tr>
<tr>
<td>Optical features</td>
<td>—</td>
</tr>
<tr>
<td>Mount</td>
<td>—</td>
</tr>
<tr>
<td>Suitable YAG</td>
<td>—</td>
</tr>
<tr>
<td>Laser type*2</td>
<td>—</td>
</tr>
<tr>
<td>Polaris*1</td>
<td>Available for observation</td>
</tr>
<tr>
<td>Suitable objective (optional)</td>
<td>M Plan Apo/HROSL, G Plan Apo</td>
</tr>
<tr>
<td>For observation</td>
<td>M/Plan Apo NRI</td>
</tr>
<tr>
<td>For laser cutting</td>
<td>M/Plan UV</td>
</tr>
<tr>
<td>Suitable camera</td>
<td>2/3&quot; or smaller C-mount compatible type</td>
</tr>
<tr>
<td>Optical system illumination</td>
<td>Telecentric reflective with aperture diaphragm</td>
</tr>
<tr>
<td>Fiber-optic illuminator (optional)</td>
<td>12v/100W (378-700D), 12v/150W (378-316D)</td>
</tr>
<tr>
<td>Mass (Dimensions: Refer to page 27)</td>
<td>650 g</td>
</tr>
</tbody>
</table>

*1: M Plan Apo 1X objective should be used together with the polarizer (378-710 or 378-715).
*2: When mounting a laser, ensure all safety precautions are observed and be aware of laser output power, beam energy density and the unit’s weight. Please consult Mitutoyo if in doubt.
*1: Compatible with 1/2-inch or less C-mount cameras.
*2: Use focusing unit B (378-706) if the distance between the mounting position and VMU main unit is desired to be as small as possible. If the manual turret nosepiece unit (378-707) is used concurrently, mount the unit in front of the VMU main unit. For details on mounting position, refer to the figures on page 9.
*3: This turret nosepiece unit cannot be used with focusing unit B (378-706). For details on mounting position, refer to the figures on page 9.
*4: Use this mount when mounting a C-mount camera using the laser port. Use this mount for 2/3-inch or smaller cameras.
*5: Mitutoyo does not sell these lasers. Consult Mitutoyo for more information.
*6: An adapter may be required when mounting any of these stages. Consult Mitutoyo for more information.

C-mount compatible analog camera or digital camera
Example: ImageX PRO 3000

Fiber-optic illumination unit 100W (378-700)
100W (376-316) P.26

Focusing unit A (378-705) P.8
Focusing unit B ** (378-706) P.8

Transmitted light unit (378-736) P.26

Simple stand (378-730) P.26

X-Y stage (50×50mm) 378-020 P.26

Third-party motorized X-Y stages 50×50mm**

Third-party YAG lasers**
 Optional Accessories for VMU

**Manual turret**
Has 4 objective mounts and can be fixed in the desired position relative (inward, outward, etc.) to the mounting surface.

<table>
<thead>
<tr>
<th>Order No.</th>
<th>378-707</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observation method</td>
<td>Bright field</td>
</tr>
<tr>
<td>No. of objective mounts</td>
<td>4</td>
</tr>
<tr>
<td>Mass</td>
<td>780 g</td>
</tr>
</tbody>
</table>

Installed on VMU-V with optional objectives

**Focus unit A and B**
Manual focus units for the VMU. An optional stand (378-730) and XY stage (378-020) are provided to be used in combination. A power focus unit is also available. Refer to page 12.

<table>
<thead>
<tr>
<th>Focus unit A</th>
<th>Focus unit B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Order No.</td>
<td>378-705</td>
</tr>
<tr>
<td>Travel range</td>
<td>50 mm</td>
</tr>
<tr>
<td>Coarse/fine feed</td>
<td>Coarse: 3.8 mm/rev., Fine: 0.1 mm/rev.</td>
</tr>
<tr>
<td>Loading capacity</td>
<td>Approx. 17.4 kg</td>
</tr>
<tr>
<td>Mass</td>
<td>2.9 kg</td>
</tr>
</tbody>
</table>

Focus unit A mounted on VMU-V with an optional objective

**Power turret**
Has 5 objective mounts and can be fixed in the desired position relative (inward, outward, etc.) to the mounting surface.

<table>
<thead>
<tr>
<th>Order No.</th>
<th>378-713</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observation method</td>
<td>Bright field</td>
</tr>
<tr>
<td>No. of objective mounts</td>
<td>5, with centering adjustment</td>
</tr>
<tr>
<td>View field adjustment</td>
<td>≥0.5 mm</td>
</tr>
<tr>
<td>Positioning accuracy</td>
<td>2μm±3 μm</td>
</tr>
<tr>
<td>Durability (life-time)</td>
<td>1 million repositioning operations</td>
</tr>
<tr>
<td>Drive method</td>
<td>DC motor</td>
</tr>
<tr>
<td>Power supply</td>
<td>AC100V - 240V, 10W</td>
</tr>
<tr>
<td>Output interface</td>
<td>RS-232C* for external PC control</td>
</tr>
<tr>
<td>Cable length</td>
<td>3 m</td>
</tr>
<tr>
<td>Dimensions (WxHxD) and mass</td>
<td>Turret: 130 x 47 x 186 mm, 1.8 kg, Console box: 108 x 63 x 176 mm, 810 g</td>
</tr>
</tbody>
</table>

*Optional RS-232C Cable: 12AAA807

**Polarizer**
Provides simplified polarized light observation. Also enhances contrast of low-magnification objectives.

378-710: For VMU-V and VMU-H
For VMU-L and VMU-L4
378-715: For VMU-LB and VMU-L4B

**TV adapter unit**
C-mount adapters for changing to a higher or lower magnification.

<table>
<thead>
<tr>
<th>2X TV adapter unit</th>
<th>0.5X TV adapter unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Order No.</td>
<td>378-703</td>
</tr>
<tr>
<td>Magnification</td>
<td>2X</td>
</tr>
<tr>
<td>Suitable camera</td>
<td>2/3&quot; or smaller type</td>
</tr>
<tr>
<td>Mass</td>
<td>25 g</td>
</tr>
</tbody>
</table>

**Camera mount**
Can be attached to the laser mount (VMU-LB and VMU-L4B) for dual-camera system. It is compatible with 2/3" or smaller C-mount cameras.

<table>
<thead>
<tr>
<th>Order No.</th>
<th>378-087</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mass</td>
<td>180 g</td>
</tr>
</tbody>
</table>
**Dimensions of Optional Accessories for VMU Series**

**Manual turret**

When mounting the turret on VMU-V or VMU-H

Note 1: The lens mount must be removed from VMU.
Note 2: The turret can be fixed in the desired position relative (inward, outward, etc.) to the mounting surface. (VMU-H only)

**Power turret**

When mounting the turret on VMU-V or VMU-H

Note 1: The lens mount must be removed from VMU.
Note 2: The turret can be fixed in the desired position relative (inward, outward, etc.) to the mounting surface. (VMU-H only)

**Focus unit A and B**

When mounting the turret on VMU-LB or VMU-L4B

Note 1: The middle optical tube and lens mount must be removed from VMU.
Note 2: The turret can be fixed at 45º intervals around the optical axis.

**TV adapter unit**

Intermediate image position

- 2X adapter lens unit

Dimensions with the 2X TV adapter unit mounted

**Camera mount**

Intermediate image position

- 0.5X TV adapter lens unit

Dimensions with the 0.5X TV adapter unit mounted

**Polarizer and Analyzer**

Installing the polarizer and analyzer on VMU-V or VMU-H and VMU-L/VMU-L4

Note: The analyzer is installed by opening the main body mirror head. The polarizer is installed by removing the illumination tube.

When installing the polarizer on VMU-LB or VMU-L4

Note: The analyzer is installed by loosening the cover ring. The polarizer is installed by removing the illumination tube.
Microscope Unit
FS70 Series

Features
> Compact microscope unit with trinocular eyepiece tube
  Suitable for observation of many different types of object: metal surfaces, semiconductors, LCDs, resins, etc.
> Compatible with YAG lasers (1064 nm, 532 nm, 355 nm and 266 nm)
  Suitable for cutting, trimming, repair and marking of IC wiring (Au, Al), removing and processing thin films (insulating film) and repair of color filters (defects repair). Also ideal as the microscope unit of a prober station for semiconductor substrates.
> Compatible with infrared optical systems
  Available for inner observation of silicon package and spectral characteristics analysis by using infrared light source and camera.
> Available for various observations in bright field, dark field*, simplified polarized and differential interference contrast (DIC).
  *Made-to-order
> Telecentric reflective illumination system with aperture diaphragm.
> High operability due to the inward turret design and long-working-distance objectives.

