OLYMPUS®

Your Vision, Our Future

Microscope General Catalog

FOR INDUSTRIAL USE

3D Measuring Laser Microscope

Semiconductor/FPD Inspection Microscopes

Wafer Loader

Metallurgical Microscopes

Stereo Microscopes

Measuring Microscopes

Digital Cameras

Image Analysis Software

- **OLYMPUS CORPORATION has obtained the ISO9001/ISO14001.**
- **Illumination devices for microscope have suggested lifetimes. Periodic inspections are required. Please visit our web site for details.**

OLYMPUS®

www.olympus.com

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Technology is quickly progressing in fields such as those related to semiconductors, FPDs and electronic equipment. As the demands of industry become more specialized and diversified, the capabilities of research and inspection equipment must keep pace.

Olympus microscopes and their accessories are developed to meet the ever-changing needs of research and inspection applications. Our accomplishments in microscope development date back more than eighty years. Olympus has accumulated a broad range of advanced optical and precision technologies and we are renowned for our innovative, forward looking approach to microscopy. An outstanding example of Olympus ingenuity is the superior UIS2 infinity-corrected optical system. Olympus has also won acclaim for its system versatility and broad range of advanced accessories.

Our microscopes are evolving with enhanced performance and operational ease. Olympus continues to answer the demands of industry and pave the way for future advances with increasingly sophisticated research and inspection equipment.

Contents

*There might be some differences in product dependent on area of purchase.

UIS2 infinity-corrected optical system

The advanced Olympus UIS2 optical system maximizes the advantages of infinity correction.
Light travels through the body tube as parallel rays as it passes through the objective lens. These are focused by the tube lens to form a completely aberration-free intermediate image. Attachments can be added between the objective lens and the built-in tube lens in the observation tube without any magnification factor alterations to total magnification. Additional correction lenses are not required.
The UIS2 optical system delivers optimum image quality with any configuration.

LEXT™

UIS2 World-leading optics

OLS4000 3D Measuring Laser Microscope

Designed for nanometer level imaging and measurement, the LEXT OLS4000 provides the first guaranteed accuracy specification in a laser confocal microscope. The creation of a Dual Confocal system allows this system to image and measure up to 85-degree slopes and image samples with both high and low reflectivity levels. **The LEXT OLS4000 is a class 2 laser product.*

OLS4000 Specifications

LSM section		Light source/Detector	Light source: 405 nm semiconductor laser, Detector: Photomultiplier
		Total magnification	108x – 17,280x
		Zoom	Optical zoom: 1x – 8x
Measurement	Planar measurement	Repeatability	100x: $3\sigma_{n-1}$=0.02 µm
		Accuracy	Measurement value ±2%
	Height measurement	System	Revolving nosepiece vertical-drive system
		Stroke	10 mm
		Scale resolution	0.8 nm
		Display resolution	1 nm
		Repeatability	50x: σ_{n-1}=0.012 µm
		Accuracy	0.2±L/100 µm or less (L=Measuring Length µm)
Color observation section		Light source/Detector	Light source: White LED, Detector: 1/1.8-inch 2-megapixel single-panel CCD
		Zoom	Digital zoom: 1x - 8x
Revolving nosepiece			Motorized BF sextuple revolving nosepiece
Differential Interference Contrast unit			Differential Interference Contrast slider: U-DICR, Polarizing plate unit built-in
Objective lens			BF Plan Semi-apochromat 5x, 10x LEXT-dedicated Plan Apochromat 20x, 50x, 100x
Z Focusing unit stroke			100 nm
XY stage			100 x 100 nm (Motorized stage), Option: 300 x 300 nm (Motorized stage)

This device is designed for use in industrial environments for the EMC performance (Class A device). Using it in a residential environment may affect other equipment in the environment.

Objective lens

Model	Magnification	Field of view	Working Distance (WD)	Numerical Aperture (NA)
MPLFLN5x	108x – 864x	2,560 – 320 µm	20.0 mm	0.15
MPLFLN10x	216x – 1,728x	1,280 – 160 µm	11.0 mm	0.30
MPLAPON20xLEXT	432x – 3,456x	640 – 80 µm	1.0 mm	0.60
MPLAPON50xLEXT	1,080x – 8,640x	256 – 32 µm	0.35 mm	0.95
MPLAPON100xLEXT	2,160x – 17,280x	128 – 16 µm	0.35 mm	0.95

UIS2 World-leading optics

U-UVF248

Deep Ultraviolet Observation System for Microscope

High-magnification DUV real-time observation just by adding a new module to a new or existing Olympus Microscope.

U-UVF248+MX61 configuration

U-UVF248 Specifications

UV248 compatible intermediate tube U-UVF248IM	DUV optics	Wavelength	248±4 nm
		Light source	80 W mercury xenon lamp
		Objective lens	Special DUV100x objective lens/ NA 0.9 WD 0.2 mm
		Intermediate magnification	2.5x
		Field number	12.5 (actual view field 50 µm)
		Usage environment	23±5°C
	Visible optics	Objective lens	UIS2 objective lens
		Intermediate magnification	1x
		Field number	22 (camera observation 20)
UV248 compatible light source box U-UVF248LB		Brightness adjustment	Manual adjustment from 0 to 100%
		Shutter	Up-down lever switch
UV quartz light guide U-UVF2FB/5FB		Length of 2 or 5 m	
Mercury xenon lamp housing		80 W mercury xenon lamp	
Power supply		Ushio product (100-120 V)	

DUV image capture

DUV camera	KP-F140UVF (Hitachi Kokusai Electric) High-resolution DUV digital camera
	SXGA 1360 (H) x 1024 (V)

Microscope

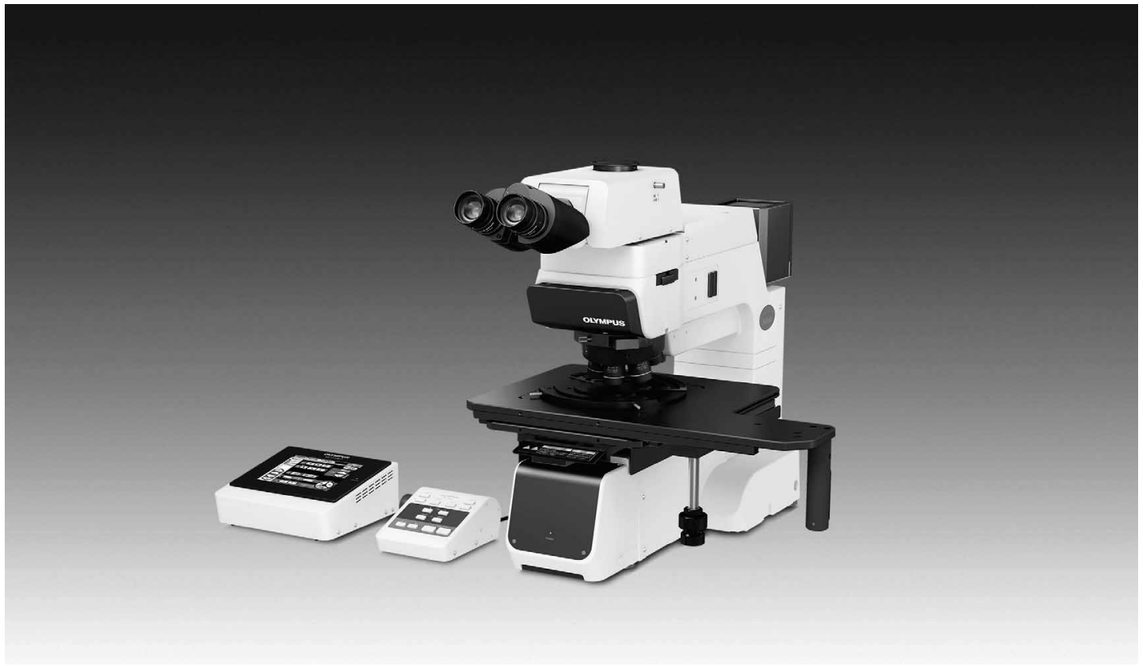
Recommended microscope system	Semiconductor inspection microscope/MX61
	300mm semiconductor/FPD inspection microscope/MX61L
	Industrial inspection microscope/MX51

Power consumption	3 kW (maximum)
Weight	Approx. 46 kg (with MX61) and approx. 28 kg (with MX51)

MX61A

Automatic Semiconductor Inspection Microscope System

MX61A is a top-end model in the semiconductor inspection microscope MX series.
The MX61A has further advanced automation and motorization of microscopic observations, and achieved a new dimension in flexibility and expandability to meet specific inspection and analysis needs of users as a Dual-Engine concept.



