INDUSTRIAL

Microscope/Optical Metrology General Overview

For Industrial Applications

EVIDENT

Semiconductor, flat panel display (FPD), and electronic equipment technologies are rapidly progressing. As the demands of industry become more specialized and diversified, the capabilities of research and inspection equipment must keep pace.

Our microscope systems are built to meet the ever-changing needs of research and inspection applications. For more than 100 years, we have developed advanced optical and precision technologies that enable us to build versatile systems with a broad range of advanced accessories, such as our renowned UIS2 infinity-corrected optical system.

Contents

**Some products shown here may not be available in your area.*

LEXT

OLS5100 3D Measuring Laser Microscope

The LEXT™ OLS5100 3D laser microscope precisely measures shape and surface roughness at the submicron level.

Boost productivity with a smart workflow:

- Total magnification: 54X–17,280X
- Acquire precise 3D measurement data with a single click
- Complete measurement tasks up to 30% faster with the Smart Experiment Manager*

**Compared with the previous model.*

OLS5100 Specifications

Model		OLS5100-SAF	OLS5100-SMF	OLS5100-LAF	OLS5100-EAF
Total magnification		54X–17,280X			
Field of view		16 µm–5,120 µm			
Measurement principle	Optical system	Reflection-type confocal laser scanning laser microscope, Color Reflection-type confocal laser scanning laser-DIC microscope, Color-DIC			
	Light receiving element	Laser: Photomultiplier (2ch), Color: CMOS color camera			
Height measurement	Dynamic range	16 bits			
	Repeatability σ_{n-1} *1 *2 *5	10x: 0.1 µm, 20x: 0.03 µm, 50x: 0.012 µm, 100x: 0.012 µm			
	Accuracy *1 *3 *5	0.15 + L/100 µm (L: Measuring length[µm])			
	Accuracy for stitched image *1 *3 *5	10x: 5.0+L/100 µm, 20x or higher: 1.0+L/100 µm (L: Stitching length [µm])			
	Measurement noise (Sq noise) *1 *4 *5	1 nm [Typ]			
Width measurement	Repeatability $3\sigma_{n-1}$ *1 *5	10x: 0.2 µm, 20x : 0.05 µm, 50x : 0.04 µm, 100x : 0.02 µm			
	Accuracy *1 *3 *5	Measurement value ±1.5%			
	Accuracy for stitched image *1 *3 *5	10x: 24+0.5L µm, 20x : 15+0.5L µm, 50x: 9+0.5L µm, 100x: 7+0.5L µm (L: Stitching length [mm])			
XY stage configulation	Operating range	100 × 100 mm Motorized	100 × 100 mm Manual	300 × 300 mm Motorized	100 × 100 mm Motorized
Maximum sample height		100 mm	40 mm	37 mm	210 mm
Laser light source	Wavelength	405 nm			
Color light source		White LED			
Mass	Microscope body	Approx. 31 kg (68.3 lb)	Approx. 32 kg (70.5 lb)	Approx. 50 kg (110.2 lb)	Approx. 43 kg (94.8 lb)
	Control box	Approx. 12 kg (26.5 lb)			

**1 Guaranteed when used in constant temperature and constant-humidity environment (temperature: 20 ˚C±1 ˚C, humidity: 50%±1%) specified in ISO554(1976), JIS Z-8703(1983).*
**2 For 20X or higher, when measured with MPLAPON LEXT series objectives. *3 When measured with dedicated LEXT objective.*
**4 Typical value when measured with MPLAPON100XLEXT objective, and may differ from the guaranteed value. *5 Guaranteed under Evident Certificate System.*

Objective Specifications

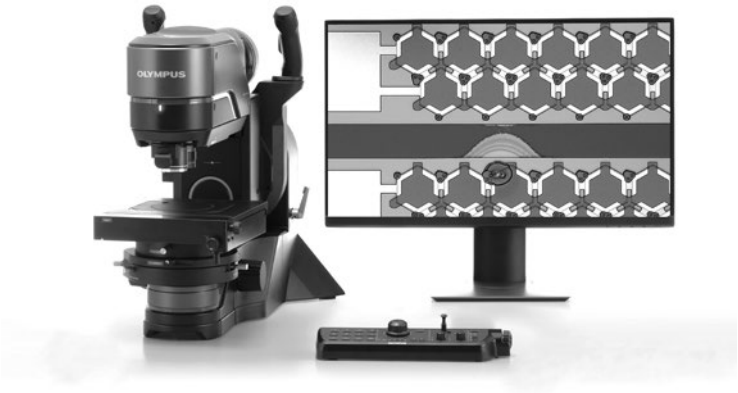
Series	Model	Numerical Aperture (NA)	Working Distance (WD)(mm)
UIS2 objective lens	MPLFLN5X	0.15	20.0
LEXT dedicated objective lens (10X)	MPLFLN10XLEXT	0.3	10.4
LEXT dedicated objective lens (High performance type)	MPLAPON20XLEXT	0.6	1.0
	MPLAPON50XLEXT	0.95	0.35
	MPLAPON100XLEXT	0.95	0.35
LEXT dedicated objective lens (Long working distance type)	LMPLFLN20XLEXT	0.45	6.5
	LMPLFLN50XLEXT	0.6	5.0
	LMPLFLN100XLEXT	0.8	3.4

DSX1000

Digital Microscope

The DSX1000 digital microscope combines world-class macro and micro optics in one system. With 23X to 8,220X magnification, it can be used for sample inspection and sample preparation at low magnification as well as detailed micro-structure analysis at high magnification.

- Large selection of lenses to find the best magnification, resolution, and working distance for your sample
- Image your sample from many directions with the coded free-angle observation system
- Multiple observations with a single click



DSX1000 Specifications

Model		DSX10-SZH (Upright frame system)	DSX10-UZH (Tilt frame system)
Optical system	Optical system	Telecentric optical system	
	Zoom ratio magnification method	10X/Motorized	
	Calibration	Automatic	
	Z-axis stroke	50 mm (manual)	
	Tilt observation tilt angle display	Not available	±90°/GUI
	Lens attachment	Quick-switch, coded lens attachments automatically update magnification and visual field information	
	Maximum total magnification (on a 27-inch monitor)	8,220X	
	Working distance (W.D)	66.1 mm–0.35 mm	
	Accuracy and repeatability (X-Y plane)*1	Accuracy of magnification: 3%	
	Repeatability (Z axis)*2	Repeatability (height): $\sigma_{n-1} \leq 1$ µm	
Camera	Image sensor	1 / 1.2 inch, 2.35 million pixel color CMOS	
	Cooling	Peltier cooling	
	Frame rate	60 fps (maximum)	
	Normal	1200 × 1200 (1:1)/1600 × 1200 (4:3)	
	Fine	Not available	1200 × 1200 (1:1)/1600 × 1200 (4:3)
	Super fine	Not available	3600 × 3600 (1:1)/4800 × 3600 (4:3)
Illumination	Color light source	LED: Lifetime 60,000 h (design value)	
Observation	BF (brightfield)	Standard	
	OBQ (oblique)	Standard	
	DF (darkfield)	Standard: LED ring divided into four divisions	
	MIX (brightfield+darkfield)	Standard: Simultaneous observation of BF + DF	
	PO (polarization)	Standard	
	DIC (differential interference)	Not available	Standard
	Contrast up	Standard	
	Depth of focus up function	Not available	Standard
	Transmitted lighting	Standard*3	
Focus	Focusing	Motorized: Stroke 101 mm (motorized)	
Monitor	Size/Resolution	23-inch flat panel display/1920 (H) × 1080 (V)	
Weight (frame, head, motorized stage, display, and console)		43.7 kg (96.3 lb)	46.7 kg (103 lb)
Power consumption		100 V–120 V/220 V–240 V, 1.1/0.54 A, 50/60 Hz	

**1 Calibration by Evident or dealer service technician necessary. To guarantee the accuracy of XY, calibration with DSX-CALS-HR (calibration sample) is required. To issue certificates, calibration work must be undertaken by an Evident calibration service technician. *2 When using a 20X or higher objective. *3 The optional DSX10-ILT is required.*

Objective Specifications

Model		DXS10-SXLOB	DSX10-XLOB	UIS2 objective
Objective lens	Maximum sample height	50 mm	115 mm	145 mm
	Maximum sample height (free angle observation)	50 mm		
	Total magnification (on a 27-inch monitor)	23X – 1,644X	49X – 6,570X	26X*4 – 8,220X
Lens attachment	Number of objectives that can be attached	Up to 1 piece (attachment is integrated with lens)	Up to 2 pieces	

**4 Total (maximum) magnification when using MPLFLN1.25X*

Stage Specifications

Model		DSX10-RMTS	DSX10-MTS	U-SIC4R2
Stage	XY stage: motorized/manual	Motorized (with rotation function)	Motorized	Manual
	XY stroke	Stroke priority mode : 100 mm × 100 mm Rotation priority mode : 50 mm × 50 mm	100 mm × 100 mm	100 mm × 105 mm
	Rotation angle	Stroke priority mode : ±20° Rotation priority mode : ±90°	Not available	
	Display rotation angle	GUI	Not available	
	Load resistance	5 kg (11 lb)		1 kg (2.2 lb)

CIX100

Technical Cleanliness Inspection System

The CIX100 system is a dedicated turnkey technical cleanliness solution. Quickly acquire, process, and document particulate residue data of manufactured parts to comply with company and international standards.

- Live processing and classification of both small and large particles (2.5 µm up to 42 mm)
- Intuitive workflow and one-click reporting for operators of all experience levels
- Pre-configured and pre-calibrated system with automatic system checks

CIX100 Specifications

Microscope	Motorized focus	• Coaxial motorized fine focus with 3-axis joystick • Focus stroke 25 mm • Fine stroke 100 µm / rotation • Maximum height of stage holder mounting: 40 mm • Focus speed 200 µm/sec • Software autofocus enabled • Customizable multi-point focus map
	Illumination	• Built-in LED illumination • Illumination mechanism with simultaneous detection of reflecting and non-reflecting particles • Light intensity controllable by software
	Imaging device	• Color CMOS USB 3.0 camera • On chip pixel size 2.2 × 2.2 µm
	Sample size	• The standard sample is a filter membrane of diameter 47 mm. Filter holders with 25 mm or 55 mm membrane diameter or customized sample holders can be provided
Nosepiece	Motorized nosepiece	• 6-position motorized nosepiece with 3 UIS2 objectives already installed • PLAPON 1.25X used for preview • MPLFLN 5X used for detecting particles bigger than 10 µm • MPLFLN 10X used for detecting particles bigger than 2.5 µm
	Software controlled	• The image magnification and relation between pixel and size is known at every moment • Selected objectives are used at selected steps into the measurement process, objectives are automatically positioned
Stage	Motorized stage X, Y	• Stepper motors control movement • Maximum range : 130 × 79 mm • Max speed 240 mm/s (4 mm ball screw pitch) • Repeatability < 1 µm • Resolution 0.01 µm • Controllable with 3-axis joystick
	Software controlled	• Scanning speed depends on the used magnification, at 10x the scanning time is less than 10 minutes • Stage alignment is performed at factory assembly
	Sample holder	• Membrane holder is specially designed to avoid an unwanted rotation of the membrane during the mounting • The membrane is mechanically flattened by the membrane holder • No tool is needed to fix the cover • Sample holder for filter membranes with diameters of 25 mm, 47 mm, and 55 mm • Sample holder for particle traps, particle trap consumables, and tape lift sampling
	Particle standard device (PSD)	• Reference sample used to validate the system measurement • Sample used in the check system; built-in function for controlling the proper function of the CIX • The PSD is always assigned slot 2 on the stage
	2-position stage insert	• Stage insert dedicated to the right positioning of the sample holder and the PSD
Controller	Workstation	• HP Z4G4, Windows 10 64-bit Professional (English) • 16 GB RAM, 256 GB SSD, and 4 TB data storage • 2 GB video adapter • Microsoft Office 2019 (English) installed • Networking capabilities, English qwerty keyboard, optical mouse 1000 dpi
	Add-in boards	• Motorized controller, RS232 serial, and USB 3.0
	Language selection	• Operating system and Microsoft Office default language can be changed by the user
	Touch panel display	• Resolution 1920 × 1080 optimized for use with the CIX software (23-inch slim screen)
Power	Rating	• AC adapter (2), Controller and Microscope frame (4 plugs necessary) • Input: 100–240 V AC 50/60 Hz, 10 A
	Power consumption	• Controller: 700 W; Monitor: 56 W; Microscope: 5.8 W; Control Box 7.4 W • Total: 769.2 W
Drawing	Dimensions (W × D × H)	Approx. 1300 mm × 800 mm × 510 mm (51.2 in. × 31.5 in. × 20 in.)
	Weight	44 kg (97 lb)

BX53M

System Microscope (General Use)

Designed with modularity in mind, the BX3M series provides versatility for a wide variety of materials science and industrial applications. With improved integration with PRECiV™ software, the BX3M series provides a seamless workflow for standard microscopy and digital imaging users from observation to report creation.