Specifications

<table>
<thead>
<tr>
<th>Standard head type (w/short focus unit)</th>
<th>Model No.</th>
<th>Order No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>FS70Z (FS70Z-S) *1</td>
<td>FS70L (FS70L-S)</td>
<td>378-165-1 (-2)</td>
</tr>
<tr>
<td>FS70L4 (FS70L4-S)</td>
<td>378-166-1 (-2)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tilting head type</th>
<th>Model No.</th>
<th>Order No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>FS70Z-TH *1</td>
<td>FS70L-TH</td>
<td>378-165-3</td>
</tr>
<tr>
<td>FS70L4-TH</td>
<td>378-166-3</td>
<td></td>
</tr>
</tbody>
</table>

| Observation | BF/simplified polarized/DIC, erect image | BF/simplified polarized, erect image |

| Applicable eyepiece (optional) | 10X (field number 24), 15X (field number 16), 20X (field number 12) |

<table>
<thead>
<tr>
<th>Optical tube</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trinocular</td>
</tr>
<tr>
<td>Field number</td>
</tr>
<tr>
<td>Pupile distance</td>
</tr>
<tr>
<td>Tilt angle</td>
</tr>
<tr>
<td>Optical pass ratio</td>
</tr>
<tr>
<td>Camera mount</td>
</tr>
<tr>
<td>Tube lens (correction range)</td>
</tr>
<tr>
<td>Laser port</td>
</tr>
<tr>
<td>Optical features</td>
</tr>
<tr>
<td>Suitable YAG laser type*2</td>
</tr>
<tr>
<td>Suitable objective (optional)</td>
</tr>
<tr>
<td>For observation*3</td>
</tr>
<tr>
<td>For laser cutting</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Focus unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coarse/fine feed</td>
</tr>
<tr>
<td>Travel range</td>
</tr>
<tr>
<td>Suitable turret (optional)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Optical system of illumination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Koehler reflective illumination with aperture diaphragm</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Fiber-optic illuminator (optional)</th>
</tr>
</thead>
<tbody>
<tr>
<td>12V/100W (378-700D), 12V/150W (178-316D)</td>
</tr>
</tbody>
</table>

| Loading capacity of camera mount | Approx. 14kg (tilting head type: 13.2 kg) |
|----------------------------------| Approx. 13 kg (tilting head type: 13.1 kg) |
| Mass (Dimension: Refer to page 28.) | 6.6 kg (tilting head type: 7.4 kg) |
| Mass | 6.7 kg (TH: 7.5 kg) |

*1: A FS70ZD type providing bright field/dark field observation is available on special request.
*2: When mounting a laser, ensure all safety precautions are observed and be aware of laser output power, beam energy density and the unit's weight. Please consult Mitutoyo if in doubt.
*3: M Plan Apo 1x objective should be used together with the polarizer (378-092 or 378-094).
Eye pieces  P.25  
WF10x/20  (378-856)  
WF15x/16  (378-857)  
WF20x/12  (378-858)  

Adapter  P.12  
(378-042)  

Polarizer*  P.12  
(378-092)  

Differential interference contrast unit  
(378-076, 378-078, 378-079, 378-080)  
P.12  

FS70L  (378-166-1)  
FS70L4  (378-167-1)  
FS70L-TH  (378-166-3)  
FS70L4-TH  (378-167-3)  

FS70Z  (378-165-1)  
FS70Z-TH  (378-165-3)  

0.5X TV adapter unit  (375-054)  
P.12  

Fiber-optic illumination unit  
100W (378-700)  
150W (176-316)  
P.26  

Filters (for fiber-optic illumination unit No. 378-700)  
12AAB251 ND2  
12AAB252 ND8  
12BAA583 G15  
12BAA584 L800  
P.26  

Objectives  
M Plan Apo series (for observation): P.16 to 17  
G Plan Apo series (for observation): P.17  
M/UCD Plan Apo NIR series on P.20  
for fundamental/second harmonic laser machining: Used for L  
for near-infrared observation: Used for L  
M/UCD Plan Apo NUV series on P.21  
for second/third harmonic laser machining: Used for L  
M Plan UV series on P.22  
for second/fourth harmonic laser machining: Used for L  

Simple stand  (378-730)  
P.26  

Transmission light unit  
(378-736)  
P.26  

Third-party YAG lasers*  

Third-party motorized X-Y stages  
(50x50mm)  
P.44  

Link cable 0.6m  
(12AA2823)  
P.26  

Fiber-optic illumination unit  
100W (378-700)  
150W (176-316)  
P.26  

Filters (for fiber-optic illumination unit No. 378-700)  
12AAB251 ND2  
12AAB252 ND8  
12BAA583 G15  
12BAA584 L800  
P.26  

FS70Z-TH (378-165-3)  

FS70L-TH (378-166-3)  
FS70L4-TH (378-167-3)  

Self-aligning motorized turret nosepiece unit (for BF) 
Quad (378-016)  
Quintuple (378-116)  
P.12  

Polarizer**  P.12  
(378-0952)  

Motorized focusing unit  
(378-061)  
P.12  

C-mount compatible analog camera or digital camera  
Example: ImageX PRO 3000  

*1: This unit is only applied to 1/2-inch or less CCD cameras.  
*2: Focusing unit A (378-705) can be attached to the simple stand (378-730).  
*3: Mitutoyo does not sell these lasers. Consult Mitutoyo for more information.  
*4: An adapter may separately be required when mounting any of these stages. Consult Mitutoyo for more information.
Optional Accessories for FS70

Manual turret

Order No. 378-018
Observation method Bright field
No. of objective mounts 4, with centering and parfocal adjustment (378-018)
View field adjustment ±0.5 mm
Parfocal adjustment ±0.5 mm
Mass 1.9 kg

Polarizer

For simplified polarized-light observation. Also suitable for enhancing contrast of low-magnification objectives.

For FS70Z 378-092
For FS70L / FS70L4 378-094

DIC unit

Used for differential interference contrast observation in conjunction with the polarizer.

Adapter B

Used for mounting a C-mount camera.

0.5X TV adapter unit

Allows observation over a wide field of view on the monitor (2X wide) due to the 0.5X relay optics. It is used in conjunction with the optional adapter B.

Power turret

Order No. 378-016
Observation method Bright field
No. of objective mounts 4, with centering adjustment
View field adjustment ±0.5 mm
Positioning accuracy ±2 μm
Durability (life-time) 1 million repositioning operations
Drive method DC motor
Power supply AC100V - 240V, 10W
Output interface RS-232C* for external PC control
Cable length 3 m
Dimensions (WxHxD) and mass
Turret: ø 114 x 137 mm, 1.4 kg
Console box: 130 x 47 x 186 mm, 1.8 kg

Order No. 378-116
Observation method Bright field
No. of objective mounts 5, with centering adjustment
View field adjustment ±0.5 mm
Positioning accuracy ±2 μm
Durability (life-time) 1 million repositioning operations
Drive method DC motor
Power supply AC100V - 240V, 10W
Output interface RS-232C* for external PC control
Cable length 3 m
Dimensions (WxHxD) and mass
Turret: 164 x 65 x 137 mm, 1.4 kg
Console box: 108 x 72 x 193 mm, 810 g

Power focusing unit

This unit is provided with a handy console box that is capable of external PC control. The power focus device is also retrofitable for the focus unit A/B for VMU series.