MX61A Specifications

Optical system	UIS2/UIS optical system (infinity-corrected system)
Illumination system	• Reflected light illumination system (FN 26.5) • 12 V, 100 W halogen bulb (pre-centered). • Motorized brightfield/darkfield selection by mirror + 1 mirror unit (* optional). * Any desired observation mirror unit can be added. • Motorized aperture iris diaphragm built in. (Preset value for each objective lens, opened automatically for DF observation.) • Available reflected light observation methods: ① Brightfield; ② Darkfield; ③ DIC; ④ Simplified Polarized Light; ⑤ Fluorescent Light; ⑥ near IR; ⑦ DUV *⑦ requires MX2-BSW (PC) and cannot be configured with the MX-OPU61A operation unit.*
Motorized focusing mechanism	• High-rigidity, 2-guide cross-roller guide system • Ball screw + Stepping motor drive. • Stroke: 25.4 mm. • Fine adjustment sensitivity: Below 1 µm. Resolution: 0.01 µm. • Maximum speed: 5 mm/sec. (Default: 3 mm/sec.) • Maximum load (including the stage holders) MX-STSP10: 10 kg MX-STSP15: 15 kg MX-STSP22: 22 kg
Observation tube	• Super-widefield erect image trinocular tube (FN 26.5) MX-SWETTR (Optical path select 100:0, 0:100, tube inclination angle 0 to 42 degrees) U-SWETTR-5 (Optical path select 100:0, 20:80, tube inclination angle 0 to 35 degrees) • Infra-red wide field trinocular tube (FN 22) U-TR30IR (Optical path select 100:0, 0:100, tube inclination angle 30 degrees (fixed)).
Motorized revolving nosepiece	• Brightfield 6-position motorized revolving nosepiece: U-D6REMC, • Brightfield/darkfield 5-position motorized revolving nosepiece: U-D5BDREMC, • Brightfield/darkfield 5-position centerable motorized revolving nosepiece: U-P5BDREMC, • Brightfield/darkfield 6-position motorized revolving nosepiece: U-D6BDREMC
Controllers	• Operation Unit MX-OPU61A LCD touch panel with built-in control software. Enables microscope controls and observation condition setups. • Hand Switch MX-HS61A Enables microscope controls (using 1 jog dial + 14 buttons). • Software MX2-BSW (for a PC use) Application software for controlling the MX61A and motorized modules.
Stage	• MX-SIC1412R2: 14x12-inch stage with coaxial knobs on the bottom right Stroke: 356 x 305 mm (Transmitted illumination field 356 x 284 mm). Roller guide type sliding belt drive (rack-less). Grip clutch mechanism (Belt interlock-release system). • MX-SIC8R: 8x8-inch stage with coaxial knobs on the bottom right. Stroke: 210 x 210 mm (Transmitted illumination field 189 x 189 mm). Roller guide type sliding belt drive (rack-less). Grip clutch mechanism (Belt interlock-release system). • 99S003-06 200mm Scanning Stage Stroke: 203 x 203 mm Please consult the Olympus with 300mm scanning stage.
Dimensions & weight	• Dimensions: Approx. 711 (W) x 853 (D) x 552 (H) mm. • Weight: Approx. 56 kg (Microscope stand only: Approx. 31 kg) *In the MX61A configuration of the following items: the MX-SIC1412R2 stage, MX-WHPR128 wafer holder, U-D6BDREMC motorized revolving nosepiece, U-AFA2M-VIS active auto focusing unit, MX-AFC MX Cover for AF, MX-SWETTR observation tube and U-LH100-3 lamp housing are combined:*
Operating environment	• Indoor use. • Altitude: Max. 2000 meters. • Ambient temperature:10º through 35ºC (50º through 95º F). • Relative humidity: 80% for temperatures up to 31ºC (88ºF) (without condensation), decreasing linearly through 70% at 34ºC (93ºF), 60% at 37ºC (99ºF) to 50% relative humidity at 40ºC (104ºF). • Supply voltage fluctuations: ±10%. • Pollution degree: 2 (in accordance with IEC60664). • Installation (overvoltage) category: II (in accordance with IEC60664)

This device is designed for use in industrial environments for the EMC performance (Class A device). Using it in a residential environment may affect other equipment in the environment.

Semiconductor/FPD Inspection Microscopes

UIS2 World-leading optics

Inspection Dual-Engine Analysis

- Selectable Dual-Engine
- Superior observation images for everyone
- Optimized solutions
- Ergonomics and environment

Inspection

◆ *The operation unit controlling the entire MX61A system as an Inspection-Engine plus auto focus compatible with a wide range of observation methods and detailed customized settings provide a higher level inspection environment.*

Optimized view and image data management
Digital imaging system

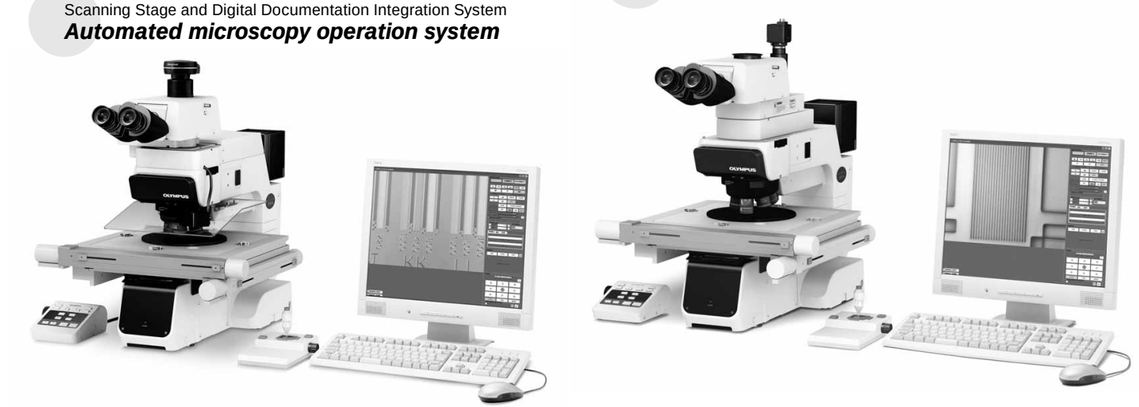
Optimized performance in wafer inspection
Wafer loader system

Analysis

◆ *The "Microscope control software" controlling the entire MX61A system as an Analysis-Engine broadens the expandability of MX61A and supports advanced analysis requirements.*