- Total magnification: 12.5–1,500X
- Observation methods: brightfield, darkfield, differential interference contrast, and MIX
- Quickly find the focus using the focus scale index on the microscope frame
- Supports sample thicknesses up to 65 mm; observe even thicker samples with an arm adapter (only for reflected light models)
- Condensers can be selected for transmitted light observation

Entry model | Standard model | Advanced model

BX53M General Use Specifications

			Entry		Standard		Advanced	
Optical system			UIS2 optical system (infinity-corrected system)					
Main set	Microscope frame	Illumination	Reflected	Reflected/transmitted	Reflected	Reflected/ transmitted	Reflected	Reflected/transmitted
		Focus	Stroke: 25 mm, Fine stroke per rotation: 100 µm, Minimum graduation: 1 µm, With upper limit stopper, torque adjustment for coarse handle					
		Maximum specimen height	Reflected 65 mm (w/o spacer) 105 mm (With BX3M-ARMAD) Reflected/transmitted 35 mm (w/o spacer) 75 mm (With BX3M-ARMAD)					
	Observation tube	Widefield (FN 22)	Inverted: trinocular					
	Reflected light illumination		BX3M-KMA-S: White LED, BF/DIC/POL/MIX FS, AS (with centering mechanism),BF/DF interlocking		BX3M-RLAS-S: Coded, White LED, BF/DF/DIC/POL/MIX FS, AS (with centering mechanism), BF/DF interlocking			
	Transmitted light illumination		-	BX3M-LEDT: White LED, Abbe/long working distance condensers	-	BX3M-LEDT: White LED, Abbe/long working distance condensers	-	BX3M-LEDT: White LED, Abbe/long working distance condensers
	Revolving nosepiece		U-5RE-2 For BF: Quintuple		U-D6BDRE: For BF/DF: Sextuple			U-D6BDRES-S: For BF/DF: Sextuple, Coded
	Eyepiece (FN 22)		WHN10X					
			WHN10X-H					
	MIX obcervation		-					BX3M-CB: Control box BX3M-HS: Handswitch U-MIXR-2: MIX slider for reflected light observation U-MIXRCBL: Cable for MIXR
	Condenser (long working distance)		-	U-LWCD	-	U-LWCD	-	U-LWCD
	Weight		Reflected: Approx.15.8 kg (34.8 lb) (Microscope frame 7.4 kg) (16.3 lb)		Reflected/transmitted: Approx. 18.3 kg (40.3 lb) (Microscope frame 7.6 kg (16.8 lb))			
Objectives	MPLFLN set		BF/POL/FL observation: MPLFLN5X, 10X, 20X, 50X, 100X		-			
	MPLFLN BD set		-		BF/DF/DIC/POL/FL observation: MPLFLN5XBD, 10XBD, 20XBD, 50XBD, 100XBD			
	MPLFLN-BD, LMPLFLN-BD set				BF/DF/DIC/POL/FL observation: MPLFLN5XBD, 10XBD, LMPLFLN20XBD, 50XBD, 100XBD			
	MPLFLN-BD, MXPLFLN-BD, LMPLFLN-BD		-		BF/DF/DIC/POL/FL observation: MPLFLN5XBD, 10XBD, MXPLFLN20XBD, 50XBD, LMPLFLN20XBD, 50XBD, 100XBD			
Stage (X × Y)	76 mm × 52 mm set		Coaxial right handle stage/76 (X) × 52 (Y) mm, with torque adjustment: U-SVRM, U-MSSP					
	100 mm × 100 mm set		Large-size coaxial right handle stage/100 (X) × 100 (Y) mm, with lock mechanism in Y axis: U-SIC4R2, U-MSSP4					
	100 mm × 100 (G)mm set		Large-size coaxial right handle stage/100 (X) × 100 (Y) mm, with lock mechanism in Y axis(Glass plate): U-SIC4R2, U-MSSPG					
	150 mm × 100 mm set		Large-size coaxial right handle stage/150 (X) × 100 (Y) mm, with torque adjustment, with lock mechanism in Y axis: U-SIC64, U-SHG, U-SP64					
	150 mm × 100 (G)mm set		Large-size coaxial right handle stage/150 (X) × 100 (Y) mm, with torque adjustment, with lock mechanism in Y axis(Glass plate): U-SIC64, U-SHG, U-SPG64					

•This product is designed for use in industrial environments for EMC performance. Using it in a residential environment may affect other equipment.

BX53M

System Microscope (Dedicated Use)

Designed for traditional industrial microscopy, the BX3M microscope has expanded functionality to meet a broad range of applications and inspection techniques. The BX3M series configurations provide the flexibility to select the system that best meets your needs.

- Total magnification: 12.5–1,500X
- Observation methods: brightfield, darkfield, differential interference contrast, MIX, fluorescence, infrared, and polarization
- Quickly find the focus using the focus scale index on the microscope frame

Fluorescence model

Infrared model

Polarization model

BX53M Dedicated Use Specifications

				Fluorescence		Infrared	Polarization
Optical system				UIS2 optical system (infinity-corrected)			
Main set	Microscope frame	Illumination		Reflected	Reflected/ transmitted	Reflected	Transmitted
		Focus		Stroke: 25 mm, Fine stroke per rotation: 100 µm, Minimum graduation: 1 µm , With upper limit stopper, torque adjustment for coarse handle			
		Maximum specimen height		Reflected 65 mm (w/o spacer) 105 mm (With BX3M-ARMAD) Reflected/transmitted 35 mm (w/o spacer) 75 mm (With BX3M-ARMAD)			
	Observation tube	Widefield (FN 22)		Inverted: trinocular		Inverted: trinocular for IR	Inverted: trinocular
		Polarized Light Intermediate Attachment(U-CPA)	Bertrand Lens	-			Focusable
			Bertrand Field Stop				ø3.4 mm diameter (fixed)
			Engage or disengage Bertrand lens changeover between orthoscopic and conoscopic observation				Position of slider ● in Position of slider ○ out
			Analyzer Slot				Rotatable Analyzer with Slot (U-AN360P-2)
	Illumination	Reflected light	FL observation	BX3M-URAS-S: Coded universal reflected light, 4-position mirror unit turret, (standard: U-FWUS, U-FWBS, U-FWGS, U-FBF etc) with FS, AS (with centering mechanism), with shutter mechanism		-	
			IR observation	-		BX3M-RLA-S: 100W halogen lamp for IR, BF / IR, AS (with centering mechanism)	-
						U-LH100IR (Including 12 V 10 W HAL-L), 100 W Halogen light source for IR	
						TH4-100: 100 W power supply	
						TH4-HS: Hand switch	
						U-RMT: Extension cord	
		Transmitted light	POL observation	-			BX3M-LEDT: White LED, Abbe/long working distance condensers
	Revolving nosepiece			U-D6BDRES-S: For BF/DF : Sextuple, Coded		U-5RE-2: For BF: Quintuple	U-P4RE: Quadruple, centerable attachable components, 1/4 wavelength retardation plate (U-TAD), tint plate (U-TP530) and various compensators can be attached using plate adapter (U-TAD).
	Eyepiece (FN22)			WHN10X			
				WHN10X-H			CROSS-WHN10X
	Mirror units			U-FDF: For DF			-
				U-FBFL: For BF, built-in ND filter			
				U-FBF: For BF, detachable ND filter			
				U-FWUS: For Ultra Violet-FL			
				U-FWBS: For Blue-FL			
				U-FWGS: For Green-FL			
	Filter/Polarizer/Analyzer			U-25FR: Frost filter		U-BP1100IR/U-BP1200IR: Band path filters for IR	43IF550-W45: Green filter
				U-POIR: Reflected polarizer slider for IR		U-AN360IR: Rotatable analyzer slider for IR	U-AN360P-2: 360° Dial-rotatable, Rotatable minimum angle 0.1°
	Condenser			U-LWCD: Long working distance		-	U-POC-2: Achromat strain-free condenser, 360° rotatable polarizer with swing-out achromatic top-lens, Click stop at position "0°" is adjustable, NA 0.9 (top-lens in)/NA 0.18 (top-lens out), Aperture iris diaphragm: adjustable from 2 mm to 21 mm diameters.
	Slider/Compensators			-			U-TAD: Slider (Plate adapter)
							U-TP530/U-TP137: Compensators
	Weight			Reflected: Approx.15.8 kg (34.8 lb) (Microscope frame 7.4 kg (16.3 lb))	Reflected/ transmitted: Approx. 18.3 kg (40.3 lb) (Microscope frame 7.6 kg (16.8 lb))	Approx. 18.9 kg (41.7 lb); microscope frame 7.4 kg (16.3 lb)	Approx. 16.2 kg (35.7 lb); microscope frame 7.6 kg (16.8 lb)
Reflected FL light source	Light guide			U-LGPS, U-LLGAD, U-LLG150: Light guide set		-	
	Marcury lamp			U-LH100HGAPO1-7, USH-103OL(x2), U-RFL-T, U-RCV: Mercury lamp set		-	
Objectives	MPLFLN set			BF/DIC/POL/FL observation: MPLFLN5X, 10X, 20X, 50X, 100X		-	-
	MPLFLN BD set			BF/DF/DIC/POL/FL observation: MPLFLN5XBD, 10XBD, 20XBD, 50XBD, 100XBD			
	MPLFLN-BD, LMPLFLN-BD set			BF/DF/DIC/POL/FL observation: MPLFLN5XBD, 10XBD, LMPLFLN20XBD, 50XBD, 100XBD			
	MPLFLN-BD, MXPLFLN-BD, LMPLFLN-BD set			BF/DF/DIC/POL/FL observation: MPLFLN5XBD, 10XBD, MXPLFLN20XBD, 50XBD, LMPLFLN20XBD, 50XBD, 100XBD			
	IR set			-		IR observation: LMPLN5XIR, 10XIR,LCPLN20XIR,50XIR,100XIR	-
	POL set			-			POL observation: UPLFLN4XP,10XP,20XP,40XP
Stage (X × Y)	76 mm × 52 mm set			Coaxial right handle stage/76 (X) × 52 (Y) mm, with torque adjustment: U-SVRM, U-MSSP			
	100 mm × 100 mm set			Large-size coaxial right handle stage/100 (X) × 100 (Y) mm, with lock mechanism in Y axis: U-SIC4R2, U-MSSP4			
	100 mm × 100 (G)mm set			Large-size coaxial right handle stage/100 (X) × 100 (Y) mm, with lock mechanism in Y axis(Glass plate): U-SIC4R2, U-MSSPG			
	150 mm × 100 mm set			Large-size coaxial right handle stage/150 (X) × 100 (Y) mm, with torque adjustment, with lock mechanism in Y axis: U-SIC64, U-SHG, U-SP64			
	150 mm × 100(G) mm set			Large-size coaxial right handle stage/150 (X) × 100 (Y) mm, with torque adjustment, with lock mechanism in Y axis (Glass plate): U-SIC64, U-SHG, U-SPG64			
	POL set			-			Polarizing rotatable stage + Mechanical stage: U-SRP +U-FMP

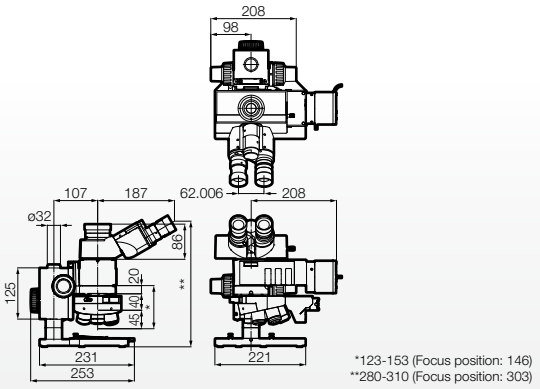
•*This product is designed for use in industrial environments for EMC performance. Using it in a residential environment may affect other equipment.*

BXFM

Modular Microscope

The BXFM system can be adapted to special applications or integrated into other instruments. The modular construction enables straightforward adaptation to unique environments and configurations with a variety of special small illuminators and fixturing mounts.