Order No. 378-061
Minimum travel 0.2 μm
Feeding speed 1.6 mm/sec
Driving method Stepping motor, jog-shuttle controls
Power supply AC100V - 240V, 6W
Output interface RS-232C* for external PC control
Cable length 3 m
Dimensions (WxHxD) and mass
Focus unit: ø 69 x 199 mm, 620 g
Console box: 108 x 87 x 201 mm, 2.4 kg

*Optional RS-232C Cable: 12AAA807
This objective adapter allows mounting the bright field objective on the bright/dark field turret (176-211 and 176-210) while maintaining the focus position (parfocal). Suitable bright field objectives: M Plan Apo/SL, G Plan Apo, M Plan Apo NIR, M Plan Apo NUV and M Plan UV.

**Optional objective adapter: 378-026-1**

This objective adapter allows mounting the bright field objective on the bright/dark field turret (176-211 and 176-210) while maintaining the focus position (parfocal). Suitable bright field objectives: M Plan Apo/SL, G Plan Apo, M Plan Apo NIR, M Plan Apo NUV and M Plan UV.

**Focus point adjust shim set**

<table>
<thead>
<tr>
<th>Order No.</th>
<th>Purpose</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>378-089</td>
<td>For bright field turret</td>
<td>The focus point adjust shim set includes 50 μm, 30 μm and 20 μm thickness SUS rings</td>
</tr>
</tbody>
</table>

**Dimensions of Optional Accessories for FS70**

**Manual turret**

- Model: 378-018
- Dimensions:
  - Ø50
  - Ø111

**Power turret**

- Model: 378-116
- Dimensions:
  - Ø50
  - Ø111

**Differences of FS70 models**

**Tilting head type (Extension TH)**

- Dimensions:
  - Objective mounting surface
  - Intermediate image position
  - Vertical travel

**Short focus unit type (Extension S)**

- Dimensions:
  - Standard focusing unit mounting dimensions
  - Manual focusing unit S mounting dimensions
**Features**

> **Microscope unit with the high-zoom function**
> Capable of continuous zooming from 100X to 4000X on a monitor (15”).

> **Equipped with a unique sliding turret, to which an additional objective (optional) for laser applications, as well as the standard high-resolution objective (M Plan Apo HR 10X), can be attached.**

> **Compatible with YAG lasers (1064 nm, 532 nm, 355 nm and 266 nm)**
> Available for cutting, trimming, repair and marking of IC wiring (Au, Al), removing and processing thin film (insulating film) and repair of color filter (defects repair). Also ideal as the microscope unit of a prober station for semiconductor substrates.

> **Compatible with infrared system**
> Available for internal observation of silicon packages and spectral characteristics analysis using an infrared source and camera.

> **Available for simplified polarized and differential interference contrast (DIC)**.
> *Made-to-order

> **Telecentric reflective illumination system with aperture diaphragm.**

### Specifications

<table>
<thead>
<tr>
<th>Without binocular unit type</th>
<th>Model No.</th>
<th>Order No.</th>
<th>With binocular unit type</th>
<th>Model No.</th>
<th>Order No.</th>
</tr>
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<tbody>
<tr>
<td>VMZ40M</td>
<td>VMZ40M-L</td>
<td>378-171</td>
<td>VMZ40R</td>
<td>VMZ40R-L</td>
<td>378-177</td>
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<tr>
<td>VMZ40R</td>
<td>VMZ40R-L</td>
<td>378-175</td>
<td>VMZ40R-L4</td>
<td>VMZ40R-L4</td>
<td>378-181</td>
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<td>VMZ40M-B</td>
<td>VMZ40M-BL</td>
<td>378-172</td>
<td>VMZ40R-B</td>
<td>VMZ40R-BL</td>
<td>378-176</td>
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<td>VMZ40R-BL</td>
<td>378-174</td>
<td>VMZ40R-BL4</td>
<td>VMZ40R-BL4</td>
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<table>
<thead>
<tr>
<th>Radiation range</th>
<th>NUV - visible - NIR</th>
<th>UV - visible</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zoom type</td>
<td>Manual</td>
<td>Power drive</td>
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<table>
<thead>
<tr>
<th>Observation</th>
<th>BF, erect image</th>
<th>BF/DF/simplified polarized/DIC, erect image</th>
<th>BF/simplified polarized, erect image</th>
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<tbody>
<tr>
<td>Main unit magnification</td>
<td>0.25X to 10X (zoom ratio: 40)</td>
<td></td>
<td></td>
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<tr>
<td>Total magnification</td>
<td>100X to 4000X (when using standard 10X objective, 1/2” camera and 15” monitor)</td>
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<tr>
<td>Observation range</td>
<td>1/2” camera: 2.56 x 1.92 mm to 0.064 x 0.048 mm, WF10X/24 eyepiece: ø 3.2 mm to ø 0.08 mm (when using standard 10X objective)</td>
<td></td>
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<tr>
<td>Suitable eyepiece</td>
<td>10X (standard), 15X (optional), 20X (optional)</td>
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</tr>
<tr>
<td>Suitable objective</td>
<td>Standard: M Plan Apo HR 10X (NA: 0.42, WD: 15mm), Optional*: M Plan Apo, G Plan Apo</td>
<td></td>
<td></td>
</tr>
<tr>
<td>For laser working (optional)</td>
<td>M/LCD Plan Apo NIR, M/LCD Plan Apo NUV</td>
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<tr>
<td>Focusing unit</td>
<td>Coarse/fine feed: coaxial feeding knob (right and left), coarse feed: 3.6 mm/rev, finely feed: 0.1 mm/rev</td>
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<tr>
<td>Travel range</td>
<td>50 mm</td>
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<table>
<thead>
<tr>
<th>Turret</th>
<th>1-mount</th>
<th>2-mount with centering adjustment</th>
<th>1-mount</th>
<th>2-mount with centering adjustment</th>
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<tbody>
<tr>
<td>Optical system of illumination</td>
<td>Koehler reflective illumination with aperture diaphragm</td>
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<tr>
<td>Fiber-optic illuminator (optional)</td>
<td>12V/100W (378-700D), 12V/150W (178-316D)</td>
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<tr>
<td>Camera mount</td>
<td>C-mount with centering and parfocal adjustment and green filter switch:*</td>
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<tr>
<td>Suitable camera</td>
<td>1/2” or smaller camera (C-mount compatible)</td>
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</table>

| Mass, *with binocular unit type | 6.5 kg/7.0 kg* | 7.5 kg/8.0 kg* | 7.0 kg/7.5 kg* | 8.0 kg/8.5 kg* | 7.5 kg (8.5 kg) |

*Recommended magnification of objective: 2X to 50X
**System diagram**

**VM-ZOOM40**

**VM240M series**

- Near-infrared/visible/near-ultraviolet light correction
- Main unit
- No illumination unit (optional)
- Binocular tube (with eyepiece WF10X/24)
- Laser port

**VM240R series**

- Visible/near-ultraviolet light correction
- Main unit (with laser port)
- Remote controller (with built-in illumination light source)
- Binocular tube (with eyepiece WF10X/24)
- Laser port

**Objectives**

- M Plan Apo HR 10X
- G Plan Apo
- M/LCD Plan Apo NIR
- M/LCD Plan Apo NUV
- M Plan UV

**Eyepieces**

- WF15X/16
- WF20X/12

**Fiber-optic illumination unit**

- 100W: 378-700
- 150W: 178-316

**Camera mount**

- VM240M-BL types (models equipped with a YAG laser). These types are recommended to use an objective with a magnification of 20X or 50X.

**Polarizer**

- For simplified polarized observation.

**Simple stand**

- 378-730

**X-Y stage**

- (50×50mm)

**Mass**

- 378-069: 115 g
- 378-087: 180 g

---

*1: Compatible with models equipped with a binocular tube.

*2: Compatible with VM240M series types (models equipped with a YAG laser). These types are recommended to use an objective with a magnification of 20X or 50X.

*3: The current position of a workpiece being observed with a camera on the zoom side can be checked by using a laser optical system (with a built-in 1X tube lens).