Ultra high resolving power in Visible/DUV light
Fully automated DUV system

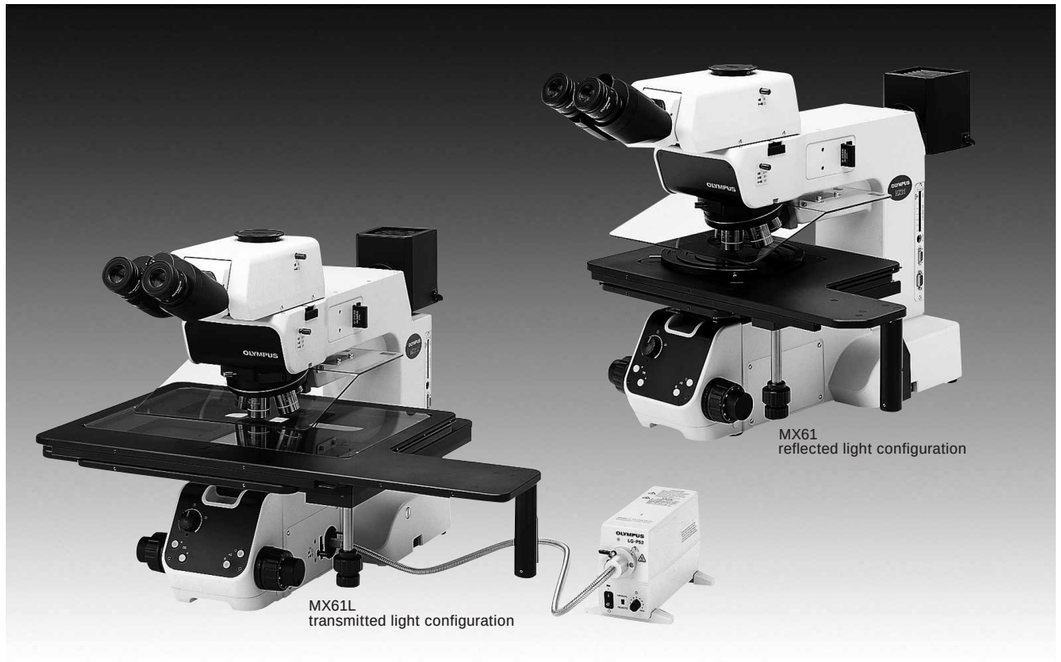
Scanning Stage and Digital Documentation Integration System
Automated microscopy operation system



MX61/ MX61L

Semiconductor/FPD Inspection Microscopes

The highest efficiency for all our customers — that's the commitment underlying the launch of the MX61/MX61L.
MX61 accepts up to 200mm specimens while MX61L accommodates up to 300mm specimens.



MX61
reflected light configuration

MX61L
transmitted light configuration

MX61/MX61L Specifications

Model		MX61	MX61L
Optical system		UIS2 optical system (infinity-corrected system)	
Microscope stand	Reflected light illumination (F.N. 26.5)	12V, 100W halogen lamp (pre-centering type) Brightfield/darkfield mirror plus 1 cube (option), exchange method Built-in motorized aperture diaphragm (Pre-setting for each objective lens, automatically open for darkfield observation)	
	Transmitted light illumination* (F.N. 26.5)	*When transmitted illumination unit MX-TILLA or MX-TILLB is combined. Illumination by light source LG-PS2 and light guide LG-SF (12V,100W halogen lamp) or their equivalent. •MX-TILLA: condenser (N.A.0.5), with aperture stop •MX-TILLB: condenser (N.A.0.6), with aperture stop and field stop	
	Observation methods	①Reflected light brightfield ②Reflected light darkfield ③Reflected light Nomarski DIC ④Reflected light simple polarizing ⑤Reflected light fluorescence ⑥Reflected light IR ⑦Transmitted light brightfield ⑧Transmitted light simple polarizing *Separate (optional) cubes are required for ③, ④ and ⑤. *⑦ and ⑧ require combination with a transmitted illumination unit.	
Observation tube		Super widefield erect image tilting trinocular tube (F.N.26.5): MX-SWETTR Others: Super widefield trinocular tube/Widefield binocular tube	Super widefield erect image tilting trinocular tube (F.N.26.5): MX-SWETTR or U-SWETTR-5 (MX-SWETTR is equipped for MX61L as standard.)
Revolving nosepiece		Motorized sextuple revolving nosepiece with slider slot for DIC: U-D6REMC Motorized quintuple BD revolving nosepiece with slider slot for DIC: U-D5BDREMC Motorized sextuple BD revolving nosepiece with slider slot for DIC: U-D6BDREMC Motorized centerable quintuple BD revolving nosepiece with slider slot for DIC: U-P5BDREMC Forward rotation by objective lens exchange button on the front panel of microscope, or directly by hand switch U-HSTR2 (user designation)	
Stage		MX-SIC8R 8" x 8" stage Stroke: 210 x 210mm (Transmitted light illumination area: 189x189mm) MX-SIC6R2 6" x 6" stage Stroke: 158 x 158mm (Reflected light use only with MX61)	MX-SIC1412R2 14" x 12" stage Stroke: 356 x 305mm (Transmitted light illumination area: 356x284mm) combination with MX-TILLB
		Roller guide slide mechanism, belt drive system (no rack), grip clutch function (belt drive disengagement system)	
Power consumption		Built-in reflected light source body 100-120/220-240V~1.9/0.9A 50/60Hz, Transmitted light source (LG-PS2) 100-120/220-240V~3.0/1.8A 50/60Hz	
Dimensions/weight		Dimensions: approx. 509(W) x 843(D) x 507(H)mm Weight: approx. 40kg (microscope stand only approx. 27kg)	Dimensions: approx. 710(W) x 843(D) x 507(H)mm Weight: approx. 51kg (microscope stand only approx. 31kg)

MX51

Industrial Inspection Microscope

More efficient inspections throughout Industry: streamlined operation for faster, more comprehensive results.

Reflected light configuration with 150mm stage
MX51+BX-RLA2+MX-SIC6R2+BH3-WHP6+BH2-WHR65