› Total magnification: 12.5–1,500X



BXFM Specifications

Optical system		UIS2 optical system (infinity-corrected system)
Microscope frame		Stroke: 30 mm Fine stroke per rotation: 200 µm Minimum graduation: 2 µm With torque adjustment for coarse handle
Illumination	BX3M-RLAS-S	Coded, white LED, BF/DF/DIC/POL/MIX FS, AS (with centering mechanism)
	BX3M-KMA-S	White LED, BF/DIC/POL/MIX FS, AS (with centering mechanism)
	BX3M-RLA-S	100 W/50 W halogen lamp, white LED, BF/DF/DIC/POL/MIX/ FS, AS (with centering mechanism), BF/DF interlocking, ND filter Erect: trinocular, tilting binocular
	U-KMAS	White LED, 100 W halogen, BF/DIC/POL/MIX

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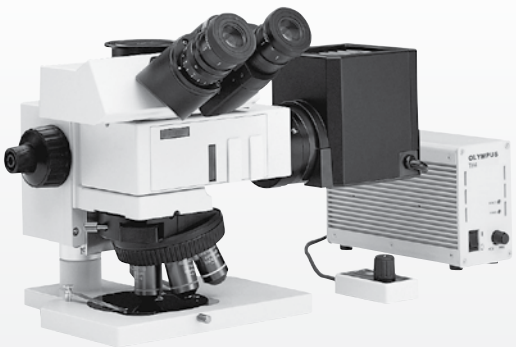
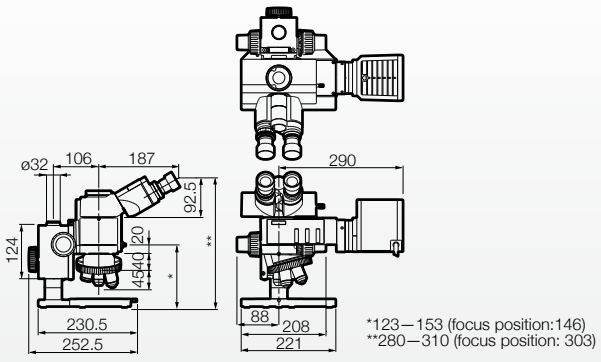
BXFM-S

Modular Microscope

The BXFM-S system is a cost-effective, space-saving focus mount for brightfield microscopy. The focus mount can be used for optical bench, plain stand, or system integration due to its compact design and convenient mounting surface. It accepts a variety of objectives that have standard or long working distances.

› Total magnification: 12.5–1,000X





BXFM-S Specifications

Optical system		UIS2 optical system (infinity-corrected system)
Microscope frame		Stroke 30 mm, rotation of fine focus knob: 200 µm, minimum adjustment gradation: 2 µm, with torque adjustment for coarse knob
Illumination	BX-KMAS	White LED,100 W halogen, BF/DIC/KPO

GX53

Inverted Metallurgical System Microscope

Designed for use in the steel, automotive, electronics, and other manufacturing industries, the GX53 inverted microscope features exceptional image clarity and excellent resolution at high magnifications. The microscope's modular design makes it easy to customize for your exact requirements.

- Total magnification: 12.5–1,500X
- Combine with a coded nosepiece and digital camera, and the scale will automatically switch when you change to a different magnification lens
- Supports metallurgical analysis methods (e.g., particle analysis, evaluating graphite nodularity, and more) when combined with a digital camera and PRECiV™ software
- Efficient, long-life illumination due to a high-intensity white LED light source
- Observation methods: brightfield, darkfield, differential interference contrast, polarization, and MIX

GX53 Specifications

Optical system		UIS2 optical system (infinity-corrected system)
Microscope frame	Imprinting of scale	All ports reversed positions (up/down) from observation positions seen through the eyepiece
	Power source	Power source for illuminator (LED) incorporated
	Focusing	Manual, coarse and fine coaxial handle, focus stroke 9 mm (2 mm above and 7 mm below the stage surface)
	Output port optional	Front port: camera and DP system (reversed image, special camera adapter for GX) Side port: camera, DP system (upright image)
Observation tube	Widefield (FN 22)	Binocular (U-BI90, U-BI90CT), trinocular (U-TR30H-2), tilting binocular (U-TBI90)
Illumination	Observation method	Brightfield, darkfield, simple polarized light, DIC, MIX (directional darkfield)
	Illuminator diaphragm	FS/AS manually controlled, with centering adjustment
	Light source	White LED (standard) /12 V, 100 W halogen lamp/100 W mercury lamp/light guide source
Revolving nosepiece		Brightfield holes: 4 to 7 pcs, Type: manual/coded, Centering: enabled/disabled Brighfield/darkfield hole: 5 to 6 pcs, Type: manual/coded, Centering: enabled/disabled
Stage	Standard type	Right handle stage for GX series microscope (X/Y stroke: 50 × 50 mm)
	Option	Flexible right handle stage, left short handle stage (X/Y stroke: 50 × 50 mm)
	Stage insert plate	A set of teardrop and long hole types
Image recording	Digital camera, video camera	Our DP series is attachable using the appropriate adapters
Combined weight		Approx. 25 kg (55.1 lb); microscope frame 20 kg (44.1 lb)
Input rating		5 V DC, 2.5 A (AC adapter 100–240 V, AC 0.4 A, 50 Hz/60 Hz)

MX63/MX63L

Semiconductor/FPD Inspection Microscopes

The MX63 and MX63L microscope systems offer quality observations of wafers as large as 300 mm, flat panel displays, printed circuit boards, and other large samples, featuring versatile functions and an ergonomic, user-friendly design.

- Total magnification: 12.5–1,500X
- Conforms to international specifications and standards, including SEMI S2/S8, CE, and UL
- Efficient, long-life illumination due to a high-intensity white LED light source
- Observation methods: brightfield, darkfield, differential interference contrast, fluorescence, polarization, infrared, and MIX

MX63

MX63L

MX63/MX63L Specifications

Model		MX63	MX63L
Optical system		UIS2 optical system (infinity-corrected system)	
Microscope frame	Reflected light illumination	White LED (with Light Intensity Manager) 12 V 100 W halogen lamp, 100 W mercury lamp, light guide source Brightfield/darkfield/mirror cube manual changeover. (Mirror cube is optional.) Built-in motorized aperture diaphragm (preset for each objective, automatically open for darkfield observation) Observation methods: brightfield, darkfield, differential interface contrast (DIC)*1, simple polarizing*1, fluorescence*1, infrared*1 and MIX observation (4 directional darkfield)*2	
	Transmitted light illumination	Transmitted light illumination unit: MX-TILLA or MX-TILLB is required. • MX-TILLA: a condenser (NA 0.5) and an aperture stop • MX-TILLB: a condenser (NA 0.6), an aperture stop and a field stop Light source: LG-PS2 (12 V, 100 W halogen lamp) Light guide: LG-SF Observation methods: brightfield, simple polarization	
Observation tube		Super widefield erect image tilting trinocular tube (FN 26.5): MX-SWETTR Others: Super widefield trinocular tube/Widefield binocular tube	Super widefield erect image tilting trinocular tube (FN 26.5): MX-SWETTR or U-SWETTR-5
Motorized nosepiece		Brightfield Motorized sextuple with a slider slot for DIC: U-D6REMC Motorized centerable quintuple with a slider slot for DIC: U-P5REMC Brightfield and darkfield Motorized sextuple with a slider slot for DIC: U-D6BDREMC Motorized quintuple with a slider slot for DIC: U-D5BDREMC Motorized centerable quintuple with a slider slot for DIC: U-P5BDREMC Motorized BD revolving nosepiece with vacuum function: U-D5BDREMC-VA	
Stage		MX-SIC8R 8 in. × 8 in. stage Stroke: 210 × 210 mm (Transmitted light illumination area: 189 × 189 mm) MX-SIC6R2 6 in. × 6 in. stage Stroke: 158 × 158 mm (Reflected light use only with MX63)	MX-SIC1412R2 14 in. × 12 in. stage Stroke: 356 × 305 mm (Transmitted light illumination area: 356 × 284 mm) combination with MX-TILLB
		Roller guide slide mechanism, belt drive system (no rack), grip clutch function (belt drive disengagement system)	
Input rating		Reflected light illumination: 100–120 V/220–240 V AC 1.9/0.9 A, 50 Hz/60 Hz Transmitted light illumination: 100–120 V/220–240 V AC 3.0/1.8 A 50/60 Hz	
Dimensions (W × D × H)		Approx. 509 × 770 × 507 mm (20 × 30.3 × 20 in.)	Approx. 711 × 790 × 507 mm (28 × 31.1 × 20 in.)
Weight		Approx. 35.6 kg (78.5 lb); microscope frame 26 kg (57.3 lb)	Approx. 44 kg (97 lb); microscope frame 28.5 kg (62.8 lb)

**1 Optional mirror cube. *2 MIX observation configuration is required.*

AL120

Wafer Loader

The AL120 wafer loader series transfers both silicon and compound semiconductor wafers from the cassette to the microscope stage with enhanced capabilities and flexibility while maintaining an ergonomic design.

- Total magnification: 12.5–1,500X
- Choose from three models based on wafer diameter: 200 mm type, 150 mm / 200 mm convertible type, and 150 mm type for wafer diameters of 150 mm or smaller

AL120 wafer loader (200 mm model) with the MX63 semiconductor inspection microscope

AL120 Specifications

Item \ Model		200 mm Type	200 mm/150 mm Convertible Type		150 mm Type	
		AL120-LMB8-90	AL120-LMB86-180	AL120-LMB86	AL120-LMB6-150	AL120-L6-150
Wafer Size (SEMI Standard)		200 mm	200 mm/150 mm		150 mm/125 mm/100 mm	
Minimum Wafer Thickness		90 µm	180 µm	400 µm	150 µm	
Type of Cassettes*1		SEMI standard 25 (26)-slot				
Number of Cassettes		1				
Inspection Recipe		All/Sampling				
Inspection Sequence	Micro (Microscope)	✔	✔	✔	✔	✔
	Top Macro	✔	✔	✔	✔	
	Back Macro	✔	✔	✔	✔	
	2nd. Back Macro	✔		✔	✔	
Wafer Orientation (Every 90º)		Non-contact (O.F./Notch)			Non-contact (O.F.)	
Compatible Microscope Model		Semiconductor Inspection Microscope MX63				
Dimensions (W × D × H)		640 × 620 × 378 mm (25.2 × 24.4 × 14.9 in.) Body Only, 1100 × 620 × 378 mm (43.3 × 24.4 × 14.9 in.) with Microscope			570 × 620 × 400 mm (22.4 × 24.4 × 15.7 in.) Body Only 980 × 620 × 400 mm (38.6 × 24.4 × 15.7 in.) with Microscope	
Weight (kg) (Main Body Only)		44 (97 lb)	44 (97 lb)	44 (97 lb)	40 (88.2 lb)	37 (81.6 lb)
Utilities		AC100 V–120 V, 1 A, or AC220 V–240 V, 0.5A 50/60 Hz, -67 to -80 kpa, 20 L or higher/min.				

**1 Up to 10 types of cassettes are registered for all models.*
• All types of wafers must be tested prior to installation of the equipment.

SZX-AR1

Augmented Reality Microscope System

The AR1 microscope system enables you to overlay text and digital images over your microscope's field of view, making it easy for assemblers to follow directions, read notes, and even watch videos without removing their eyes from the oculars. The AR1 module works with our stereo microscopes, turning them into augmented reality tools that improve the speed and efficiency of your microscope-based manufacturing tasks and training.