This camera mount is compatible with VM240M series types (models equipped with a YAG laser oscillator). Use a 2/3-inch or less analog or digital camera (with a C mount).
**Objectives for Bright Field Observation (long working distance)**

**M Plan Apo / M Plan Apo HR**

<table>
<thead>
<tr>
<th>Specifications</th>
<th>VMU</th>
<th>FS70</th>
<th>MF-U</th>
<th>Hyper MF-U</th>
<th>FS300</th>
<th>VM-ZOOM</th>
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<tbody>
<tr>
<td><strong>Features</strong></td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>&gt; Infinity corrected &gt; Bright field observation &gt; Long working distance &gt; Plan-Apochromat</td>
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<td><strong>Dimensions</strong></td>
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<tr>
<td>(Working distance)</td>
<td>1/4 Retardation plate</td>
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<tr>
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<td>95 (Parfocal distance)</td>
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<td>95 (Parfocal distance)</td>
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<td>M Plan Apo 7.5X</td>
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<td>95 (Parfocal distance)</td>
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</tr>
<tr>
<td>M Plan Apo 10X</td>
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<tr>
<td>(Working distance)</td>
<td>2.2</td>
<td>33.5</td>
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<td>95 (Parfocal distance)</td>
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<tr>
<td><strong>Order No.</strong></td>
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<td><strong>W.D. (mm)</strong></td>
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</tr>
<tr>
<td><strong>f (mm)</strong></td>
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<tr>
<td><strong>R (μm)</strong></td>
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<tr>
<td><strong>±DOF (μm)</strong></td>
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<tr>
<td><strong>Real FOV (mm)</strong></td>
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<tr>
<td><strong>Mass (g)</strong></td>
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<td>200</td>
<td>11.0</td>
<td>200</td>
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<td>0.055</td>
<td>34.0</td>
<td>100</td>
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<td>91</td>
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<td>14.0</td>
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<td>7.5X</td>
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<td>6.2</td>
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<tr>
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<td>0.28</td>
<td>34.0</td>
<td>20</td>
<td>1.0</td>
<td>3.5</td>
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<td>0.42</td>
<td>20.0</td>
<td>10</td>
<td>0.7</td>
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<tr>
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<td>0.6</td>
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<td><strong>378-814-4</strong></td>
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<td><strong>378-815-4</strong></td>
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<td>2.1</td>
<td>2</td>
<td>0.3</td>
<td>0.34</td>
</tr>
</tbody>
</table>

*1: It should be used together with an appropriate polarizer for the microscope used.

*2: It is recommended to be used together with the 1/4 wavelength plate A (02ALN370) and appropriate polarizer for the microscope used. (W.D.: 95.5mm, f: 30.0 mm)

*3: The specifications of this objective are as in the use with VM-ZOOM.

Objectives for Bright Field Observation (ultra-long working distance)
M Plan Apo SL

Features
- Infinity corrected
- Bright field observation
- Ultra-long working distance
- Plan Apochromat

Dimensions

Specifications

Objectives for Bright Field Observation (with glass-thickness compensation)
G Plan Apo

Features
- Infinity corrected
- Bright field observation
- Ultra-long working distance
- Plan Apochromat
- Designed to observe a specimen through glass 3.5 mm thick.

Dimensions

Specifications

N.A.: Numerical aperture  W.D.: Working distance  f: Focal length  R: Resolving power  aDOF: Depth of field  FOV: Real field of view
Objectives for Bright/Dark Field Observation (long working distance)

BD Plan Apo / BD Plan Apo HR

**Features**
- Infinity corrected
- Bright/dark field observation
  - Suited to the observation of scratches, concavity and convexity on a surface
- Long working distance
- Plan Apochromat

**Dimensions**

<table>
<thead>
<tr>
<th>Order No.</th>
<th>Mag.</th>
<th>N.A.</th>
<th>W.D. (mm)</th>
<th>f (mm) (λ=550 nm)</th>
<th>R (μm) (λ=550 nm)</th>
<th>±DOF (μm)</th>
<th>Real FOV (mm)</th>
<th>Mass (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>378-831-7</td>
<td>2X</td>
<td>0.055</td>
<td>34.0</td>
<td>100</td>
<td>5.0</td>
<td>91</td>
<td>ø 12</td>
<td>ø 12</td>
</tr>
<tr>
<td>378-832-7</td>
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<td>0.14</td>
<td>34.0</td>
<td>40</td>
<td>2.0</td>
<td>14.0</td>
<td>ø 4.8</td>
<td>ø 4.8</td>
</tr>
<tr>
<td>378-835-7</td>
<td>7.5X</td>
<td>0.21</td>
<td>34.0</td>
<td>26.67</td>
<td>1.3</td>
<td>6.2</td>
<td>ø 3.6</td>
<td>ø 3.6</td>
</tr>
<tr>
<td>378-833-7</td>
<td>10X</td>
<td>0.28</td>
<td>34.0</td>
<td>20</td>
<td>1.0</td>
<td>3.5</td>
<td>ø 2.4</td>
<td>ø 2.4</td>
</tr>
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<td>20.0</td>
<td>10</td>
<td>0.7</td>
<td>1.6</td>
<td>ø 1.2</td>
<td>ø 1.2</td>
</tr>
<tr>
<td>378-835-7</td>
<td>50X</td>
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<td>13.0</td>
<td>4</td>
<td>0.5</td>
<td>0.9</td>
<td>ø 0.49</td>
<td>ø 0.49</td>
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<td>6.0</td>
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<td>0.6</td>
<td>ø 0.24</td>
<td>ø 0.24</td>
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<td>4</td>
<td>0.4</td>
<td>0.49</td>
<td>ø 0.48</td>
<td>ø 0.48</td>
</tr>
<tr>
<td>378-846-7</td>
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<td>0.90</td>
<td>1.3</td>
<td>2</td>
<td>0.3</td>
<td>0.34</td>
<td>ø 0.24</td>
<td>ø 0.24</td>
</tr>
</tbody>
</table>

*1: Recommended to be used together with the 1/4 wavelength plate A (02ALN380) and appropriate polarizer for the microscope used. (W.D.: 95.5 mm, f: 30.0 mm)


**Specifications**
Objectives for Bright/Dark Field Observation (ultra-long working distance)

BD Plan Apo SL

**Features**
- Infinity corrected
- Bright/dark field observation
  - Suited to the observation of scratches, concavity and convexity on a surface
- Ultra-long working distance
- Plan-Apochromat

**Dimensions**

**BD Plan Apo SL20X**
- (Working distance)
  - Dimensions:
    - Ø1.2
    - Ø40
    - 64.5
    - 30.5
    - 7.5
    - 30.5
    - 5
    - 95 (Parfocal distance)

**BD Plan Apo SL50X**
- (Working distance)
  - Dimensions:
    - Ø1.2
    - Ø40
    - 64.5
    - 30.5
    - 7.5
    - 30.5
    - 5
    - 95 (Parfocal distance)

**BD Plan Apo SL80X**
- (Working distance)
  - Dimensions:
    - Ø1.2
    - Ø40
    - 64.5
    - 30.5
    - 7.5
    - 30.5
    - 5
    - 95 (Parfocal distance)

**BD Plan Apo SL100X**
- (Working distance)
  - Dimensions:
    - Ø1.2
    - Ø40
    - 64.5
    - 30.5
    - 7.5
    - 30.5
    - 5
    - 95 (Parfocal distance)

**Specifications**

<table>
<thead>
<tr>
<th>Order No.</th>
<th>Mag.</th>
<th>N.A.</th>
<th>W.D. (mm)</th>
<th>f (mm)</th>
<th>R (μm)</th>
<th>±DOF (μm)</th>
<th>Real FOV (mm)</th>
<th>Mass (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>378-840-7</td>
<td>20X</td>
<td>0.28</td>
<td>30.5</td>
<td>10</td>
<td>1.0</td>
<td>3.5</td>
<td>ø 1.2</td>
<td>0.24 x 0.32</td>
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<tr>
<td>378-841-7</td>
<td>50X</td>
<td>0.42</td>
<td>20.5</td>
<td>4</td>
<td>0.7</td>
<td>1.6</td>
<td>ø 0.48</td>
<td>0.10 x 0.13</td>
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<td>15.0</td>
<td>2.5</td>
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<td>1.1</td>
<td>ø 0.3</td>
<td>0.06 x 0.08</td>
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<td>13.0</td>
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<td>0.5</td>
<td>0.9</td>
<td>ø 0.24</td>
<td>0.05 x 0.06</td>
</tr>
</tbody>
</table>
Near-infrared Radiation Range Objectives for Bright Field Observation