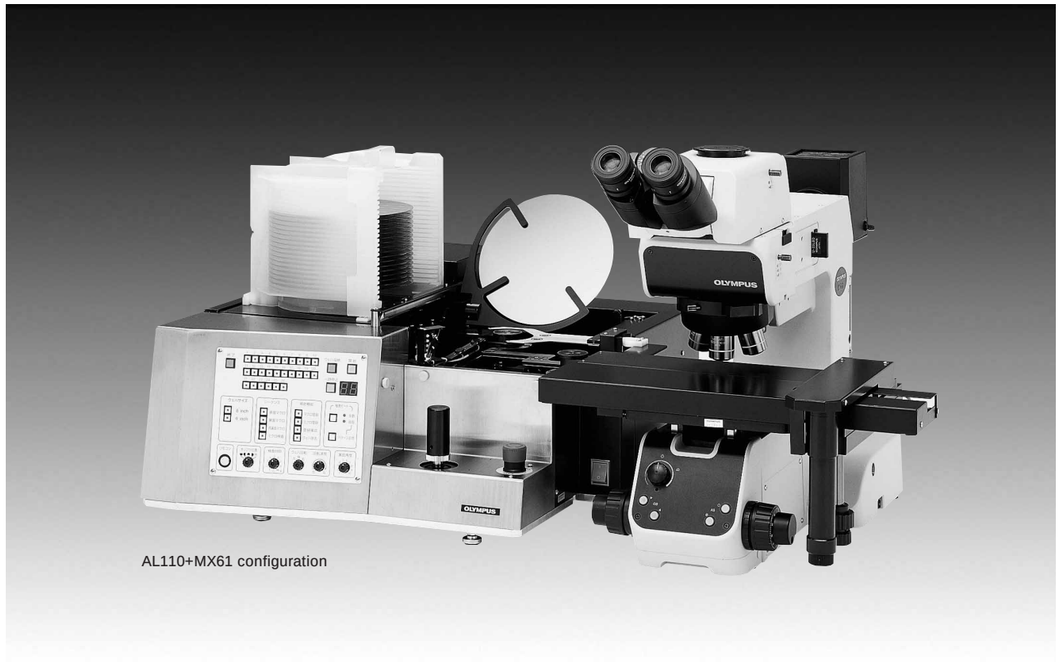
MX51 Specifications

Optical system		UIS2 optical system (infinity-corrected system)		
Microscope stand		2-guide rack and pinion method Course and fine co-axial Z-axis control stroke 32mm (2mm upper and 30mm below from the focal plane) The same stroke 15mm (combination with transmitted illumination) Stroke per rotation of course Z-axis control 0.1 mm (1 unit 1μm) Course handle torque adjustment Course handle upper limit lever		
Illumination		BX-KMA Brightfield illuminator	BX-RLA2 Brightfield/Darkfield illuminator	BX-URA2 Universal Fluorescence illuminator
	Contrast changeover method	—	BF-DF slide method	Mirror (Max. up to 6) turret method
	Applicable observation mode	① Brightfield ② Normaski DIC ③ Polarized light	① Brightfield ② Darkfield ③ Normaski DIC ④ Polarized light ⑤ IR	① Brightfield ② Darkfield ③ Normaski DIC ④ Polarized light ⑤ Fluorescence
Lamp housing		6V30W Halogen Lamp socket: U-LS30-4 Transformer: TL-4	12V100W Halogen Lamp house: U-LH100L-3 Power supply is integrated in MX51	Mercury lamp house: U-LH100HGAPO External power supply BH2-RFL-T3 needed
Transmitted illumination		Brightfield MX-TILLK combined with fiber light guide illumination (configured with MX-SIC6R2)		
Power supply unit		—	Rated voltage: 100-120/220-240V~1.8A/0.8A 50/60Hz Continuous light intensity dial	
Observation tube		U-BI30-2 Widefield binocular, U-TR30-2 Widefield trinocular, U-ETR4 Widefield erect image trinocular (F.N. 22) U-SWTR-3 Super widefield trinocular, MX-SWETTR/U-SWETTR-5 Super widefield erect image tilting trinocular (F.N. 26.5)		
Revolving nosepiece Either of the left two stages is configured		U-5RE-2, U-6RE U-D5BDRE, U-D6BDRE, U-P5BDRE (with slider slot for DIC Prism)		
Stage		U-SIC4R2/SIC4L2 Coaxial right/left-hand control 4"x 4" stage	MX-SIC6R2 Coaxial right/left-hand control 6 x 6" stage	
		Drive method: rack and pinion method Y axis stopper: lever method	Drive method: Belt method Stroke: 158(X) x158 (Y) mm Clutch method: 2 clutch plates (Built-in-clutch ON/OFF handle) Holder dimensions: 200 x 200mm Transmitted light area: 100 x 100mm	
Dimensions & Weight		Dimensions: Approx. 430(W) x 591(D) x 495(H)mm Weight: Approx. 26kg (Stand Approx. 11kg)		

AL110

Wafer Loader

The easy-to-use functions and compact design of the AL110 and MX61/MX61L combination maximize efficiency of wafer inspection.



AL110+MX61 configuration

AL110 Specifications

Item \ Model		200mm versions					200/150mm compatible versions					100/125/150mm compatible versions		
		L	LM	LB	MB	LMB	L	LM	LB	MB	LMB	L	LM	LMB
Wafer diameters*1	200mm orientation flat type, 200mm notch type			○					○					
	150mm orientation flat type								○					
	100mm, 125mm and 150mm orientation flat type												○	
Cassette	Fluoroware, H-ber type								○					
Number of cassette	One								○					
Inspection modes	Sequential and sampling								○					
Transfer modes	Micro inspection	○	○	○		○	○	○	○		○	○	○	○
	Top macro inspection		○		○	○		○		○	○		○	○
	Back macro inspection			○	○	○			○	○	○			○
	2nd back surface macro inspection			○	○	○			○	○	○			○
Orientation flat/notch alignment	One every 90°, O.F./notch alignment also available before unloading wafers into cassette								○					
No-contact centering									○					
Wafer transfer	Robot arms with vacuum pickup								○					
Adaptable microscope*2	MX61/MX61L								○					
Dimensions (mm)		580 (W) x 580 (D) x 297 (H)										490 (W) x 520 (D) x 297 (H)		
Weight (kg)		30	32	31	31	33	30	32	31	31	33	26	28	30
Utilities		Power source: AC100 to 120V 0.90A or AC220 to 240V 0.55A 50/60Hz, Vacuum pressure: -67kPa to -80kPa												

*1 *Applicable for SEMI and JEIDA 6- and 8-inch wafers.* *2 *Besides the MX61/MX61L, other equivalent microscopes are available. Please consult your Olympus dealer for the options.*

MS200 motorized stage

Combining MS200 motorized stage enables complete surface inspections of a 200mm wafer, with specific inspection points quickly detected and examined according to preset programs.

BX61

System Microscope

The motorized BX61 microscope is provided with auto focus and automatic reflect/ transmitted light mode select. Either of two types of motorized incident illuminator are mountable for the BX61: BX-RLAA with automatic BF/DF observation mode select, or BX-RFAA with automatic 6-position observation cube select .

BX61+BX-RFAA

BX61+BX-RLAA+U-AFA2M

BX61 Specifications

Optical system		UIS2 optical system (infinity-corrected system)
Microscope stand	Illumination	Reflected/transmitted: External 12V100W light source , light preset switch, LED voltage indicator, reflected/transmitted changeover switch
	Focus	Motorized focusing, stroke 25mm, minimum graduation 0.01µm
	Maximum specimen height	25mm (without spacer)
Reflected light illuminator		BX-RLAA: Motorized BF/DF changeover, motorized AS BX-RFAA: Motorized 6 position turret, built-in motorized shutter, with FS, AS
Transmitted light		100W halogen, Abbe/long working distance condensers, built-in transmitted light filters (LBD,ND25, ND6) (BX51)
Observation tube	Widefield (F.N. 22)	Inverted: binocular, trinocular, tilting binocular Erect: trinocular, tilting binocular
	Super widefield (F.N. 26.5)	Inverted: trinocular Erect: trinocular, tilting trinocular
Revolving nosepiece	For BF	Motorized sextuple, centering quintuple
	For BF/DF	Motorized quintuple
Stage		Coaxial left (right) handle stage: 76(X) x 52(Y)mm, with torque adjustment large-size coaxial left (right) handle stage: 100(X) x 105(Y)mm, with lock mechanism in Y axis

BX51/BX51M

System Microscopes

The BX51 microscope model offers reflected and transmitted light illumination, the BX51M model offers reflected light illumination only.
Both accept the reflected light brightfield/darkfield illuminator BX-RLA2 or the universal illuminator, BX-URA2, which includes fluorescence capability.