SZX-AR1 Specifications

Hardware

AR tilting trinocular tube SZX2-ARTTR	Angle of observation tube: 5 to 45 degrees
	Interpupillary distance adjustment range: 57 to 80 mm
	Equipped with eyepiece clamping knob
	Light-path switching mechanism: None
	Magnification of eyepiece: 1.25X, magnification of camera: 1X
	Functions of buttons on the front panel: AR image brightness adjustment (7 levels) and AR image ON/OFF
	Input connectors: HDMI x 1, USB 2.0 (Type-C) x 1, DC jack x 1
	Drive voltage: AC 100–240 V (AC adaptor)
	Maximum power consumption: 10 W
Zoom magnification sensor	Main Functions:
	(a) Get the zoom magnification (at click position only)
	(b) Forward and backward the slides created on software
	Output connector: USB 2.0 (Type-C)

Software

Camera control function	Exposure control: Switching between Auto and Manual
	ISO sensitivity adjustment: ISO100, 200, 400
	White balance adjustment function: Equipped (one-touch adjustment)
Acquisition function	Snapshot acquisition
	Save format: BMP, JPEG, PNG
	Resolution: DP23: 3088 × 2076, DP28: 4104 × 2174
	The camera image can be saved with the AR image simultaneously
	Recording
	File saving formats: mp4, mov; Video codec: H264
	Audio format: MP3; Audio codec: mp3
	Resolution: DP23: 1920 × 1080 (camera image range: 1600 × 1080), DP28: 1920 × 1080 (camera image range: 1920 × 1080)
	The video cannot be recorded out of the camera image range
	The camera image can be saved with the AR image simultaneously
	The recording time is approximately one hour
Barcode function	The SZX-AR1 software can generate a QR code linked to the procedure
	The QR code can be scanned with a barcode reader to recall the procedure in the eyepiece field of view
	Compatible barcode reader
	COM communication is available
	A QR code can be loaded
	Output barcode: QR code
	Software language
Software language	English, Japanese, Chinese, German, Spanish, Portuguese, French

PC requirements

OS	Windows 10 Pro (64-bit), Windows 10 pro for Workstation (64-bit)
	Windows 10 version: 2004, 21H1
	Windows 10 IoT Enterprise LTSC 2019 (combined with a DP23 or a DP28)
OS language	English, Japanese
Processor	10th Gen Intel® Core™ i5 or later (or equivalent) (Recommended core: 4 or more, clock frequency: 3.2 GHz)
Memory	8 GB or more
Storage capacity to install software	1 GB or more
Graphic controller	Intel UHD Graphics 630 or higher
Monitor resolution	1366 × 768 or higher
USB interface	USB 2.0 Type-A x1 (for connecting to the AR tilting trinocular tube)
	USB 2.0 Type-A x1 (for the zoom magnification sensor)
	USB 3.1 Type-A x1 (for a DP23 and a DP28 camera)
Monitor interface	HDMI x1 (for connecting to the AR tilting trinocular tube)
	HDMI 1.4 or more
	HDMI connector: Type-A

SZX16

Research Stereo Microscope System

The SZX16 microscope is designed for very demanding applications with the ability to resolve 900 line pairs/mm. The full zoom range (0.7x–11.5x) can be expanded with our dual turret.

SZX16 slim design LED transmitted light illumination base SXZ2-ILLTQ combination

SZX16 Specifications

Zoom microscope body	Zoom ratio: 16.4:1 (0.7x–11.5x) Magnification indication: 0.7/0.8/1/1.25/1.6/2/2.5/3.2/4/5/6.3/8/10/11.5		
	Built-in AS zoom body, Objective mounting: screw mount		
Objective	SDFPLFL0.3x	NA 0.045	W.D. 141 mm
	SDFPLAPO0.5xPF	NA 0.075	W.D. 70.5 mm
	SDFPLAPO0.8x	NA 0.12	W.D. 81 mm
	SDFPLAPO1xPF	NA 0.15	W.D. 60 mm
	SDPLAPO1.6xPF	NA 0.24	W.D. 30 mm
	SDFPLAPO2xPFC	NA 0.3	W.D. 20 mm
Eyepiece	WHN10x-H: FN 22, WHSZ15x-H: FN 16, WHSZ20x-H: FN12.5, WHSZ30x-H: FN 7		
Observation tube Interpupillary distance adjustment: 52–76 mm	SZX2-TTR/SZX2-TTRPT: Tilting trinocular head Convergence angle, Tilting angle: 5°-45°, Light path select: 2 (TTR: Bi 100%, Bi 50%/Camera 50%. TTRPT: Bi 100%, Camera 100%)		
	SZX2-TR30/SZX2-TR30PT: 30-degree trinocular head Convergence angle, Tilting angle: 30°, Light path select: 2 (TR30: Bi 100%, Bi 50%/Camera 50%. TR30PT: Bi 100%, Camera 100%)		
Focusing assembly	SZX2-FO: Focusing unit (with torque adjustment) Coarse handle stroke: 80 mm, coarse handle stroke per rotation: 21 mm, load capacity: 0–10.0 kg		
	SZX2-FOF: Fine focusing unit (with torque adjustment) Coarse/fine handle stroke 80 mm, coarse handle stroke per rotation 36.8 mm, fine handle stroke: 80 mm, fine handle stroke per rotation: 0.77 mm, load capacity: 2.7–15.0 kg		
	SZX-FOA2: Motorized focus unit		
Stands	SZX-ST: Stand Pillar height: 270 mm (10.6 in.), base dimensions (W × D × H): 284 × 335 × 31 mm (11.2 × 13.2 × 1.2 in.)		
	SZX2-STL: Large stand Pillar height: 400 mm (15.7 in.), base dimensions (W × D × H): 400 × 350 × 28 mm (15.7 × 13.8 × 1.1 in.)		

SZX10

Research Stereo Microscopes System

The SZX10 microscope features a 10:1 zoom ratio (0.63x–6.3x) and is the logical choice when working distance and field size are important. Our careful system selection of lens design allows the observation and documentation of specimens in their original, authentic colors without distortion.

SZX10

SZX10 Specifications

Zoom microscope body	Zoom ratio: 10:1 (0.63x–6.3x) Magnification indication: 0.63/0.8/1/1.25/1.6/2.5/3.2/4/5/6.3		
	Built-in AS zoom body, Objective mounting: screw mount		
Objective	DFPL0.5x-4	NA 0.05	W.D. 171 mm
	DFPL0.75x-4	NA 0.075	W.D. 116 mm
	DFPLAPO1x-4	NA 0.1	W.D. 81 mm
	SZX-ACH1x	NA 0.1	W.D. 90 mm
	DFPLAPO1.25x	NA 0.125	W.D. 60 mm
	SZX-ACH1.25x-2	NA 0.125	W.D. 68 mm
	DFPL1.5x-4	NA 0.15	W.D. 45.5 mm
	DFPL2x-4	NA 0.2	W.D. 33.5 mm
Eyepiece	WHSZ10x-H: FN 22, WHSZ15x-H: FN 16, WHSZ20x-H: FN 12.5, WHSZ30x-H: FN 7		
Observation tube Interpupillary distance adjustment: 52–76 mm	SZX2-TTR/SZX2-TTRPT: Tilting trinocular head Convergence angle, Tilting angle: 5°-45°, Light path select: 2 (TTR: Bi100%, Bi 50%/Camera 50%. TTRPT: Bi 100%, Camera 100%)		
	SZX2-TR30/SZX2-TR30PT: 30 degree trinocular head Convergence angle, Tilting angle: 30°, Light path select: 2 (TR30: Bi 100%, Bi 50%/Camera 50%. TR30PT: Bi 100%, Camera 100%)		
	SZX-BI30 30° binocular head, SZX-BI45 45° binocular head, SZX-TBI tilting binocular head		
Focusing assembly	SZX2-FO: Focusing unit (with torque adjustment) Coarse handle stroke: 80 mm, coarse handle stroke per rotation: 21 mm, load capacity: 0–10.0 kg		
	SZX2-FOF: Fine focusing unit (with torque adjustment) Coarse/fine handle stroke 80 mm, coarse handle stroke per rotation 36.8 mm, fine handle stroke: 80 mm, fine handle stroke per rotation: 0.77 mm, load capacity: 2.7–15.0 kg (6–33 lb)		
	SZX-FOA2: Motorized focus unit		
Stands	SZX-ST: Stand Pillar height: 270 mm, base dimensions (W × D × H): 284 × 335 × 31 mm (11.2 × 13.2 × 1.2 in.)		
	SZX2-STL: Large stand Pillar height: 400 mm, base dimensions (W × D × H): 400 × 350 × 28 mm (15.7 × 13.8 × 1.1 in.)		

SZX7

Stereo Microscopes

The SZX7 stereo microscope features a 7:1 zoom ratio (0.8x to 5.6x) and built-in electro static discharge protection. It uses an advanced Galilean optical system, providing high-quality resolved images with easy access controls for comfortable viewing at an affordable price.

SZX7+SZX-BI45

SZX7+SZX2-TR30

SZX7 Specifications

Zoom microscope body SZX-ZB7 *Lead-free materials used*	Click stop for each zoom magnification: On/off switching possible Zoom ratio values: 7:1 (0.8x to 5.6x) Zoom magnification indication: 0.8, 1, 1.25, 1.6, 2, 2.5, 3.2, 4, 5, 5.6 Objective mounting: Screw mounting into thread		
	Aperture iris diaphragm control: The AS unit (SZX-AS) is mountable		
Observation tube SZX-BI45 SZX-TBI SZX-TR30	SZX-BI45	SZX-TBI/SZX2-TTR	SZX2-TR30
	Binocular tube View inclination angle 45° Lead-free materials used	Tilting binocular (trinocular) tube View tilting angle 5° to 45°	Trinocular tube View inclination angle 30° Light path selection:2 steps (Binocular 100%, Video 50%/Binocular 50%)
	Interpupillary distance adjustable range: 52 to 76 mm		

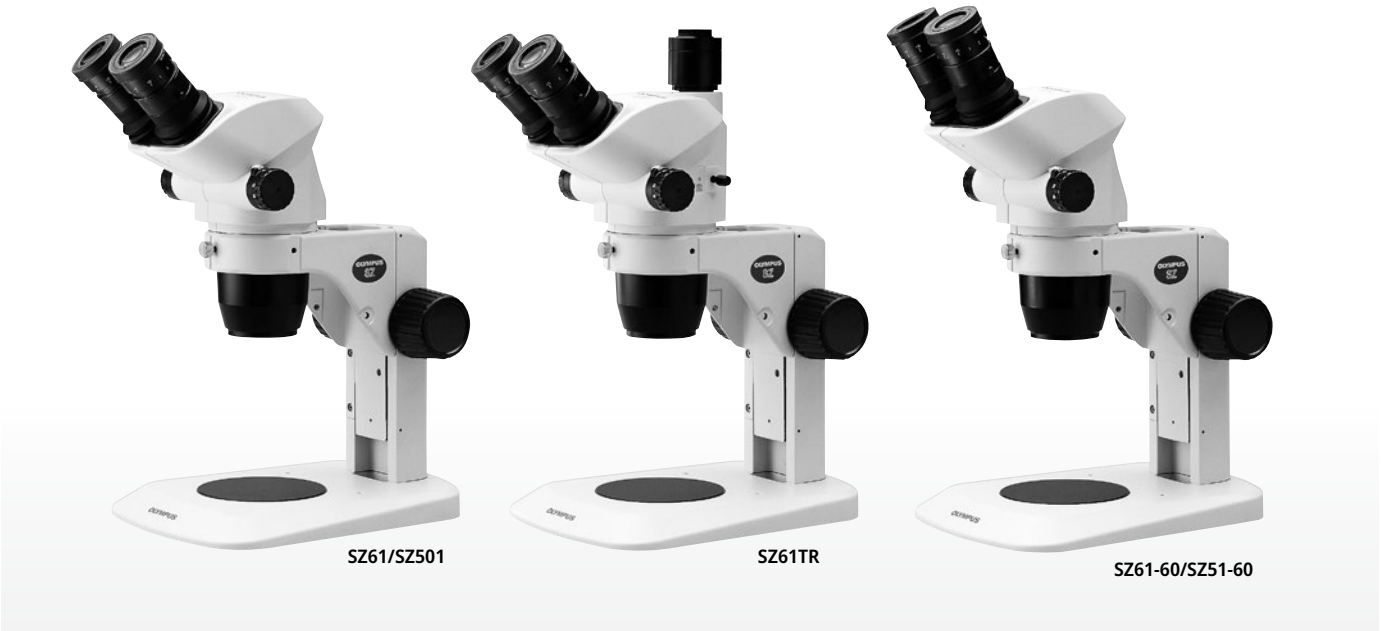
Stand SZ2-ST SZ2-ILST		SZ2-ST	SZ2-ILST
		Standard stand	LED reflected/transmitted illumination stand
	Frame installation	Mounting diameter: 76 mm	
	Focusing adjustment	Focusing stroke: 120 mm	
	Stage plate	SZ2-SPBW (Black and white for anti-ESD) SP-C (Clear glass plate)	The dedicated glass plate in 100 mm dia. included
	Light source	Compact light guide illuminator (SZ2-CLS) mountable (optional) Transmitted light illumination attachment (SZ2-ILA) mountable (option)	Transmitted illumination: LED Reflected illumination: LED Average LED life span: 6000 hrs. Input rating: 100–120 V/200–240 V ~ 0.15/0.1A, 50/60 Hz

Objective *All objectives: lead-free materials* * The SZ2-ET auxiliary sleeve is required when the SZ2-ST/SZ2-ILST is used.	Model	NA	Working Distance
	DFPL0.5x-4*	0.05	171 mm
	DFPL0.75x-4	0.075	116 mm
	DFPLAPO1x-4	0.10	81 mm
	DFPLAPO1.25x	1.25	60 mm
	SZX-ACH1x	0.10	90 mm
	SZX-ACH1.25x-2	0.125	68 mm
	DFPL1.5x-4	0.15	45.5 mm
	DFPL2x-4	0.20	33.5 mm
Eyepieces *All eyepieces: lead-free materials*	ComfortView WHSZ series		

SZ61/SZ51

Stereo Microscopes

The SZ61 and SZ51 microscopes deliver images with an excellent depth of field paired with clarity, detail, and true-to-life color as well as built-in ESD protection. Their dependable, high-performance optics are central to producing consistent, precise results.