**M Plan Apo NIR**

**Features**
- Infinity corrected
- Suitable for bright field observation and laser applications
- Long working distance
- Plan Apochromat
- Wavelength correction from visible to near-infrared (1800nm)
- Available high-power type (M Plan Apo NIR HR)

**Dimensions**

<table>
<thead>
<tr>
<th>Order No.</th>
<th>Mag.</th>
<th>N.A.</th>
<th>W.D. (mm)</th>
<th>f (mm)</th>
<th>R (μm)</th>
<th>±DOF (μm)</th>
<th>Real FOV (mm)</th>
<th>Mass (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>378-823-5</td>
<td>5X</td>
<td>0.14</td>
<td>37.5</td>
<td>40</td>
<td>2.0</td>
<td>14.0</td>
<td>ø 4.8</td>
<td>220</td>
</tr>
<tr>
<td>378-823-5</td>
<td>10X</td>
<td>0.28</td>
<td>30.5</td>
<td>20</td>
<td>1.1</td>
<td>6.1</td>
<td>ø 2.4</td>
<td>250</td>
</tr>
<tr>
<td>378-824-5</td>
<td>20X</td>
<td>0.40</td>
<td>20.0</td>
<td>10</td>
<td>0.7</td>
<td>1.7</td>
<td>ø 1.2</td>
<td>300</td>
</tr>
<tr>
<td>378-825-5</td>
<td>50X</td>
<td>0.42</td>
<td>17.0</td>
<td>4</td>
<td>0.7</td>
<td>1.6</td>
<td>ø 0.48</td>
<td>315</td>
</tr>
<tr>
<td>378-826-5</td>
<td>100X</td>
<td>0.50</td>
<td>12.0</td>
<td>2</td>
<td>0.6</td>
<td>1.1</td>
<td>ø 0.24</td>
<td>335</td>
</tr>
<tr>
<td>378-863-5</td>
<td>50X</td>
<td>0.65</td>
<td>10.0</td>
<td>4</td>
<td>0.4</td>
<td>0.7</td>
<td>ø 0.48</td>
<td>450</td>
</tr>
<tr>
<td>378-864-5</td>
<td>100X</td>
<td>0.70</td>
<td>10.0</td>
<td>2</td>
<td>0.4</td>
<td>0.6</td>
<td>ø 0.24</td>
<td>450</td>
</tr>
</tbody>
</table>

**Near-infrared radiation range objectives for bright field observation (with glass-thickness compensation)**

**LCD Plan Apo NIR**

**Features**
- Infinity corrected
- Suitable for bright field observation and laser applications
- Long working distance
- Plan Apochromat
- Performance optimized for visible to near-infrared (1800 nm) wavelengths
- Designed to observe a specimen through glass 1.1 mm or 0.7 mm thick.

**Specifications**

<table>
<thead>
<tr>
<th>Order No.</th>
<th>Mag./glass thickness (mm)</th>
<th>N.A.</th>
<th>W.D. (mm)</th>
<th>f (mm)</th>
<th>R (μm)</th>
<th>±DOF (μm)</th>
<th>Real FOV (mm)</th>
<th>Mass (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>378-827-5</td>
<td>20X/1.1</td>
<td>0.40</td>
<td>19.98</td>
<td>10</td>
<td>0.7</td>
<td>1.7</td>
<td>ø 1.2</td>
<td>305</td>
</tr>
<tr>
<td>378-827-5</td>
<td>50X/1.7</td>
<td>0.42</td>
<td>17.26</td>
<td>3.9</td>
<td>0.7</td>
<td>1.6</td>
<td>ø 0.48</td>
<td>320</td>
</tr>
<tr>
<td>378-725-5*</td>
<td>100X/1.1</td>
<td>0.50</td>
<td>12.13</td>
<td>2</td>
<td>0.6</td>
<td>1.1</td>
<td>ø 0.24</td>
<td>335</td>
</tr>
<tr>
<td>378-754-5</td>
<td>100X/1.7</td>
<td>0.50</td>
<td>11.76</td>
<td>2</td>
<td>0.6</td>
<td>1.1</td>
<td>ø 0.24</td>
<td>335</td>
</tr>
</tbody>
</table>

*Made-to-order

Near-ultraviolet Radiation Range Objectives for Bright Field Observation

M Plan Apo NUV

**Features**
- Infinity corrected
- Suitable for bright field observation and laser applications
- Long working distance
- Plan Apochromat
- Performance optimized for near-ultraviolet (355nm) to visible
- High-power type available (M Plan Apo NUV HR)

**Dimensions**

<table>
<thead>
<tr>
<th>Order No.</th>
<th>Mag.</th>
<th>N.A.</th>
<th>W.D. (mm)</th>
<th>f (mm)</th>
<th>R (μm)</th>
<th>aDOF (μm)</th>
<th>Real FOV (mm)</th>
<th>Mass (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>378-809-5</td>
<td>10X</td>
<td>0.28</td>
<td>30.5</td>
<td>20</td>
<td>1</td>
<td>3.5</td>
<td>ø 2.4</td>
<td>255</td>
</tr>
<tr>
<td>378-816-4</td>
<td>20X</td>
<td>0.40</td>
<td>17.0</td>
<td>10</td>
<td>0.7</td>
<td>1.7</td>
<td>ø 1.2</td>
<td>340</td>
</tr>
<tr>
<td>378-819-4</td>
<td>50X</td>
<td>0.42</td>
<td>15.0</td>
<td>4</td>
<td>0.7</td>
<td>1.6</td>
<td>ø 0.48</td>
<td>150</td>
</tr>
<tr>
<td>378-888-4</td>
<td>50X</td>
<td>0.65</td>
<td>10.0</td>
<td>4</td>
<td>0.42</td>
<td>0.65</td>
<td>ø 0.48</td>
<td>500</td>
</tr>
</tbody>
</table>

**Specifications**

Near-ultraviolet radiation range objectives for bright field observation (with glass-thickness compensation)

**LCD Plan Apo NUV**

**Features**
- Infinity corrected
- Suitable for bright field observation and laser applications
- Long working distance
- Plan Apochromat
- Wavelength correction from near-ultraviolet (355nm) to visible
- Designed to observe a specimen through glass 1.1mm or 0.7mm thick.

**Dimensions**

<table>
<thead>
<tr>
<th>Order No.</th>
<th>Mag.</th>
<th>N.A.</th>
<th>W.D. (mm)</th>
<th>f (mm)</th>
<th>R (μm)</th>
<th>aDOF (μm)</th>
<th>Real FOV (mm)</th>
<th>Mass (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>378-753-4</td>
<td>50X/t1.1</td>
<td>0.42</td>
<td>14.53</td>
<td>4</td>
<td>0.7</td>
<td>1.6</td>
<td>ø 0.48</td>
<td>310</td>
</tr>
<tr>
<td>378-820-4</td>
<td>50X/t0.7</td>
<td>0.42</td>
<td>14.76</td>
<td>4</td>
<td>0.7</td>
<td>1.6</td>
<td>ø 0.48</td>
<td>310</td>
</tr>
<tr>
<td>378-751-4</td>
<td>100X/t1.1</td>
<td>0.50</td>
<td>11.03</td>
<td>2</td>
<td>0.6</td>
<td>1.1</td>
<td>ø 0.24</td>
<td>380</td>
</tr>
</tbody>
</table>

**Specifications**

*Made-to-order

N.A.: Numerical aperture  
W.D.: Working distance  
f: Focal length  
R: Resolving power  
aDOF: Depth of field  
Real FOV: Real field of view
**Features**
- Infinity corrected
- Suitable for bright field observation and laser applications
- Long working distance
- Plan Apochromat
- Performance optimized for ultraviolet (266nm) and visible wavelengths
- High-transmittance in the ultraviolet range