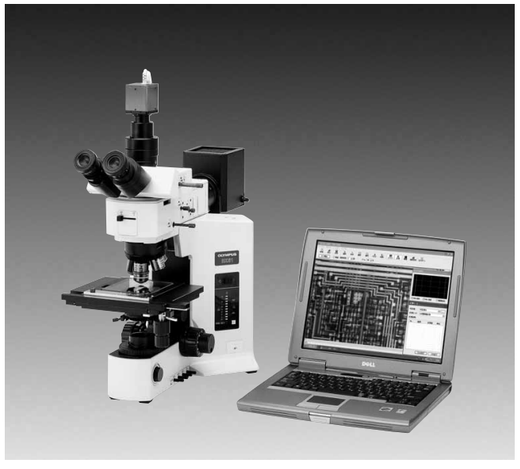
BX51/BX51M Specifications

Optical system		UIS2 optical system (infinity-corrected system)
Microscope stand	Illumination	Reflected/transmitted: built-in 12V/100W light source, light preset switch, LED voltage indicator, reflected/transmitted changeover switch (BX51) Reflected: built-in 12V/100W light source, light preset switch, LED voltage indicator (BX51M)
	Focus	Stroke: 25mm, fine stroke per rotation: 100µm minimum graduation: 1µm, with upper limit stopper, torque adjustment for coarse handle
	Maximum specimen height	25mm (without spacer: BX51), 65mm (without spacer: BX51M)
Reflected light illuminator	BF etc.	BX-RLA2: 100W halogen (high intensity burner, fiber illuminator mountable), BF/DF/DIC/KPO, with FS, AS (with centering mechanism, BF/DF interlocking ND filter)
	Reflected fluorescence	BX-URA2: 100 Hg lamp, 75W Xe lamp, 50W metal halide lamp, 6 position mirror unit turret (standard: WB, WG, WU+BF etc), with FS, AS (with centering mechanism), with shutter mechanism
Transmitted light		100W halogen, Abbe/long working distance condensers, built-in transmitted light filters (LBD,ND25, ND6) (BX51)
Observation tube	Widefield (F.N. 22)	Inverted: binocular, trinocular, tilting binocular Erect: trinocular, tilting binocular
	Super widefield (F.N. 26.5)	Inverted: trinocular Erect: trinocular, tilting trinocular
Revolving nosepiece	For BF	Sextuple, centering sextuple, septuple (motorized septuple: optional)
	For BF/DF	Quintuple, centering quintuple, sextuple (motorized quintuple optional)
Stage		Coaxial left (right) handle stage: 76(X) X 52(Y)mm, with torque adjustment, large-size coaxial left (right) handle stage: 100(X) X 105(Y)mm, with lock mechanism in Y axis

BX51/BX51M-IR

System IR Microscopes

With the same microscope stand and reflected light illuminator, it is possible to conduct near infrared light observations of semiconductor interiors and the back surface of a chip package as well as CSP bump inspections.



BX51/BX51M-IR Unit

100W halogen lamp housing for IR	U-LH100IR
Trinocular tube for IR	U-TR30IR
Single port tube lens with lens for IR	U-TLUIR
Transmitted polarizer for IR	U-POTIR
Rotatable analyzer slider for IR	U-AN360IR
Reflected polarizer slider for IR	U-POIR
Band path filter (1100nm) for IR	U-BP1100IR
Band path filter (1200nm) for IR	U-BP1200IR
Objective lenses for IR	LMPL5 x IR, LMPL10 x IR, LMPL20 x IR, LMPL50 x IR, LMPL100 x IR, MPL100 x IR

* For other specifications, please refer to BX51/BX51M.

BX41M-LED

System Microscope

The BX41M-LED with built-in bright and super long-life LED illumination has ESD capability to protect electronic devices from potentially harmful static electricity, and to broaden the inspection field of this advanced, high-performance microscope.

BX41M-LED Specifications

Optical system		UIS2 optical system (infinity-corrected system)
Microscope stand	Illuminator	Reflected light (ESD capability), Built-in power supply for 3W white LED, light preset switch
	Focus	Stroke 35mm Fine stroke per rotation 100µm Minimum graduation 1µm With upper limit stopper, torque adjustment for coarse handle
	Maximum specimen height	65mm (without spacer)
Reflected light illuminator	BX-AKMA-LED/BX-KMA-LED 3W white LED BF/DIC/KPO ESD capable *Following features are for BX-AKMA-LED only:* *KPO/oblique illumination* *AS (with centering mechanism)* *Oblique illumination position settings*	
Observation tube	Widefield (F.N. 22)	Inverted: binocular, trinocular, tilting binocular Erect: trinocular, tilting trinocular
	Super widefield (F.N. 26.5)	Inverted: trinocular Erect: trinocular, tilting trinocular
Revolving nosepiece	For BF	Quintuple, sextuple (ESD capable), septipule
Stage	Coaxial left(right) handle stage: 76(X)x52(Y)mm, with torque adjustment Large-size coaxial left (right) handle stage: 100(X)x105(Y)mm, with lock mechanism in Y axis	

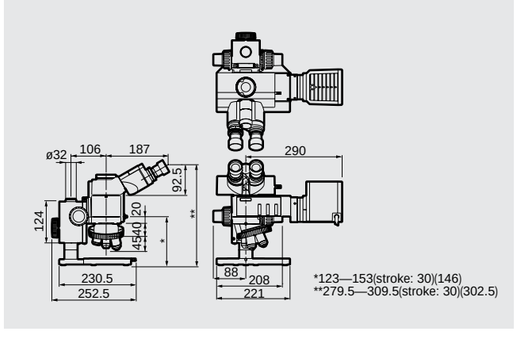
BXFM-S

System Industrial Microscope

Accommodates the reflected light brightfield/darkfield and fluorescence illuminators.

BXFM-S Specifications

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



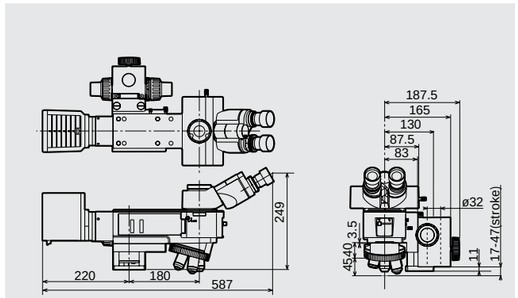
BXFM

System Industrial Microscope

Compact focusing unit suitable for building into existing equipment.

BXFM Specifications

Optical system		UIS2 optical system (infinity-corrected system)
Microscope stand		Focus: 30mm, rotation of fine focus knob: 200µm, minimum adjustment gradation: 2µm, with torque adjustment for coarse knob
Illuminator	BX-RLA2	100W halogen, etc., BF/DF/DIC/KPO
	BX-URA2	100W Hg, etc., fluorescence illuminator



GX71

Top-of-the Line Inverted Metallurgical System Microscope

Ideal for every observation method from brightfield to fluorescence.
Zoom function for easy image trimming.
Erect images — observation and recording of the specimen "as is".