SZ61/SZ501 SZ61TR SZ61-60/SZ51-60

SZ61/SZ51 Specifications

Microscope body SZ61 SZ61-60 SZ61TR SZ51 SZ51-60		SZ61	SZ61-60	SZ61TR	SZ51	SZ51-60
	Magnification	0.67X to 4.5X			0.8X to 4X	
	Zoom ratio	6.7: 1			5: 1	
	Working distance	110 mm				
	Tube inclination angle	45°	60°	45°	45°	60°
	Interpupillary distance adjustment	Left/right interlocked Adjustment range: 52 to 76 mm (using the WHSZ10X eyepieces)				
	Video camera adaptability	—	—	C-mount (0.5x built in)	—	—
	Zoom adjustment knob	Left/right single-shaft horizontal knob Interpupillary distance high/low magnification stopper incorporated				
	Optical components	Lead-free materials used				
Auxiliary objective		Mounting by screwing into the thread at the bottom of frame (M48 thread X 0.75)				
Eyepiece		ComfortView WHSZ series Lead-free materials used				

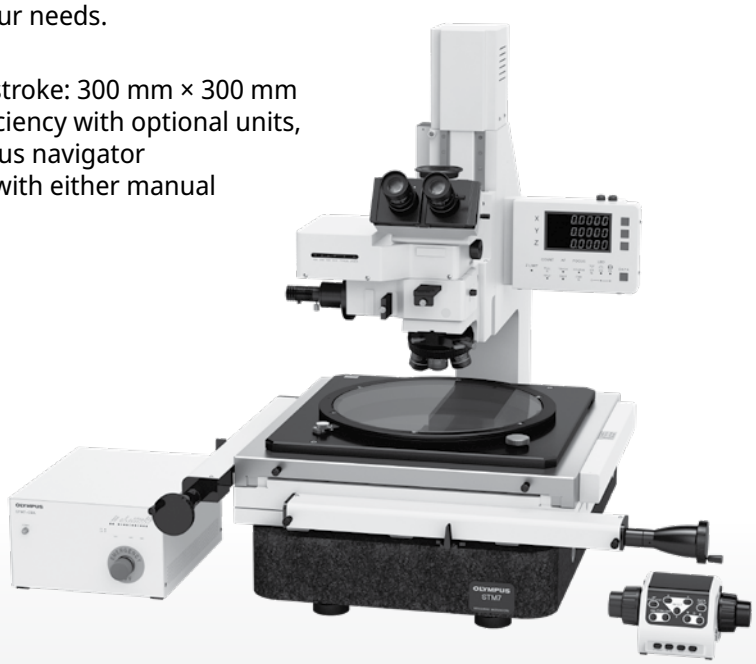
Stand SZ2-ST SZ2-ILST		SZ2-ST	SZ2-ILST
		Standard stand	LED reflected/transmitted illumination stand
	Frame installation	Mounting diameter: 76 mm	
	Focusing adjustment	Focusing stroke: 120 mm	
	Stage plate	SZ2-SPBW (Black and white for anti-ESD) SP-C (Clear glass plate)	The dedicated glass plate in 100 mm dia. included
	Light source	Compact light guide illuminator (SZ2-CLS) mountable (optional) Transmitted light illumination attachment (SZ2-ILA) mountable (optional)	Transmitted illumination: LED Reflected illumination: LED Average LED life span: 6000 hrs. Input rating: 100–120 V/200–240 V ~ 0.15/0.1 A, 50/60 Hz

STM7

Measuring Microscope

STM7 microscopes offer versatility and high-performance three-axis measurements of parts and electrical components with sub-micron precision. Whether samples are small or large, simple or complex, or measurements are being taken by a novice or an expert, the STM7 range features measuring microscopes tailored to fit your needs.

- Maximum measurement stroke: 300 mm × 300 mm
- Further improve work efficiency with optional units, such as autofocus and focus navigator
- Focus control is available with either manual or motorized operation



STM7 Specifications

			Manual type			Motorized type	
			Small stage	Midsize stage	Large stage	Midsize stage	Large stage
Microscope body			STM7-SF	STM7-MF	STM7-LF	STM7-MFA	STM7-LFA
Optical system			UIS2 optical system (Infinity-corrected)			UIS2 optical system (Infinity-corrected)	
Microscope frame	Observation method		BF/DF/DIC/KPO*1			BF/DF/DIC/KPO*1	
	Reflected/Transmitted		Reflected/Transmitted			Reflected/Transmitted	
	LED Illumination system		White: for reflected light illumination, green: for transmitted light illumination			White: for reflected light illumination, green: for transmitted light illumination	
	Focus	Stroke	175 mm		145 mm	175 mm	145 mm
		Maximum measurable height	120 mm (with measurement objective) 175 mm (with metallurgical objective)		120 mm (with measurement objective) 175 mm (with metallurgical objective)*2	120 mm (with measurement objective) 175 mm (with metallurgical objective)	120 mm (with measurement objective) 175 mm (with metallurgical objective)*2
		Z-axis measurement resolution	0.1 µm			0.1 µm	
		Z-axis drive method	Manual coaxial fine/coarse focusing knobs			Motorized • Focus button: Coarse movement speed 8 mm/s (max.) • Fine/coarse focusing knob: Fine focusing speed can be selected from 4 values (800 µm, 400 µm, 100 µm, 50 µm)	
	Objectives		Measuring objectives/Metallurgical objectives			Measuring objectives/Metallurgical objectives	
Observation tube			Erect image monocular tube, erect image trinocular tube (100:0/0:100)			Erect image monocular tube, erect image trinocular tube (100:0/0:100)	
Stage	Stroke		100 (X) × 100 (Y) mm	200 (X) × 200 (Y) mm	300 (X) × 300 (Y) mm	200 (X) × 200 (Y) mm	300 (X) × 300 (Y) mm
	Measurement accuracy (L: measuring length)		(3+2L/100) µm	(3+4L/200) µm	(3+6L/300) µm	(3+4L/200) µm	(3+6L/300) µm
	Accuracy assurance weight		6 kg (13.2 lb)	10 kg (22 lb)	15 kg (33 lb)	10 kg (22 lb)	15 kg (33 lb)
Counter display	Number of axes		Three			Three	
	Unit		µm/mm/inch/mil			µm/mm/inch/mil	
	Minimum resolution		0.1 µm			0.1 um	
Dimensions (W × D × H)			466 × 583 × 561 mm (18.3 × 23 × 22 in.)	606 × 762 × 651 mm (23.9 × 30 × 25.6 in.)	804 × 1024 × 686 mm (31.7 × 40.3 × 27 in.)	606 × 762 × 811 mm (23.9 × 30 × 31.9 in.)	804 × 1024 × 844 mm (31.7 × 40.3 × 33.2 in.)
Weight			84 kg (185.2 lb) (Approx.)	152 kg (335.1 lb) (Approx.)	277 kg (610.7 lb) (Approx.)	159 kg (350.5 lb) (Approx.)	284 kg (626.1 lb) (Approx.)

**1 Simple polarized light observation.*
**2 When using the large frame STM7-LF/STM7-LFA, a specimen whose height is 100 mm or less can be placed at the position backward from the light axis by 180 mm or more.*

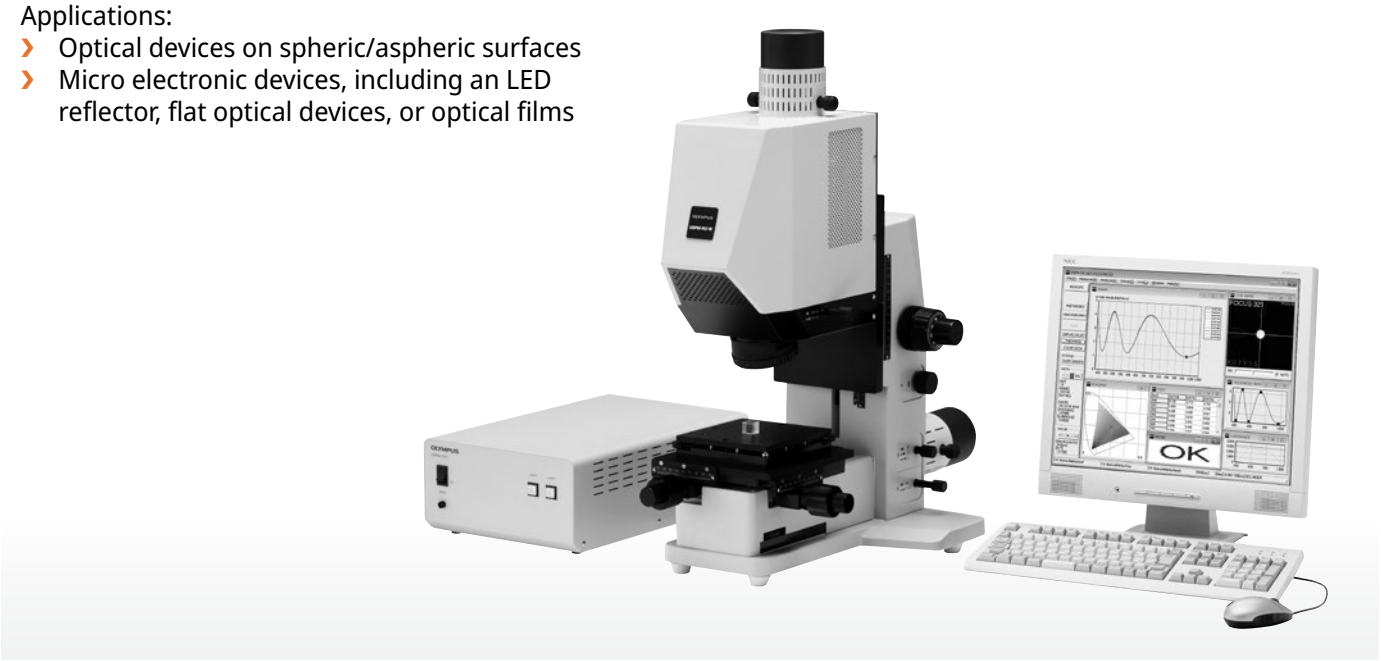
USPM-RU-W

NIR Micro-Spectrophotometer

Obtain spectrometry across of a wide range of wavelengths, from visible to near-infrared light (380–1050 nm). Take precise and fast measurements of curved surfaces and minute areas with a diameter of 17 to 70 µm. Spectral analysis software features an easy-to-use user interface.