**Dimensions**

**M Plan UV 10X**
- W.D.: 20.0
- f: 20.3
- R: 1.1
- DOF: 4.4
- Real FOV (mm): 80.2
- Mass (g): 3.1

**M Plan UV 20X**
- W.D.: 15.0
- f: 10.4
- R: 0.8
- DOF: 2.1
- Real FOV (mm): 60.2
- Mass (g): 3.3

**M Plan UV 50X**
- W.D.: 4.0
- f: 4.5
- R: 0.7
- DOF: 1.7
- Real FOV (mm): 20.2
- Mass (g): 4.0

**M Plan UV 80X**
- W.D.: 2.5
- f: 2.9
- R: 0.5
- DOF: 0.9
- Real FOV (mm): 10.3
- Mass (g): 3.8

**Specifications**

<table>
<thead>
<tr>
<th>Order No.</th>
<th>Mag.</th>
<th>N.A.</th>
<th>W.D. (mm)</th>
<th>f (mm) (λ=266 nm)</th>
<th>f (mm) (λ=550 nm)</th>
<th>R (μm) (λ=550 nm)</th>
<th>±DOF (μm)</th>
<th>Real FOV (mm)</th>
<th>Mass (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>378-844-5</td>
<td>10X</td>
<td>0.25</td>
<td>20.0</td>
<td>20</td>
<td>20.3</td>
<td>1.1</td>
<td>4.4</td>
<td>80.2</td>
<td>3.1</td>
</tr>
<tr>
<td>378-837-5</td>
<td>20X</td>
<td>0.36</td>
<td>15.0</td>
<td>10</td>
<td>10.4</td>
<td>0.8</td>
<td>2.1</td>
<td>60.2</td>
<td>3.3</td>
</tr>
<tr>
<td>378-838-5</td>
<td>50X</td>
<td>0.40</td>
<td>12.0</td>
<td>4</td>
<td>4.5</td>
<td>0.7</td>
<td>1.7</td>
<td>20.2</td>
<td>4.0</td>
</tr>
<tr>
<td>378-839-5</td>
<td>80X</td>
<td>0.55</td>
<td>10.0</td>
<td>2.5</td>
<td>2.9</td>
<td>0.5</td>
<td>0.9</td>
<td>10.3</td>
<td>3.8</td>
</tr>
</tbody>
</table>

Note: When projecting a mask image on a specimen by using a YAG laser system mounted on a Mitutoyo microscope unit, the mask image will be scaled by the factor f/200 times (f=200mm, Mitutoyo tube lens). Since the focal length (f) in ultraviolet radiation (λ=266 nm) is slightly smaller than that in visible radiation (λ=550 nm) as above, the working area in ultraviolet radiation also becomes slightly smaller than the mask image in visible radiation.

**Reference: Transmission of Mitutoyo Objectives**

Mitutoyo’s long working-distance objectives are grouped by working wavelength range: ultraviolet, near-ultraviolet, visible, and near-infrared. The M Plan UV series (for ultraviolet), M Plan Apo NUV series (for near-ultraviolet), and M Plan Apo NIR series (for near-infrared) are designed especially for YAG laser working applications in cutting thin films. Each series is designed for optimal spectral transmission factor within its respective wavelength range.

- M (BD) Plan Apo series: Wavelength range 436 nm to 656 nm
- M Plan Apo NIR series: Wavelength range 480 nm to 1800 nm
- M Plan Apo NUV series: Wavelength range 355 nm to 620 nm
- M Plan UV series: Optimized for wavelengths of 266 nm and 550 nm

**M Plan UV 100X**
- Wavelength range 300 nm to 800 nm
- Spectral transmission factor (%)

**M Plan UV 80X**
- Wavelength range 300 nm to 800 nm
- Spectral transmission factor (%)
**Tube Lens MT**

**Aberration correction range**
- **MT-1, 2, 40**: Visible wavelength range (435.8 – 656.3 nm)
- **MT-L**: Near-ultraviolet (355 nm) to near-infrared (1064 nm)
- **MT-L4**: Ultraviolet (266 nm) to visible (620 nm).

**Dimensions**

<table>
<thead>
<tr>
<th>Tube Lens</th>
<th>Objective exit pupil diameter</th>
<th>Focal length</th>
<th>Effective diameter of tube lens</th>
<th>Dimensions</th>
<th>Mass (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-1</td>
<td>ø1 = 2 • f • N.A. [mm]</td>
<td>200</td>
<td>ø18.0</td>
<td>ø35 x 32.5</td>
<td>43</td>
</tr>
<tr>
<td>MT-2</td>
<td>ø1 = 2 • f • N.A. [mm]</td>
<td>400</td>
<td>ø18.0</td>
<td>ø60 x 32.0</td>
<td>42</td>
</tr>
<tr>
<td>MT-L</td>
<td>ø2 = 24 mm, f2 = 200 mm</td>
<td>200</td>
<td>ø12.0</td>
<td>ø34 x 27.5</td>
<td>45</td>
</tr>
<tr>
<td>MT-L4</td>
<td>ø2 = 24 mm, f2 = 200 mm</td>
<td>200</td>
<td>ø12.0</td>
<td>ø35 x 30.6</td>
<td>30</td>
</tr>
</tbody>
</table>

**Specifications**

<table>
<thead>
<tr>
<th>Order No.</th>
<th>Focal length (mm)</th>
<th>Magnification (tube lens)</th>
<th>Image field (mm)</th>
<th>Effective lens dia. (mm)</th>
<th>Dimensions (mm)</th>
<th>Mass (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>970208</td>
<td>200</td>
<td>1X</td>
<td>ø30</td>
<td>ø24.0</td>
<td>ø40 x 32.5</td>
<td>43</td>
</tr>
<tr>
<td>970209</td>
<td>400</td>
<td>2X</td>
<td>ø30</td>
<td>ø18.0</td>
<td>ø60 x 32.0</td>
<td>42</td>
</tr>
<tr>
<td>378-010</td>
<td>200</td>
<td>1X</td>
<td>ø24</td>
<td>ø11.2</td>
<td>ø34 x 27.5</td>
<td>45</td>
</tr>
<tr>
<td>378-008</td>
<td>200</td>
<td>1X</td>
<td>ø24</td>
<td>ø22.0</td>
<td>ø35 x 32.0</td>
<td>30</td>
</tr>
<tr>
<td>378-009</td>
<td>200</td>
<td>1X</td>
<td>ø24</td>
<td>ø23.0</td>
<td>ø35 x 30.6</td>
<td>30</td>
</tr>
</tbody>
</table>

Note: A distance of 76.5mm in 970208 and 970209 drawings is for an image field of ø30 (without vignetting). For an image field of ø24 or ø11 (the latter is the image field of a 2/3-inch camera), use the formula (1) and (2) below to calculate the distance.

### Reference: Placement of Objective and Tube Lens

Mitutoyo’s long working-distance objective lenses are designed to cover a field of view of up to ø30mm (ø24mm), when the tube lens **970208 or 970209 (378-008, 378-009 or 378-010)** is placed at the specified distance from the objective. However, use the following formula to calculate the approximate distance, when a distance other than that as specified is required in order to insert your own optical system or other optical elements:

\[ L = (\alpha - \alpha_1) \cdot \frac{f_2}{\alpha_2} \text{[mm]} \]  
\[ \alpha_1 = 2 \cdot f_1 \cdot N.A. \text{[mm]} \]  
\[ \alpha_1 : \text{Objective exit pupil diameter (mm)} \]
\[ f_1 : \text{Focal length of tube lens} \]
\[ \alpha : \text{Image field diameter} \]

Example: What is the distance (L), when using **M Plan Apo 10X* (378-803-3)** and tube lens** *(970208)* to cover an image field of ø24?

*|ø=20 mm, N.A.=0.28 (Refer to page 15.) | ø=24 mm, f=200 mm (Refer to the above chart.)|

From formula (2): \[ \alpha_1 = 2 \cdot 20 \cdot 0.28 \]  
=11.2 (mm) 

From formula (1): \[ L = (24-11.2) \cdot 200 / 24 \]  
=106.6 (mm) 

Therefore a distance (L) up to 106 mm can cover an image field of ø24 without shading.