GX71 (motorized model) + DP72 configuration

GX71 Specifications

Optical system		UIS2 optical system (infinity-corrected system)
Microscope body	Intermediate magnification	Zoom incorporated (1x - 2x) Clicks in the two intermediate positions (can be released)
	Imprinting of scale	All ports Reversed positions (up/down/left/right) from observation positions seen through the eyepiece
	Power source	Power source for illuminator (12V100W halogen) incorporated
	Focusing	Manual, Coarse and Fine coaxial handle. Focus stroke 9 mm (2 mm above and 7 mm below the stage surface)
	Output port	Front port : Video and DP system (reversed image, special video adapter for GX) Side port: Video, DP system (reversed image)
Illuminator	Observation method	Brightfield, darkfield, simple polarized light, DIC, Fluorescence
	Illuminator diaphragm	FS/AS manually controlled, with centering adjustment
	Light source	100W halogen (standard), 100W Hg, 75W Xe (option)
Observation tube	Super widefield (F.N. 26.5)	U-SWBI30, U-SWTR-3
Revolving nosepiece	Manual operation	Sextuple for BF/DIC, quintuple for BF/DF/DIC, quintuple for BF with centering
	Motorized operation	Sextuple for BF/DIC, quintuple for BF/DF/DIC
Stage	Standard type	Right handle stage for GX series microscope (each X/Y stroke: 50 x 50 mm)
	Option	Flexible right handle stage, left short handle stage (each X/Y stroke: 50 x 50 mm)
	Stage insert plate	A set of teardrop and long hole types
Image recording	Digital camera, video camera	Olympus DP series, etc. attachable using appropriate adapters
Combined weight		Approx. 39 kg (BF, DF and DIC observations, combined with DP72)
Power consumption		170VA, 140W

GX51

Inverted Metallurgical System Microscope

Single lever switchover for brightfield/darkfield observation.
Expandable functionality.
Improved operating convenience.

GX51+ DP21 configuration

GX51 Specifications

Optical system		UIS2 optical system (infinity-corrected system)
Microscope body	Imprinting of scale	All ports Reversed positions (up/down) from observation positions seen through the eyepiece
	Power source	Power source for illuminator (12V100W halogen) incorporated
	Focusing	Manual, Coarse and fine coaxial handle, Focus stroke 9 mm (2 mm above and 7 mm below the stage surface)
	Output port	Front port: video and DP system (reversed image, special video adapter for GX) Side port (option): video, DP system (upright image)
Illuminator	Observation method	Brightfield, darkfield, simple polarized light, DIC
	Illuminator diaphragm	FS/AS manually controlled, with centering adjustment
	Light source	100W halogen (standard), 100W Hg, 75W Xe, (option)
Revolving nosepiece	Manual operation	Sextuple for BF/DIC, quintuple for BF/DF/DIC, quintuple for BF with centering
	Motorized operation	Sextuple for BF/DIC, quintuple for BF/DF/DIC
Stage	Standard type	Right handle stage for GX series microscope (each X/Y stroke: 50 x 50 mm)
	Option	Flexible right handle stage, left short handle stage (each X/Y stroke: 50 x050 mm)
	Stage insert plate	A set of teardrop and long hole types
Image recording	Digital camera, video camera	Olympus DP series, etc. attachable using appropriate adapters
Combined weight		Approx. 28 kg (BF, DF and DIC observations, combined with DP20)
Power consumption		170VA, 140W

GX41

Compact Inverted Metallurgical System Microscope

New advances in both imaging and functionality: featuring the brighter, clearer visibility of UIS2 optics, and the convenience of observation with instant image recording.

GX41 Specifications

Optical system		UIS2 optical system (infinity-corrected system)
Observation method		Brightfield, Reflected light simple polarizing
Focus		Vertical revolving nosepiece movement (fixed stage), coarse and fine handles (with torque adjustment), roller guide movement. Stroke per coarse handle rotation: 36.8mm, Stroke per fine handle rotation: 0.2mm
Illumination	Illuminator	Built-in aperture diaphragm (Lever operation type) Various ø25mm filters can be inserted
	Light source	6V30WHAL-L: long-life halogen lamp 6V30WHAL: High intensity halogen lamp
Observation tube	Eyepieces: Attached to microscope stand (F.N. 18)	U-CTBI (tilting tube) Inclination angle: 30°-60°, adjustable interpupillary distance range: 48-75mm
	Eyepieces: WHB10X3, WHB10X3-H (F.N. 20)	U-CBI30-2-2 (binocular tube), U-CTR30-2-2 (trinocular tube) Inclination angle: 30°, interpupillary distance: 48-75mm
	Eyepieces: WHN10x series (F.N. 22)	U-BI30-2-2 (binocular tube), U-TR30-2-2 (trinocular tube) Inclination angle: 30°, interpupillary distance: 50 - 76mm U-TBI-3 (tilting binocular tube) Inclination angle: 5°-35°, interpupillary distance: 50-76mm
Revolving nosepiece		Quadruple revolving nosepiece
Stage	Plane stage	Size: 160(W) x 250(D)mm, stage insert plate type (no accessories)
	Mechanical stage	Stroke: 120mm(X) x 78(Y)mm Coaxial handle: attachable to right/left side of plane stage Use special stage plate CK40M-CP to observe specimens up to ø50mm.
Intermediate attachments		U-CA, GX-SPU, U-ECA, U-DA, U-DO3

BX-P

Polarizing Microscopes

Employing UIS2 optics to achieve unsurpassed performance in polarized light observation, this series delivers optimum compensation for optical aberrations to achieve images of unprecedented sharpness. Six compensators are available to allow observations and measurement at various retardation levels.

BX41-P conoscopic/ orthoscopic version

BX51-P orthoscopic version

BX-P series Specifications

Item		Conoscopic and orthoscopic observation (U-CPA)	Orthoscopic observation (U-OPA)
Polarized light intermediate attachment (U-CPA or U-OPA)	F.N.	22	22
	Bertrand lens	Focusable	—
	Bertrand field stop	ø3.4mm 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)	
Analyzer (U-AN360P-2)		360° dial-rotatable, rotatable minimum angle 0.1°	
Centerable revolving nosepiece (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)	
Stage (U-SRG2)		Polarizing rotatable stage with 3-point centering function.360° rotatable, lockable in any position, 360° graduated in 1° increments [Slide holder (U-SCB2) and mechanical stage (U-FMP) can be attached	
Condenser (U-POC-2)		Achromat strain-free condenser (U-POC-2), 360° rotatable polarizer with swing-out achromatic top lens, Click stop at position "0°" is adjustable. N.A. 0.9 (top-lens in) N.A. 0.18 (top-lens out) Aperture iris diaphragm: adjustable from 2mm to 21mm diameters	

* For other specifications, please refer to BX51/BX41.

CX31-P

Polarizing Microscope

Simple to use, the CX31-P offers a variety of functions to answer a range of applications from mineralogical training and educational use to chemical research in the laboratory.

CX31-P Specifications

Optics		UIS2 optical system (infinity-corrected system)
	Objective lens	ACHN-P series, UPFL-P series
	Eyepiece	WHN10x, WHN10x-H, CROSS WHN10x
		WHB10x3, WHB10x2-H
Microscope stand	Illuminator	6V30W halogen lamp
	Stage	Polarizing rotatable stage with centering function 360° rotatable, lockable in any position 360° graduated in 1° increments (minimum retardation resolution 6', using vernier scale)
	Condenser	Strain-free polarizing condenser N.A. 0.9 (with oil immersion: 1.25), Aperture iris diaphragm incorporated Polarizer 360° rotatable, detachable
	Focusing	Rack & pinion, Full stroke range: 25mm, Minimum graduation in fine movement: 2.5µm Upper limit stop mechanism in coarse movement Tension adjustment on coarse focus adjustment knob
Conoscopic Intermediate tube (U-PA)	Bertrand lens	Incorporated, detachable, focusable
	Changeover between orthoscopic/conoscopic observation	Engage or disengage of Bertrand lens Position: ● IN Position: ○ OUT
	Analyzer	Incorporated, detachable, 180° rotatable, lockable in any position 2° increments, minimum retardation resolution 6', using vernier scale
	Slot for compensators	Tint plate (U-TP530), 1/4 wavelength retardation plate (U-TP137) and various compensators attachable

SZX16/SZX10

Research Stereomicroscope System

The SZX2 Series is today's first choice in research stereo microscopy. Represents a new class of research stereo microscope with superb optical performance. The system modularity allows users to create the application dedicated configurations they need.