Applications:

- Optical devices on spheric/aspheric surfaces
- Micro electronic devices, including an LED reflector, flat optical devices, or optical films



USPM-RU-W Specifications

	Reflectivity measurement			Transmissivity measurement*1	Reflectivity measurement for 45-degrees*1
Name	NIR Micro-Spectrophotometer			Transmittance measurement set for NIR Micro-Spectrophotometer	45-degree reflectance measurement set for NIR Micro-Spectrophotometer
Model	USPM-RU-W				
Measured wavelength	Compared with a reference sample for measurement			Transmissivity is measured with 100% as standard	Compared with a reference sample for measurement
Measurement method	Compared with a reference sample for measurement			Transmissivity is measured with 100% as standard	Compared with a reference sample for measurement
Measurement range	See the specifications of the objective below			Approx. 2.0 mm in diameter	
Measurement repeatability (3s)*2	Reflectivity measurement	During use of 10X and 20X objectives	0.02% or less (430 to 1010 nm)	0.3% or less (430 to 1010 nm)	
		During use of a 40X objective	0.2% or less (Except as described below) 0.05% or less (430 to 950 nm)	1.0% or less (Except as described above)	
	Film thickness measurement		±1%	—	
Lighting accessory	Dedicated halogen light source, JC12V 55 W (Average life: 700 hours)				
Shift stage	Loading surface size (W × D): 200 × 200 mm (7.9 × 7.9 in.), Operating range: (XY) 40 mm, (Z) 125 mm, With stand load: 3 kg (6.6 lb)				
Tilt stage	—			Loading surface size (W × D): 140 × 140 mm (5.5 × 5.5 in.), Withstand load: 1 kg, Operating range: (XT) 1°, (YT) 1°	
Weight	Main body: Approx. 26 kg (57.3 lb) (not including PC)			Main body: Approx. 31 kg (68.3 lb) (not including PC)*3	
	Control power box: Approx. 6.7 kg (14.8 lb)				
Dimensions (W × D × H)	Main body: Approx. 360 × 446 × 606 mm (14.2 × 17.6 × 23.9 in.)			Main body: Approx. 360 × 631 × 606 mm (14.2 × 24.8 × 23.9 in.)	
	Control power box: 250 (W) x 270 (D) x 125 (H) mm				
Power specifications	Input specifications: 100 to 240 VAC, 110 VA 50/60 Hz				
Operating environment	Horizontal place not subject to vibration, Temperature: 15 °C to 30 °C (59 °F to 86 °F)				

**1 Optional unit *2 Measured under the measurement conditions of our company. *3 The total combined weight of both the transmissivity measurement set and 45-degree reflectivity measurement set installed is approx. 33 kg (72.8 lb).*

Objective Specifications

Model	USPM-OBL10	USPM-OBL20	USPM-OBL40
Magnification	10X	20X	40X
Measurement NA*4	0.12	0.24	0.24
Measurement range*5	70 µm	35 µm	17.5 µm
Operating distance	14.3 mm	4.2 mm	2.2 mm
Radius of sample curvature	5 mm or more	1 mm or more	1 mm or more

**4 It differs from objective's NA *5 Spot diameter*

PRECiV

Imaging and Measurement Platform

Simple-to-use PRECiV™ software gives you control over your microscope so that you can perform precise, repetitive 2D measurements during production, quality control, and inspection operations. Obtain results that comply with the latest industrial standards and create professional reports that can be easily exported to your company's network. With robust data sharing and security features, PRECiV software makes your workflow faster and more efficient.

	Capture	Core	Pro	Desktop
Image Acquisition				
Basic image acquisition from our cameras, including auto calibration	✓	✓	✓	
Extended image acquisition, including HDR, Live HDR (with the DP75), and position navigator	✓	✓	✓	
Halation removal using the MIX slider (microscope) or LED ring light (stereo microscope)		✓	✓	
Extended Focal Image (EFI) using manual or instant mode		✓	✓	
Large-size image acquisition (panorama) using manual or instant mode		O	✓	
Combined EFI and panorama using manual mode		O	✓	
Image and customization tools				
Overlay information layer (scale bar, cross hair, digital reticle)	✓	✓	✓	
Static annotations	✓	✓	✓	✓
Live zoom	✓	✓	✓	
Measurements / Image Analysis				
Basic interactive measurements (arbitrary line, polyline, 3-point circle, rectangle, rotated rectangle, 3-point angle, 4-point angle, perpendicular line, parallel line distance, polygon area, XY distance, distance between two crosslines, circle-to-circle distance, linear ruler, point coordinates)	✓	✓	✓	✓
Advanced interactive measurement, including auto-edge detection and auxiliary lines (horizontal line, vertical line, angle ruler, 2-point circle, rotated ellipse, closed polygon, magic wand, interpolated polygon, multiple perpendicular lines, asymmetry lines, throat thickness)		O	✓	✓
Image enhancement filters (edge detection filters, smoothing filters, and sharpening filters), intensity and contrast adjustment, shading correction and backgroud subtraction, dynamic contrast enhancement, morphological filters		✓	✓	✓
Reporting				
Data export to our workbook	✓	✓	✓	✓
Data export to Microsoft Excel		✓	✓	✓
Report and presentation creation in Microsoft 365 or Office 2019, 2021		O	✓	✓
Device Support[*1]				
Our microscopes[*2] and cameras[*3]	✓	✓	✓	
3rd party SWIR camera		O	O	
3rd party motorized stages and encoded stage controllers[*4]		O	O	
Optional Add-Ons				
Count and Measure		O	O	O
Materials Solutions for PRECiV (e.g., Grain Sizing, Non-Metallic Inclusions, Cast Iron, Layer Thickness, Porosity, Particle Distribution, Coating Thickness, Phase Analysis, Dendrite Arm Spacing)		O	O	O
Motorization of X,Y,Z devices		O	O	
Acquisition of 3D images (z control only)		O	O	
Neural network training		O	O	O
Chart comparison on select standards for grain size, graphite sizing, non-metallic inclusions, and hardened metals		O	O	O
Customized software solutions		O	O	O
✓: Standard Feature; O :Optional Feature				

PC Requirements	
CPU	Intel Core i5, i7, i9
RAM / HDD	8 GB / 2.4 GB free space
Operating System	Windows 10 (64-bit); Editions: Pro. Pro for Workstations, Enterprise
.Net Framework	Version 4.6.2 or higher
Optimized resolution	1920 × 1080
License activation	By internet connection or code-based
Graphics card	64-bit graphics card with 2 GB RAM (compatible with CUDA 9.1 with special combinations)

Digital Microscope Cameras

Our digital microscope cameras are exclusively designed for use with our microscopes. All cameras provide their best digital imaging performance with our microscopes and image analysis software systems.

Note: Please refer to the Camera Overview catalog for detailed product information.

	DP75	DP28	DP23
Resolution (megapixels)	49.2	8.9	6.4
Imaging sensor size	1.1 in. Color CMOS	1 in. Color CMOS	1/1.8 in. Color CMOS
Pixel size (µm)	3.45 × 3.45	3.45 x 3.45	2.4 x 2.4
Exposure times	28µs – 120s	27 µs – 15 s	29 µs – 15 s
Dynamic range*1	12-bit	10-bit	10-bit
Live frame rates*2	60 to 22	64 to 30	60 to 30
IR cut filter	Switchable In: 400 nm ~ up to 650 nm Out: 400 nm~ up to 1000 nm	—	—
Dimensions (Ø × H)	116 mm × 92.3 mm (4.6 in. × 3.6 in.)	76.7 mm × 37.3 mm (3 in. × 1.5 in.)	76.7 mm × 37.3 mm (3 in. × 1.5 in.)
Weight (approx)	1400 g (49.4 oz)	380 g (13.4 oz)	380 g (13.4 oz)
3CMOS mode	Available	—	—
LiveHDR	Available	—	—
Camera mount	C-mount	C-mount	C-mount
Stand-alone	—	DP2-AOU	DP2-AOU
PC I/F	USB3.1 Gen2	USB 3.1	USB 3.1

*1 Analog-to-digital converter. The camera's actual bit depth depends on the software used. *2 Frame rate depends on the condition of your PC and/or software.

	DP23M *3	SC180	LC35 *4
Resolution (megapixels)	6.4	18.0	3.5
Sensor size and type	1/1.8 in. Backside illuminated monochrome CMOS	1/2.3 in. Color CMOS	1/1.2 in. Color CMOS
Pixel size (µm)	2.4 x 2.4	1.25 x 1.25	2.64 × 2.64
Exposure times	0.013 ms – 25 s	22 µs – 1 s	25 µs - 1.5 s
Dynamic range*1	10-bit	12-bit	10-bit
Live frame rates*2	60 to 45	59 to 10.5	49 to 10
IR cut filter	—	—	—
Dimensions (Ø × H)	—	58 mm × 32 mm (2.3 in. × 1.3 in.)	—*5
Weight (approx)	380 g (13.4 oz)	188 g (6.6 oz)	33 g (1.16 oz)
3CMOS mode	—	—	—
LiveHDR	—	—	—
Camera adaptor	C-mount	C-mount	C-mount
Stand-alone	—	—	—
Camera I/F	USB 3.1	USB 3.0	USB 3.1

*1 Analog-to-digital converter. The camera's actual bit depth depends on the software used.
*2 Frame rate depends on the condition of your PC and/or software.
*3 PRECiV v1.1 or higher required.
*4 PRECiV v1.1: service update required.
*5 Unlike other cameras, the LC35 is not cylindrical. Dimensions (H × W × H): 47 mm x 46 mm x 24 mm (1.9 in x 1.7 in x 1.2 in).

UIS2 Objectives

Universal Infinity System

UIS2 optical characteristics for industrial and metallurgical applications.

MPLAPON series
This is a plan-apochromat objective series for brightfield observation with chromatic aberration corrected at a high level. We have realized optical performance (wavefront aberration) with a Strehl ratio*1 of 95% or more*2 with this series.

This series is also compatible with differential interference contrast or simple polarized observation.

MPLAPON100xO
This is an oil-immersion plan-apochromat objective*3 that features a numerical aperture of 1.45. It provides our highest level of chromatic aberration correction and a high resolving power.

MXPLFLN(-BD) series
MXPLFLN objectives add depth to the MPLFLN series for epi-illumination imaging by offering simultaneously improved numerical aperture and working distance.

MPLFLN (-BD) series
These plan semi-apochromat objectives eliminate chromatic aberration at a high level, which is helpful for a wide range of microscopic methods, including brightfield, darkfield, fluorescence, Nomarski DIC*4, and simple polarized observation. All 50X or higher objectives have a 1 mm working distance to minimize the risk of collision between the objective and sample. Since the exit pupil position of the 5X–150X objectives is standardized, the position of the DIC prism does not have to be switched when changing the magnification.

MPLFLN-BDP series
The plan semi-apochromat polarization design realizes thorough compensation for coma aberration. Distortion is also minimized, making these objectives the most appropriate choice in the UIS2 series for Nomarski DIC microscopy.

SLMPLN series
This super-long working distance plan achromat series minimizes the risk of collision between the sample and the objective. It also delivers high-contrast imaging.

LMPLFLN (-BD) series
This series of long working distance plan semi-apochromat objectives provides high-level correction for chromatic aberration and are suitable for observing samples with height or varying topography. Since the exit pupil position of the 5X–100X objectives is standardized, the position of the DIC prism does not have to be switched when changing the magnification. Use the BD series in brightfield and darkfield observation.

MPLN (-BD) series
Plan achromat objectives with excellent flatness up to OFN 22. Use the BD series in brightfield and darkfield observation.

LCPLFLN-LCD series
These objectives are designed for making observations through LCD panels and other samples that have a glass substrate. The correction collar provides aberration correction that can be matched to the thickness of the glass.

LMPLN-IR, LCPLN-IR series
Objective series designed for near-infrared microscopy to view the internal structure in silicon wafers. The LCPLN-IR series has correction collars for aberration depending on the thickness of the silicon or glass substrate.