In other words a distance (L) smaller than the specification does not affect optical performance. Contact Mitutoyo for detailed information.
Objectives for Measuring Microscopes ML

Features

- Finite-correction (image-object distance: 280mm, parfocal length: 110 mm)
- Bright field observation
- Long working distance
- Telecentric for lenses lower than 10X magnification

Dimensions

<table>
<thead>
<tr>
<th>Order No.</th>
<th>Mag.</th>
<th>N.A.</th>
<th>W.D. (mm)</th>
<th>R (μm)</th>
<th>±DOF (μm)</th>
<th>Real FOV (mm)</th>
<th>Mass (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>375-036-2</td>
<td>1X</td>
<td>0.03</td>
<td>61.0</td>
<td>9.2</td>
<td>306</td>
<td>ø 24</td>
<td>4.8 x 6.4</td>
</tr>
<tr>
<td>375-037-1</td>
<td>3X</td>
<td>0.09</td>
<td>77.0</td>
<td>3.06</td>
<td>34</td>
<td>ø 6</td>
<td>1.6 x 2.1</td>
</tr>
<tr>
<td>375-034-1</td>
<td>5X</td>
<td>0.13</td>
<td>61.0</td>
<td>12.1</td>
<td>16.3</td>
<td>ø 9</td>
<td>1.0 x 1.3</td>
</tr>
<tr>
<td>375-039</td>
<td>10X</td>
<td>0.21</td>
<td>51.0</td>
<td>14.3</td>
<td>6.2</td>
<td>ø 18</td>
<td>0.48 x 0.64</td>
</tr>
<tr>
<td>375-051</td>
<td>20X</td>
<td>0.42</td>
<td>20.0</td>
<td>0.65</td>
<td>1.6</td>
<td>ø 32</td>
<td>0.24 x 0.32</td>
</tr>
<tr>
<td>375-052</td>
<td>50X</td>
<td>0.55</td>
<td>13.0</td>
<td>0.5</td>
<td>0.9</td>
<td>ø 48</td>
<td>0.10 x 0.13</td>
</tr>
<tr>
<td>375-053</td>
<td>100X</td>
<td>0.70</td>
<td>6.0</td>
<td>0.4</td>
<td>0.6</td>
<td>ø 24</td>
<td>0.05 x 0.06</td>
</tr>
</tbody>
</table>

Objectives for Centering Microscopes CF

Features

- Finite-correction (image-object distance: 280 mm, parfocal length: 110 mm)
- Bright field observation
- Long working distance
- Available zoom type

Specifications

<table>
<thead>
<tr>
<th>Order No.</th>
<th>Mag.</th>
<th>N.A.</th>
<th>W.D. (mm)</th>
<th>R (μm)</th>
<th>±DOF (μm)</th>
<th>Real FOV (mm)</th>
<th>Mass (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>375-031</td>
<td>1X</td>
<td>0.03</td>
<td>37.7</td>
<td>3.2</td>
<td>306</td>
<td>ø 24</td>
<td>4.8 x 6.4</td>
</tr>
<tr>
<td>375-032</td>
<td>2X</td>
<td>0.06</td>
<td>92.0</td>
<td>3.6</td>
<td>76</td>
<td>ø 12</td>
<td>2.4 x 3.2</td>
</tr>
<tr>
<td>375-033</td>
<td>3X</td>
<td>0.07</td>
<td>77.8</td>
<td>2.9</td>
<td>56</td>
<td>ø 8</td>
<td>1.6 x 2.1</td>
</tr>
<tr>
<td>375-038</td>
<td>1X</td>
<td>0.04</td>
<td>10.0</td>
<td>6.9</td>
<td>171</td>
<td>ø 24</td>
<td>4.8 x 6.4</td>
</tr>
<tr>
<td>375-039</td>
<td>3X</td>
<td>0.1</td>
<td>30.0</td>
<td>2.75</td>
<td>27</td>
<td>ø 8</td>
<td>1.6 x 2.1</td>
</tr>
<tr>
<td>375-040</td>
<td>5X</td>
<td>0.1</td>
<td>50.0</td>
<td>2.75</td>
<td>27</td>
<td>ø 4.8</td>
<td>0.96 x 1.28</td>
</tr>
</tbody>
</table>
Wide Field of View Eyepieces and Reticles
WF / UWF

Features
> Wide field of view, especially the UWF 10X type (30 field number)
> External focusing system* allows installing an optional reticle. *Except for UWF 10X

Specifications

<table>
<thead>
<tr>
<th>Order No. (2pcs.)</th>
<th>Magnification</th>
<th>Field number</th>
<th>Visibility adjustment</th>
<th>Eye point</th>
<th>Reticle</th>
<th>Mass (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>378-851</td>
<td>10X</td>
<td>30</td>
<td>-8D to +4D</td>
<td>High eye point</td>
<td>—</td>
<td>250</td>
</tr>
<tr>
<td>378-856</td>
<td>10X</td>
<td>24</td>
<td>-10D to +5D</td>
<td>High eye point</td>
<td>Available</td>
<td>45</td>
</tr>
<tr>
<td>378-857</td>
<td>15X</td>
<td>16</td>
<td>-8D to +5D</td>
<td>Normal</td>
<td>Available</td>
<td>35</td>
</tr>
<tr>
<td>378-858</td>
<td>20X</td>
<td>12</td>
<td>-8D to +5D</td>
<td>Normal</td>
<td>Available</td>
<td>35</td>
</tr>
</tbody>
</table>

Reticles

Features
> Fitted to the eyepiece at the intermediate image position for simple measurement. *Not available for UWF 10X
> Outside diameter of 25 mm and thickness of 1 mm
> Reticle line widths: 10 µm (516577: 7 µm)

Specifications

<table>
<thead>
<tr>
<th>Order No.</th>
<th>516848</th>
<th>516576</th>
<th>516578</th>
<th>516577</th>
<th>516849</th>
<th>516850</th>
<th>516851</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remarks</td>
<td>90° full lines</td>
<td>90°, 60° chain lines</td>
<td>Crosshairs, one line graduated (P=0.1/20 mm)</td>
<td>Concentric circles with crosshairs (P=1.2/12.1 - 18 mm)</td>
<td>Graduation marks (P=0.1/10 mm)</td>
<td>Graduation marks (P=0.05/5 mm)</td>
<td>Grids (P=1 mm/10 mm square)</td>
</tr>
</tbody>
</table>
Optional Accessories for VMU, FS70 and VM-ZOOM

Stand

For mounting the VMU, FS70, or VM-ZOOM microscope unit. Can be combined with an XY stage, stage illumination unit and fiber-optic illuminator to work as a compact microscope for surface observation.

<table>
<thead>
<tr>
<th>Feature</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Order No.</td>
<td>378-730</td>
</tr>
<tr>
<td>Mass</td>
<td>6.7 kg</td>
</tr>
</tbody>
</table>

Stand with XY stage and stage illumination unit mounted on FS70Z with optional objectives and eyepieces.

XY stage

<table>
<thead>
<tr>
<th>Feature</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Order No.</td>
<td>378-020</td>
</tr>
<tr>
<td>Travel range</td>
<td>50 x 50 mm</td>
</tr>
<tr>
<td>Handle feed</td>
<td>34 mm/rev.</td>
</tr>
<tr>
<td>Mass</td>
<td>3.3 kg</td>
</tr>
</tbody>
</table>

Stage illumination unit

Attaches to the stand to provide contour illumination in conjunction with a fiber-optic illuminator (100W or 150W).