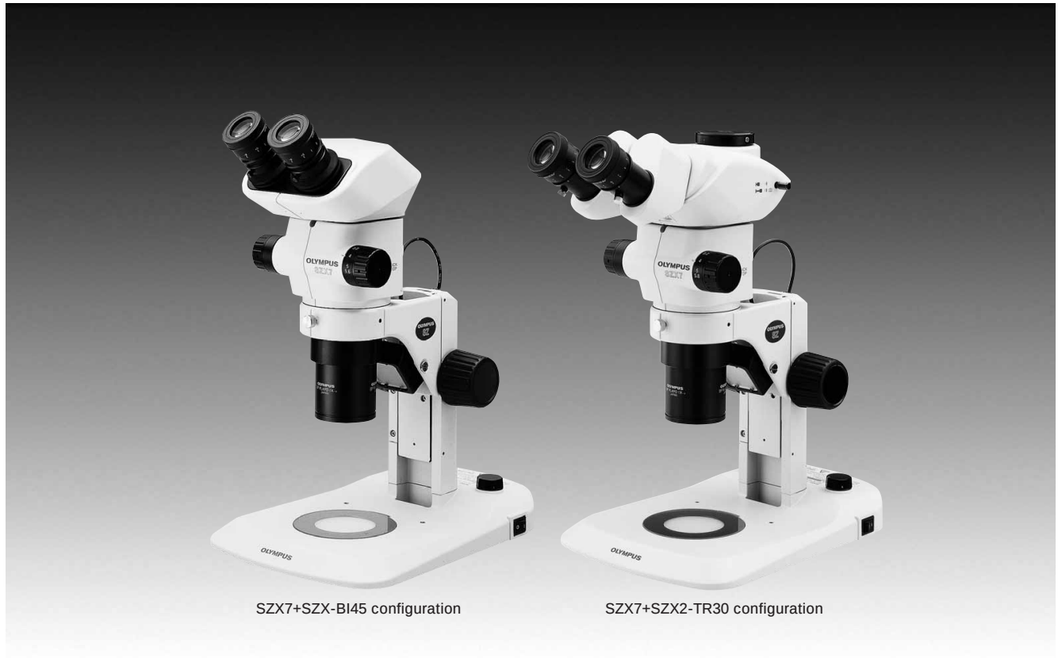
SZX16/SZX10 Specifications

	SZX16			SZX10		
Zoom microscope bodies	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			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		
	Zoom variable magnification system with parallel optical axis, Zoom drive system: Horizontal handle click-stop for various zoom positions incorporated Built-in AS zoom body, Objective lens mounting: screw mount					
Objective lens	For SZX2-ZB16			For SZX2-ZB10		
	Objective lens	N.A.	W.D. (mm)	Objective lens	N.A.	W.D. (mm)
	SDFPLFL0.3x	0.045	141	DFPL0.5x-4	0.05	171
	SDFPLAPO0.5xPF	0.075	70.5	DFPL0.75x-4	0.075	116
	SDFPLAPO0.8x	0.12	81	DFPLAPO1x-4	0.1	81
	SDFPLAPO1xPF	0.15	60	SZX-ACH1x	0.1	90
	SDPLAPO1.6xPF	0.24	30	DFPLAPO1.25x	0.125	60
	SDFPLAPO2xPFC	0.3	20	SZX-ACH1.25x-2	0.125	68
				DFPL1.5x-4	0.15	45.5
				DFPL2x-4	0.2	33.5
Eyepiece	WHN10x-H (for SZX16): F.N. 22, WHSZ10x-H (for SZX10):F.N. 22, WHSZ15x-H: F.N. 16, WHSZ20x-H: F.N.12.5, WHSZ30x-H: F.N. 7					
Observation heads Interpupillary distance adjustment: 52-76mm	SZX2-TTR/SZX2-TTRPT: Tilting trinocular head Convergence angle, Tilting angle: 5°-45°, ray switcher: 2ways (TTR: binocular 100%, binocular50%/camera 50%. TTRPT: binocular100%, camera 100%)					
	SZX2-TR30/SZX2-TR30PT: 30 degree trinocular head Convergence angle, Tilting angle: 30°, ray switcher: 2ways (TR30: binocular 100%, binocular50%/camera 50%. TR30PT: binocular100%, camera 100%)					
Observation heads mountable onto SZX10	—			SZX-BI30 30° binocular head, SZX-BI45 45° binocular head, SZX-TBI tilting binocular head		
Focusing assembly	SZX2-FO: Focusing unit Focus: rack and pinion with roller guide (with torque adjustment ring for focusing), optional counter balance, coarse handle stroke: 80 mm, coarse handle stroke per rotation: 21 mm, load capacity: 0-10.0kg					
	SZX2-FOF: Fine focusing unit Focus: rack and pinion with roller guide (with torque adjustment ring for coarse focusing), coarse and fine coaxial handle, built-in counter balance, coarse handle stroke 80 mm, coarse handle stroke per rotation 36.8 mm, fine handle stroke: 80 mm, fine handle stroke per rotation: 0.77mm, load capacity: 2.7-15.0kg					
	SZX-FOA2: Motorized focus unit, accessible to SZX16/SZX10					
Stands	SZX-ST: Stand Pillar height: 270 mm, base dimensions: 284 (W) x 335 (D) x 31 (H) mm, Stage clips are mountable, with stage adapter fixing screw holes					
	SZX2-STL: Large stand Pillar height: 400 mm, base dimensions: 400 (W) x 350 (D) x 28 (H) mm, Stage clips are mountable, with stage adapter fixing screw holes					

SZX7

Stereomicroscope

Galilean optical system using parallel light paths for outstanding performance and easy expandability.



SZX7 Specifications

Zoom microscope body SZX-ZB7 *Lead-free materials used*	Zoom drive: Horizontal knob system Click stop for each zoom magnification: ON-OFF switching possible Zoom ratio values: 7:1 (0.8x to 5.6) Zoom magnification indication: 0.8, 1, 1.25, 1.6, 2, 2.5, 3.2, 4, 5, 5.6 Objective lens 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 Eyepiece clamping knob provided			
Stand SZ2-ST SZ2-ILST		SZ2-ST	SZ2-ILST	
		Standard stand	LED reflected/transmitted illumination stand	
	Frame installation	Mounting diameter 76mm		
	Focusing adjustment	Knob rotation tension adjustment Focusing stroke 120mm		
	Stage plate	SZ2-SPBW (Black & white) SP-C (Glass clear transparent)	The dedicated glass plate in 100mm dia. included	
	Light source	Fiber optic illumination system SZ2-LGB mountable (option) Transmitted light illumination attachment (SZ2-ILA) mountable (option)	Transmitted illumination: LED Reflected illumination: LED Average LED life span: 6000 hrs. Input rating: 100-120V/200-240V∿0.15/0.1A, 50/60Hz	

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

SZ61/SZ51

Stereomicroscopes

SZ61: Top-of-the-line optical performance, with zoom ratio of 6.7:1.
Model variations: SZ61TR with trinocular tube, SZ61-60 with 60° observation tube inclination.
SZ51: Versatile, cost-efficient, ideal in all line inspection applications.
Model variation: SZ51-60 with 60° observation tube inclination.