Objectives	Magnifications	NA	W.D. (mm)	Cover Glass Thickness*5 (mm)	Silicon Thickness (mm)*12	Resolution*6 (μm)
MPLAPON	50X 100X	0.95 0.95	0.35 0.35	0 0	--- ---	0.35 0.35
MPLAPON2	100XOil*3	1.45	0.1	0	---	0.23
MXPLFLN	20X 50X	0.6 0.8	3 3	0 0	--- ---	0.56 0.42
MXPLFLN-BD*9	20X 50X	0.55 0.8	3 3	0 0	--- ---	0.61 0.42
MPLFLN	1.25X*7*8 2.5X*8 5X 10X 20X 40X*4 50X 100Xx	0.04 0.08 0.15 0.30 0.45 0.75 0.80 0.90	3.5 10.7 20.0 11.0 3.1 0.63 1.0 1.0	— — — — 0 0 0 0	--- --- --- --- --- --- --- ---	8.39 4.19 2.24 1.12 0.75 0.45 0.42 0.37
MPLFLN-BD*9	2.5X 5X 10X 20X 50X 100X 150X	0.08 0.15 0.30 0.45 0.80 0.90 0.90	8.7 12.0 6.5 3.0 1.0 1.0 1.0	— — — 0 0 0 0	--- --- --- --- --- --- ---	4.19 2.24 1.12 0.75 0.42 0.37 0.37
MPLFLN-BDP*9	5X 10X 20X 50X 100X	0.15 0.25 0.40 0.75 0.90	12.0 6.5 3.0 1.0 1.0	— — 0 0 0	— — — — —	2.24 1.34 0.84 0.45 0.37
SLMPLN	20X 50X 100X	0.25 0.35 0.6	25 18 7.6	— 0 0	— — —	1.34 0.96 0.56
LMPLFLN	5X 10X 20X 50X 100X	0.13 0.25 0.40 0.50 0.80	22.5 21.0 12.0 10.6 3.4	— — 0 0 0	— — — — —	2.58 1.34 0.84 0.67 0.42
LMPLFLN-BD*9	5X 10X 20X 50X 100X	0.13 0.25 0.40 0.50 0.80	15.0 10.0 12.0 10.6 3.3	— — 0 0 0	— — — — —	2.58 1.34 0.84 0.67 0.42
MPLN*7	5X 10X 20X 50X 100X	0.10 0.25 0.40 0.75 0.90	20.0 10.6 1.3 0.38 0.21	— — 0 0 0	--- --- --- --- ---	3.36 1.34 0.84 0.45 0.37
MPLN-BD*7*9*10	5X 10X 20X 50X 100X	0.10 0.25 0.40 0.75 0.90	12.0 6.5 1.3 0.38 0.21	— — 0 0 0	— — — — —	3.36 1.34 0.84 0.45 0.37
LCPLFLN-LCD	20X 50X 100X	0.45 0.70 0.85	8.3 – 7.4 3.0 – 2.2 1.2 – 0.9	0 – 1.2 0 – 1.2 0 – 0.7	--- --- ---	0.75 0.48 0.39
LMPLN-IR*7	5X 10X	0.1 0.3	23 18	— —		6.71*11 2.24*11
LCPLN-IR*7	20X 50X 100X	0.45 0.65 0.85	20X Glass:8.38 - 7.63 Silicon:8.38 - 7.07 50X Glass:4.50 - 3.76 Silicon:4.50 - 4.20 100X Glass:1.20 - 0.90 Silicon:1.20 - 1.05	0 – 1.2 0 – 1.2 0 – 0.7	0 – 1.2 0 – 1.2 0 – 1.0	1.49*11 1.03*11 0.79*11

*1 Strehl ratio: When the light condensing ratio (central intensity) on the image field of an ideal aplanatic optical system is assumed as 100%, a light condensing ratio in % that an actual optical system can condense is known as Strehl ratio. The greater is this numeric value, the better becomes the quality of an optical system.

*2 Strehl Ratio is guaranteed by the following conditions. •Measurement : Transmitted Wavefront Interferometer (Evident in-house equipment) •Temperature : 23 ± 1 centigrade •Measurement Area : 97% in pupil diameter

*3 Specified oil: IMMOIL-F30CC

*4 The MPLFLN40x objective is not compatible with the differential interference contrast microscopy.

*5 — : Applicable to the view of specimens with/without a cover glass
0 : Applicable to the view of specimens without a cover glass

*6 Resolutions calculated with aperture iris diaphragm wide open.

*7 Limited up to OFN 22. No compliance with OFN 26.5.

*8 Analyzer and polarizer are recommended for use with MPLFLN1.25x or 2.5x.

*9 BD: Brightfield/darkfield objectives

*10 Slight vignetting may occur in the periphery of the field when MPLN-BD series objectives are used with high-intensity light sources such as mercury and xenon for darkfield observation.

*11 With the use of 1100 nm laser.

*12 --- Not applicable.

UIS2 Eyepieces

Universal Infinity System

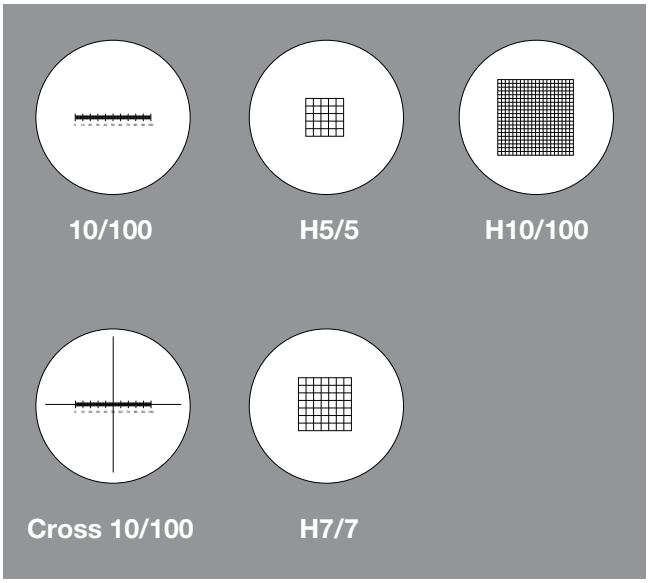
UIS2 Eyepiece Specifications

Product	FN	Diopter (1/m)	Micrometer (mm)	Remarks
WHN10x	22	—	24	—
WHN10x-H	22	-8 – +5D	24	with helicoid
CROSS WHN10x	22	-8 – +5D	—	with cross, helicoid
WH15x	14	—	24	—
SWH10x-H	26.5	-8 – +2	—	with helicoid
MICRO SWH10x	26.5	-8 – +2	—	with micrometer, helicoid
CROSS-SWH10x	26.5	-8 – +2	—	with cross, helicoid

OC-M

Micrometer Reticles (ø24 mm)

When the OC-M is inserted into the WHN10x eyepiece field iris diaphragm, the length of the specimen within the field of view can be measured.
Various types are available, depending on the specimen.



OC-M Specifications

10/100	10 mm in 100 divisions
Cross 10/100	10 mm in 100 divisions on crosslines
H5/5	5 mm in 5 divisions in grid pattern
H7/7	7 mm in 7 divisions in grid pattern
H10/100	10 mm in 100 divisions in grid pattern

Optical Terminology

1. Field Number (FN) and Practical Field of View

The field number (FN) is referred to as the diaphragm size of the eyepiece in mm, which defines the specimen's image area.
The diaphragm diameter actually seen through the eyepiece is known as the practical field of view (FOV), which is determined by the formula:

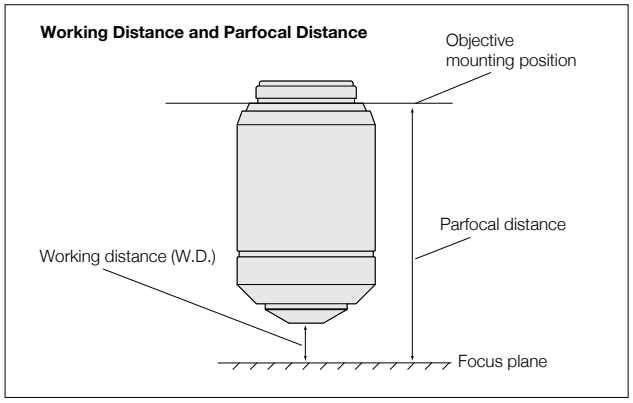
$$FOV = \frac{\text{Eyepiece FN}}{\text{Objective magnification}} \text{ (mm)}$$

2. Working Distance (W.D.)

The distance between the front edge of the objective and the specimen surface (with the surface of the cover glass in the case of a cover glass objective) when the specimen is focused.

3. Parfocal Distance

The distance between the objective mounting plane and the specimen. In UIS2 objectives, the parfocal distance is designed at 45 mm.



Parfocal distances of the LCPLFLN-LCD and LCPLN-IR series are changed by the thickness of the cover glasses or silicon films on samples.

4. Relationship between the objective's focal length and magnifications

Indicated magnifications of UIS2 objectives are the values when the focal length of the tube lens is 180 mm.

$$M_{(ob)} = \frac{\text{Focal length of tube lens}}{f}$$

$M_{(ob)}$: Objective magnification
f: Objective's focal length

5. Total Magnification

5.1 Observation through eyepiece (binocular observation)

$$M_{(bin)} = M_{(ob)} \times M_{(oc)}$$

$M_{(bino)}$: Total magnification for binocular observation
$M_{(ob)}$: Objective magnification
$M_{(oc)}$: Eyepiece magnification

5.2 Video Monitor observation

- Total magnification for video monitor

$$M_{(monitor)} = M_{(ob)} \times M_{(camera\ adapter)} \times \text{Monitor magnification*}$$

$M_{(monitor)}$: Total magnification on the monitor
$M_{(ob)}$: Objective magnification
$M_{(camera\ adapter)}$: Projected magnification for camera adapter *(refer to Table 1)*
** Refer to Table 3 for "Monitor magnification"*

- Practical field of view for monitor observation

$$\text{Practical field of view for monitor observation} = \frac{\text{Image device size*}}{M_{(ob)} \times M_{(camera\ adapter)}}$$

M (ob): Objective magnification
M (camera adapter): Projected magnification for camera adapter including photo eyepiece *(refer to Table 1 for projected magnifications)*
** Refer to Table 2 for image device size*

Table 1 Camera adapter and projection magnifications

Video camera adapter (projection lens)	Projection magnifications
U-TV1XC	1X
U-TV1X + camera mount adapters	1X
U-TV0.63XC	0.63X
U-TV0.5XC	0.5X
U-TV0.35XC	0.35X

Table 2 Imaging device size

Camera format	Diagonal	Horizontal	Vertical
1/3 inch	6.0 mm	4.8 mm	3.6 mm
1/2 inch	8.0 mm	6.4 mm	4.8 mm
2/3 inch	11.0 mm	8.8 mm	6.6 mm

The above table is for standard image device sizes.
Check your device size for precise calculation.

Table 3 Imaging device size and monitor magnifications

Camera format	Monitor size (diagonal)				
	10 inch	15 inch	17 inch	19 inch	21 inch
1/3 inch	42.3X	63.5X	72.0X	80.4X	88.9X
1/2 inch	31.8X	47.6X	54.0X	60.3X	66.7X
2/3 inch	23.1X	34.6X	39.3X	43.9X	48.5X

Example
What is the total magnification of a monitor when a 50X objective, U-TV0.5XC camera adapter, 2/3 in. camera, and 21 in. monitor are used?

•Total magnification on the monitor:
$M_{(ob)}$ = 50X, $M_{(video\ camera\ adapter)}$ is 0.5X from Table 1, and the monitor magnification is 48.5X from Table 3.
$M_{(monitor\ observation)} = M_{(ob)} \times M_{(video\ camera\ adapter)}$ × monitor magnification = 50 × 0.5 × 48.5 = 1213X

•Practical field of view for observation (horizontal side):
$M_{(ob)}$ = 50X, $M_{(camera\ adapter)}$ is 0.5X from Table 1, and the horizontal side of a 2/3 in. imaging device is 8.8 mm from Table 2.

$$\text{Practical field of view for observation} = \frac{\text{Image device size}}{M_{(ob)} \times M_{(video\ camera\ adapter)}}$$

$$= \frac{8.8\ (\text{mm})}{50 \times 0.5} = 352\ \mu\text{m}$$

6. Numerical Aperture (NA)

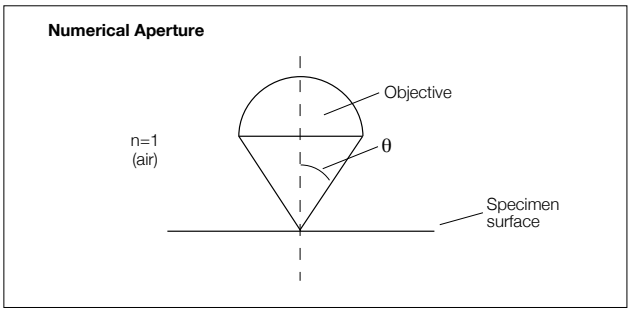
The numerical aperture is a key factor to the performance of an objective (resolving power, depth of field, and brightness). The NA is determined by the following formula:

$$NA = n \times \sin\theta$$

n=Refraction rate of the medium between the specimen and objectives. (Air: n=1, oil: n=1.515)
θ: Angle which is made by the optical axis and refraction of the light farthest from the center of the lens.

The visual field brightness (B) of the microscope is determined by the following formula in relation to the objective magnification (M). The larger the NA and the lower the objective magnification, brightness will increase in the factor of the second power.

$$B \propto \frac{NA\ 2}{M\ 2}$$



7. Resolving Power

The resolving power of an objective is measured by its ability to differentiate two lines or points in an object. The greater the resolving power, the smaller the minimum distance between two lines or points that can still be distinguished. The larger the NA, the higher the resolving power.