<table>
<thead>
<tr>
<th>Feature</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Order No.</td>
<td>378-736</td>
</tr>
<tr>
<td>Mass</td>
<td>0.8 kg</td>
</tr>
</tbody>
</table>

Fiber-optic illuminator (100W)

<table>
<thead>
<tr>
<th>Feature</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Order No.</td>
<td>378-700D</td>
</tr>
<tr>
<td>Light source</td>
<td>12V/100W parabolic-type halogen bulb (517181), 100h service life</td>
</tr>
<tr>
<td>Light guide</td>
<td>Fiber-optic cable (1.5 m length, 5 mm dia.)</td>
</tr>
<tr>
<td>Brightness</td>
<td>Adjustable by volume</td>
</tr>
<tr>
<td>Filter (optional)</td>
<td>LB80 Color temperature conversion filter (12BAA584)</td>
</tr>
<tr>
<td></td>
<td>ND2 For 1/2 light intensity (12AAB251)</td>
</tr>
<tr>
<td></td>
<td>ND8 For 1/8 light intensity (12AAB252)</td>
</tr>
<tr>
<td></td>
<td>GIF Green filter (12BAA253)</td>
</tr>
</tbody>
</table>

Fiber-optic illuminator (150W)

<table>
<thead>
<tr>
<th>Feature</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Order No.</td>
<td>176-316D</td>
</tr>
<tr>
<td>Light source</td>
<td>15V/100W parabolic-type halogen bulb (12BAJ076), 500h service life</td>
</tr>
<tr>
<td>Light guide</td>
<td>High-brightness type</td>
</tr>
<tr>
<td></td>
<td>Fiber-optic cable (1.5 m length, 5 mm dia.)</td>
</tr>
<tr>
<td>Brightness</td>
<td>Adjustable by rotary control</td>
</tr>
</tbody>
</table>
Dimensions

VMU series

VMU-V

VMU-H

VMU-L

VMU-L4

VMU-LB

VMU-L4B

Adapter for Mitutoyo fiber-optic cable

Adapter for Mitutoyo fiber-optic cable
FS70 series
FS70Z

Back of standard focus unit (for all models)

Detail of fiber mount (for all models)

Mitutoyo
VM-ZOOM series

VMZ40M

VM40R-BL

VM40R-BL4 (camera mount position)
Other dimensions except for camera mount are same as those for VM40R-BL.
1. **N.A. (Numerical Aperture)**
N.A. determines resolving power, depth of field, and luminosity of the image. The larger the N.A., the higher is the resolving power and smaller is the depth of field.

\[ N.A. = n \times \sin \theta \]

- \( n \) is the index of refraction of the medium in which the lens is working. \( n=1.0 \) for air.
- \( \theta \) is the half-angle of the maximum cone of light that can enter or exit the lens.

2. **R (Resolving Power)**
Minimum distance between points or lines that are just distinguishable as separate entities.

Resolving power is determined by N.A. and wavelength \( \lambda \).

\[ R (\mu m) = \frac{\lambda}{2 \times N.A.} \]

3. **W.D. (Working Distance)**
Distance between the surface of the specimen and the front face of the objective when in focus.

4. **Parfocal Length**
Distance between the surface of the specimen and the objective mounting position when in focus.

5. **Infinity-corrected system**
An optical system in which the image is formed by an objective and a tube lens with an ‘Infinity Space’ between them, into which optical accessories can be inserted.

6. **Finite-corrected optical system**
An optical system in which the image is formed only by an objective.

7. **F (Focal Length)**
Distance between a principal point and a focal point. \( f_1 \) is a focal length of an objective, \( f_2 \) is a focal length of a tube lens. Magnification is determined by the ratio of the focal length of the tube lens to that of the objective. (For an infinity-corrected optical system.)

\[ \text{Magnification of objective} = \frac{\text{Focal length of tube lens}}{\text{Focal length of objective}} \]

Ex.) 1X = \( \frac{200 \text{ (mm)}}{200 \text{ (mm)}} \)  
Ex.) 10X = \( \frac{200 \text{ (mm)}}{20 \text{ (mm)}} \)

8. **Field number and FOV (Real Field of View)**
The field number of an eyepiece is determined by the field stop diameter of the eyepiece and it is expressed in mm.

FOV is the area of specimen observable and is determined by the field number of the eyepiece and magnification of the objective.

\[ \text{FOV (mm)} = \frac{\text{Field number of eyepiece}}{\text{Magnification of objective}} \]

Ex. Using an eyepiece of field number 24:

- FOV for 1X objective = \( \frac{24}{1} = 24 \text{ (mm)} \)
- FOV for 10X objective = \( \frac{24}{10} = 2.4 \text{ (mm)} \)

**Area of specimen observable on TV monitor**

\[ \text{Area of specimen observable on TV monitor} = \frac{\text{Area of camera image element (V \times H)}}{\text{Magnification of objective}} \]

**Indication magnification on TV monitor**

\[ \text{Diagonal line length} \times \text{Magnification of objective} \times \text{Diagonal line length of camera image element} \]

*Size of camera image element (V \times H \times Diagonal):
- 1/3 inch image element: 3.6x4.8x6.0 mm
- 1/2 inch image element: 4.8x6.4x8.0 mm
- 2/3 inch image element: 6.6x8.8x11.0 mm

9. **DOF (Depth of Focus)**
Vertical distance in the specimen, measured from above and below the exact plane of focus, which still yields an acceptable image. The larger the N.A., the smaller the depth of field.

**Eyepiece observation (Formula of Berek)**

\[ \pm \text{DOF (\mu m)} = \frac{\omega \times 250,000}{N.A. \times M} + \frac{\lambda}{2x(N.A.)^2} \]

\( \omega \): Resolution of human eye (Visual angle: 5 minute)
\( M \): Total magnification (Objective mag. \times Eyepiece mag.)
\( \lambda \): Radiation wavelength

**TV monitor observation**

\[ \pm \text{DOF (\mu m)} = \frac{\lambda}{2x(N.A.)^2} \]

\( \lambda = 550 \text{nm} \) (Standard wavelength)
10. Bright field illumination and dark field illumination
Bright field illumination directly lights the specimen with a solid cone of rays and is the simplest method available. Dark field illumination uses a hollow cone of rays formed by an opaque stop at the center of the condenser large enough to prevent direct light from entering the objective. The specimen is placed at the concentration of the light cone, and is seen with light scattered or diffracted by it, therefore scratches and dents on the specimen surface are illuminated while the rest remains dark.

11. Apochromatic objective and achromatic objective
An apochromatic objective is corrected for chromatic aberration at the red, blue, and yellow wavelengths. An achromatic objective is corrected for chromatic aberration at the red and blue wavelengths only.

12. Koehler illumination
Koehler illumination overcomes the disadvantages of other schemes by causing parallel rays to light the specimen so that, because they will not be in focus, the image of the specimen will not include an image of the light source.

13. Telecentric illumination
This illuminating optical system is designed so that principal light passes through the focal point. This system has the advantage of retaining the size of the image center even if it is out of focus (although the circumference of the image is defocused). This illumination system provides an even illumination intensity over the entire field of view.

14. Aperture diaphragm
This diaphragm adjusts the amount of light passing through and is related to the brightness and resolving power of an optical system. This diaphragm is especially useful in width dimension measurement of cylindrical objects with contour illumination, and provides the highest degree of correct measurement/observation by suppressing diffraction in an optimal aperture.

15. Field stop
This diaphragm is used for blocking out unwanted light and thereby preventing it from degrading the image.

16. Plan
Denotes an objective lens that produces a flat (planar) image by correcting the spherical aberration/curvature of the field of an achromatic lens or an apochromatic lens. All Mitutoyo FS series objectives are plan apochromat.

17. Vignetting
This unwanted effect is the reduction of an image's brightness or saturation at the periphery compared to the image center. May be caused by external (lens hood) or internal features (dimensions of a multi-element lens).

18. Flare
Lens flare is typically seen as several starbursts, rings, or circles in a row across the image or view, caused by unwanted image formation mechanisms, such as internal reflection and scattering of light.

19. Double image
An image degrading a phenomenon in which an image appears as if it is a double image due to redundant light projection and optical interference within the optical system.

20. Pupil Diameter and Spot Diameter of an Objective
  • Pupil diameter
  Denotes the maximum diameter of a parallel light flux along the optical axis that can enter an objective from the rear. The pupil diameter is calculated according to the following expression.

  \[ \varnothing \text{ mm} = 2 \times \text{N.A.} \times f \]

  • Spot diameter
  If a beam of light with a uniformly distributed intensity enters an objective from the rear, the beam is condensed to a spot of finite size. This size is known as the spot diameter. The approximate value of a spot diameter is calculated from the following expression.

  \[ \varnothing \text{ \mu m} = 1.22 \times \frac{\lambda}{\text{N.A.}} \]

  However, the above expression cannot be applied if the light source is a laser beam of which the intensity forms a Gaussian distribution on the cross section. The diameter of a laser beam is generally indicated by 1/e² of the peak value, i.e. 13.5% of the peak value. The spot diameter of a laser beam is calculated from the following expression.

  \[ \varnothing \text{ \mu m} = \frac{4 \times \lambda \times f}{\pi \times D} \]
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