●Resolving power formula
The following formula is generally used for determing resolution.

$$\varepsilon = 0.61 \times \frac{\lambda}{NA}\ \text{(Reyleigh formula)}$$

λ: Wavelength or radiation in use
(λ=0.55 μm is used for visible light)
NA: Objective NA

Example
MPLFLN100 × (NA=0.90), λ=0.55 μm

$$\varepsilon = 0.61 \times \frac{\lambda}{NA} = \frac{0.3355}{NA} = \frac{0.3355}{0.90} = 0.37\ \mu\text{m}$$

8. Microscope Depth of Field

The depth of field refers to the depth of the specimen layer that is in sharp focus at the same time, even if the distance between the objective and the specimen plane using a changed when observing and shooting the specimen plane by microscope. As human eyes are different in their focus adjustment abilities, each person's perception of the depth of field varies.
At present, the Berek formula is generally used, because it gives a depth of field value that often coincides with that obtained through experiments.

Depth of Field Formula

●Visual observation (Berek formula)

$$\pm \text{DOF} = n\left(\frac{\omega \times 250{,}000}{\text{NA} \times M} + \frac{\lambda}{2\,(\text{NA})^2}\right)\ (\mu m)$$

DOF: Depth Of Field

ω: Resolving power of eyes 0.0014
(visual angle 5 arc minutes)
M: Total magnification
(objective magnification x eyepiece magnification)

$$\rightarrow \pm \text{DOF} = n\left(\frac{350}{\text{NA} \times M} + \frac{0.275}{\text{NA}\ 2}\right)\ (\lambda = 0.55\ \mu m)$$

This indicates that the depth of field becomes smaller as the numerical aperture becomes larger.

Example
With MPLFLN100× (NA =0.90), WHN10×:

$$\pm \text{DOF} = 1 \times \left(\frac{350}{0.90 \times 1{,}000} + \frac{0.275}{0.81}\right) = 0.39 + 0.34 = 0.73\ \mu m$$

●Camera
In the case of a camera, the depth of field will vary according to the number of pixels of the camera, optical magnification, and numerical aperture. The above-mentioned formula is used as a rough guide only.

9. Aberrations

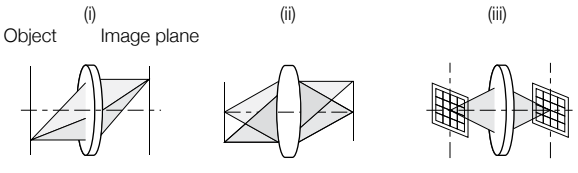
A difference between an ideal image and an actual image that passes through an optical system is called an aberration.

9.1 Requirements for Ideal Image Formation

The following three requirements must be satisfied to form an image with no aberration, or an ideal image.

(i) All the light rays coming from a single point and passing through an image formation optical system converge on a single point.
(ii) Image points, which correspond to object points on the same plane perpendicular to the optical axis, are present on the same plane.
(iii) The planar shape of an object and the planar shape of an image that are on the same plane perpendicular to the optical axis have a similarity relation.

Figure 9-1 Requirements for Ideal Image Formation



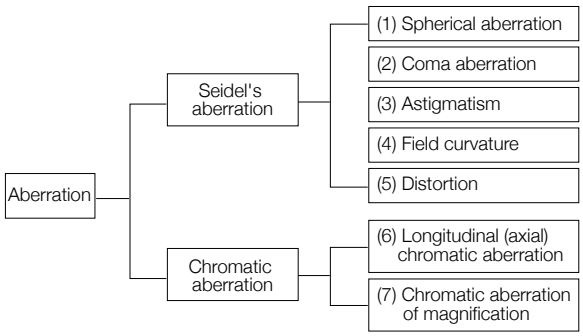
In an actual optical system, however, it is very difficult to strictly meet the requirements for ideal image formation, and this causes aberrations that interfere with image forming performance.

9.2 Classification of Aberrations

Aberrations that interfere with image forming performance are classified as shown below in Figure 9-2.

Seidel's aberration = "Expansion of a point image" + "Curvature of image plane" + "Deformation"

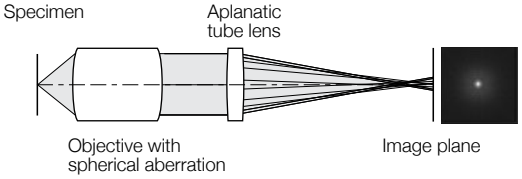
Figure 9-2 Classification of Aberrations



Types (1) to (3) correspond to "expansion of a point image" that goes against requirement (i) for ideal image formation in Figure 9-1. Type (4) corresponds to "curvature of image plane" that goes against requirement (ii) in Figure 9-1. Type (5) corresponds to "deformation" that goes against requirement (iii) in Figure 9-1.
Types (6) and (7) correspond to "color blur" of images caused by characteristics of glass materials used for the optical system.
"Expansion of a point image" can also be expressed by wavefront aberration, which regards the light as waves and takes account of the phase to include the influence of diffraction.

(1) Spherical aberration
When light rays coming out of an axial object point enter a lens, the light rays with a larger numerical aperture (NA) are subjected to stronger refraction power and cross the optical axis in positions with larger differences from the ideal image formation position. The aberration caused this way by different image forming positions due to differences in NA of axial light rays is called spherical aberration. Spherical aberration is proportional to the cube of NA.

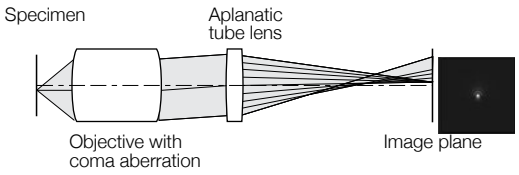
Figure 9-3 Spherical Aberration



It is said that objectives with a larger NA have better resolution but worse spherical aberration. Our advanced design and manufacturing techniques have realized good optical performance, even with a large numerical aperture.

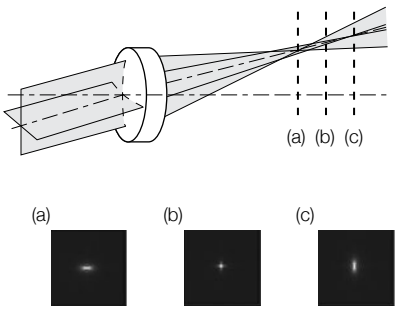
(2) Coma aberration
Even though spherical aberration is compensated to be very small, there are cases where light rays coming out of an off-axis object point are not condensed to a single point on the image plane but generate asymmetric blur just like a comet leaving traces. This is called coma aberration.

Figure 9-4 Coma Aberration and Spot Shape on the Image Plane



(3) Astigmatism
Even though a lens is compensated for spherical aberration and coma aberration, there are cases where an image of an off-axis object point is not focused to a single point but separated to a concentric line image and a radial line image. This is called astigmatism. When astigmatism is present, a point image blurs vertically and horizontally, before and after the focus position.

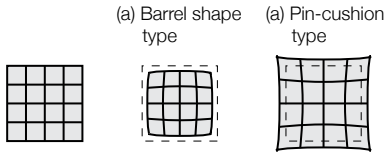
Figure 9-5 Astigmatism and Change in Spot Shape in Different Focus Positions



(4) Field curvature
An image plane of an object on a plane perpendicular to an optical axis does not always become a plane perpendicular to the optical axis, but it generally becomes a curved plane. This symptom is called "field curvature."
When field curvature is present, the image is more displaced as it becomes closer to the periphery of the visual field. Therefore, when the center of an image is brought into focus, blur occurs in the peripheral areas of the image. To bring the entire image, including the periphery, into clear focus, it is necessary to adequately compensate for this type of aberration.

(5) Distortion
When there is no similar relation between a planar shape on an object and a shape on the image plane, this is called "distortion." When distortion is present, a square image appears in the shape of a barrel or pin-cushion as shown in Figure 9-6.

Figure 9-6 Distortion



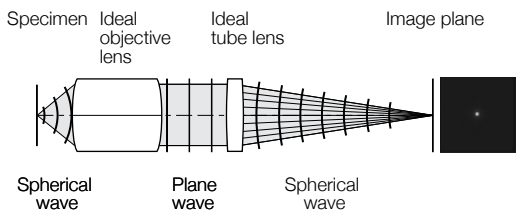
The microscope optical system contains some distortion. When distortion is present, it can bring erroneous results of shape measurements. When a microscope is used for precision measurements, pay close attention to this aberration, for example, by providing it with an aberration compensation function.

(6) Chromatic aberration
Glasses used for optical systems have different refractive indexes depending on the wavelength. This causes differences in focal length between wavelengths and generates displacement of image forming position. This phenomenon is called chromatic aberration, which is sometimes subdivided into axial displacement on the optical axis, called axial chromatic aberration (or lateral chromatic aberration) and displacement on the image plane, called chromatic aberration of magnitude.
Many special glass materials are used, e.g., for apochromats (our MPlanApo objectives), to eliminate chromatic aberration in a wide range from violet light (g-rays with wavelength of 435 nm) to red light (c-rays with wavelength of 656 nm).

9.3 Wavefront aberration

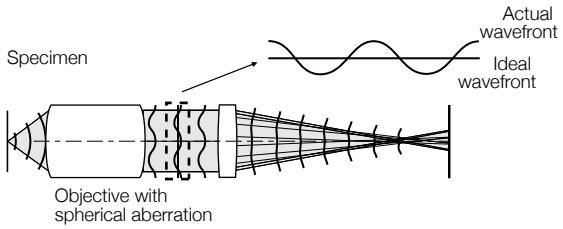
For many years, aberrations have been used in geometric optics, which considers light as light rays. Microscope optical systems are often used for observation of very small specimens at a wavelength level and sometimes wave optics, which regards light as waves and handles the phase information, taking account the influence of diffraction. In such a case, wavefront aberration is used for evaluation. As shown below, when the requirements for ideal imaging are satisfied in a microscope optical system, the spherical wavefront (spherical waves) coming from a single point on an object (specimen) is converted to plane waves through an ideal objective. The plane waves are converted to spherical waves through an ideal tube lens and condensed to a single point. The wavefront of these waves is called the ideal wavefront.

Figure 9-7 Ideal Microscope Optical System



Based on the figure indicated for (1) spherical aberration, the behavior of the wavefront in an optical system that has an aberration is described below.

Figure 9-8 Illustration of Wavefront Aberration

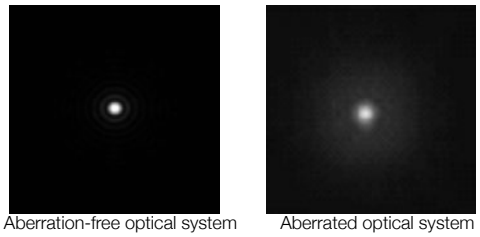


A difference (a degree of disagreement) between the ideal wavefront and the actual wavefront shown above is called wavefront aberration.

9.4 Strehl ratio

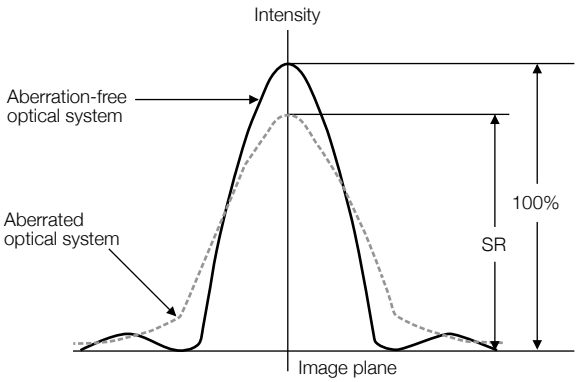
When a point light source is observed with an aberration-free optical system and an aberrated optical system, the former concentrates the focal point to a point at the image formation position. In contrast, the latter fails to produce a focal point, instead causing a spread in the intensity distribution of the point image (this is known as point spread). The specific appearance of such a point image (i.e. point spread) is shown in Fig. 9-9.

Figure 9-9 Appearance of Condensed Light in the Image Plane (Point Spread)



With the proportion of light concentrated in the image plane (intensity of light concentrated in the Airy disk) by an aberration-free optical system serving as 100%, the proportion of light concentrated by an aberrated optical system is known as the Strehl ratio. When graphed, the Strehl ratio reveals peaks in intensity as shown in Fig. 9-10. The higher the SR, the closer an optical system is to being aberration-free.

Figure 9-10 Strehl Ratio (SR)



A Strehl ratio of 80% is typically called the diffraction limit, and lenses with a lower ratio lack the performance required to serve as an objective. A ratio of over 95% means that the lens' performance in general observations is comparable to that of an aplanatic lens (which is corrected for spherical aberrations and coma).
Note: A laser interferometer is used for actual assessment of optical performance, so assessment is done at a single wavelength. Unless otherwise noted, Strehl ratio measurements are at the e-line (544 nm).