SZ61/SZ51 SZ61TR SZ61-60/SZ51-60

SZ61/SZ51 Specifications

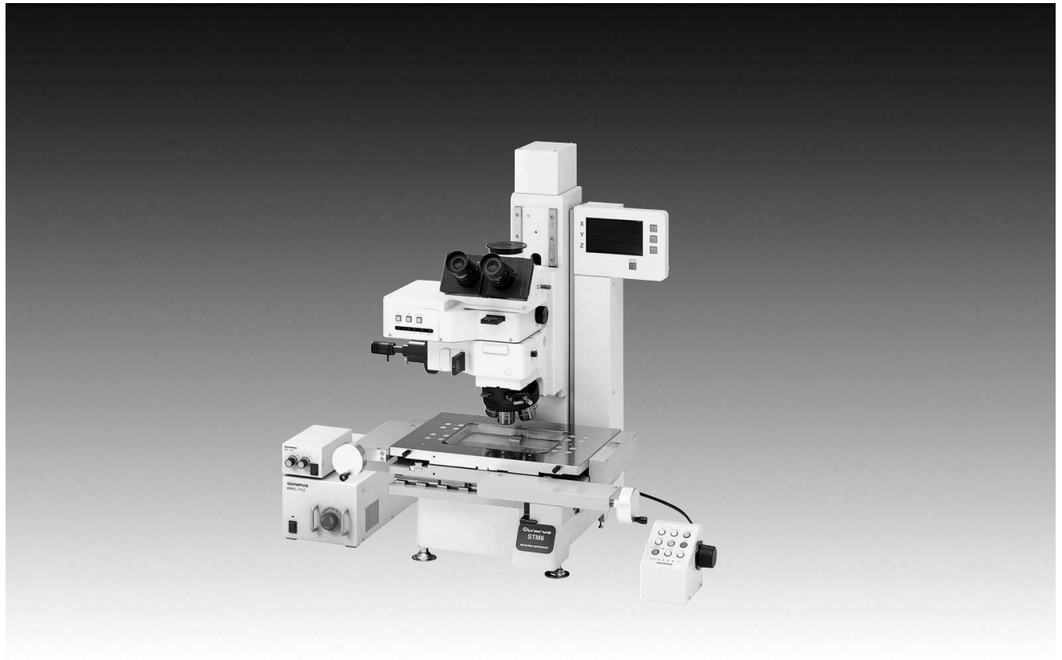
Microscope body		SZ61	SZ61-60	SZ61TR	SZ51	SZ51-60
SZ61	Magnification	0.67x to 4.5x			0.8x to 4x	
SZ61-60	Zoom ratio	6.7: 1			5: 1	
SZ61TR	Working distance	110mm				
SZ51	Tube inclination angle	45°	60°	45°	45°	60°
SZ51-60	Interpupillary distance adjustment	Left/right interlocked Adjustment range: 52 to 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 lens		Mounting by screwing into the thread at the bottom of frame (M48 thread X 0.75)				
Eyepiece		"Comfort*View*" WHSZ series Lead-free materials used				
Stand		SZ2-ST		SZ2-ILST		
SZ2-ST		Standard stand		LED reflected/transmitted illumination stand		
SZ2-ILST	Frame installation	Mounting diameter: 76mm				
	Focusing adjustment	Focusing stroke: 120mm				
	Stage plate	SZ2-SPBW (Black & white for anti-ESD) SP-C (Clear glass plate)		The dedicated glass plate in 100mm dia. included		
	Light source	Fiber optic illumination system SZ2-LGB mountable (option) Transmitted light illumination attachment (SZ2-ILA) mountable (option)		Transmitted illumination: LED Reflected illumination: LED Average LED life span: 6000 hrs. Input rating: 100-120V/200-240V ∼0.15/0.1A, 50/60Hz		

UIS2 World-leading optics

STM6

Measuring Microscope

Compact and highly functional design, with many possible combinations of bodies and stages.



STM6 Specifications

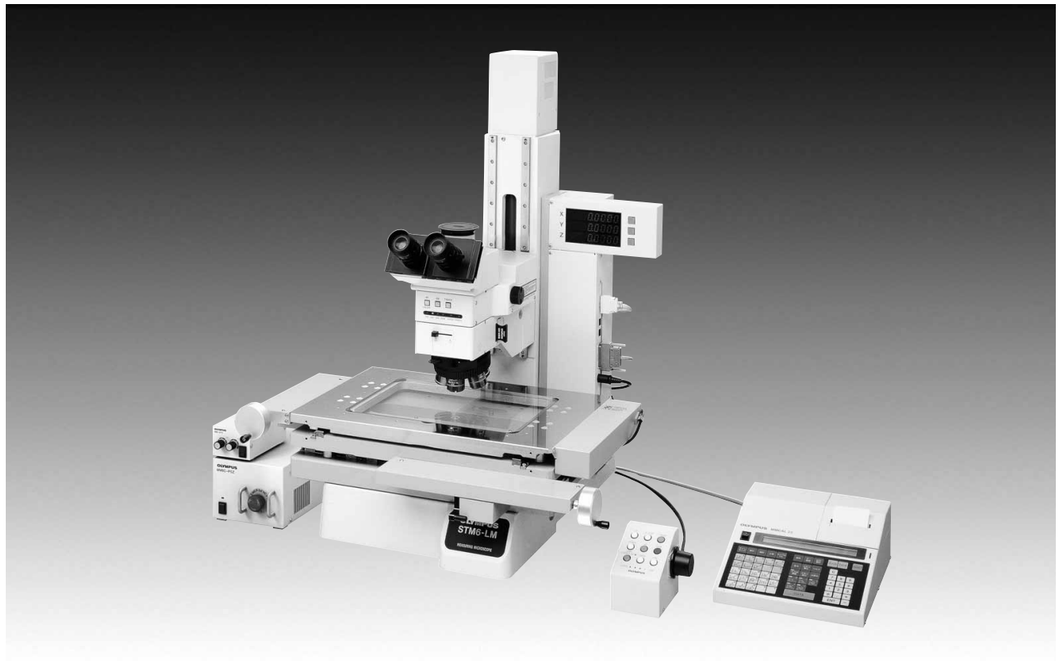
Item			Manual 2-axis	Manual 3-axis	Motorized 3-axis
Objective lenses		For measuring microscope	MM6-OB series		
		For metallurgical microscope	MPLFLN series, LMPLFLN series, MPLFLN-BD series, LMPLFLN-BD series		
Eyepiece			MM6-OCC10x (with cross hairs, F.N. 22), MM6-OC10x (F.N. 22)		
Microscope body	Focus	Vertical movement range	155mm		
		Maximum accepted specimen height	155mm *1, 100mm *2		
		Z-axis measurement range	—	155mm *1, 100mm *2	
		Coarse focusing speed	—	—	4.8mm/s
		Fine focusing speed (variable)	—	—	800µm/400µm/200µm/50µm (full rotation of knob) 4 steps
	Illumination	LED illumination	White: for reflected light illumination, green: for transmitted light illumination Max. power consumption: 10W		
Observation tube			Erect image monocular tube, erect image trinocular tube (100:0/0:100)		
Stage		Stroke	MM6C-CS50 = X-axis: 50mm, Y-axis: 50mm/MM6C-CS100R = X-axis: 100mm, Y-axis: 50mm MM6C-CS100 = X-axis: 100mm, Y-axis: 100mm/MM6C-CS150 = X-axis: 150mm, Y-axis: 100mm		
		Measuring accuracy	50mm stroke: (3+L/50)µm 100mm stroke: (3+2L/100)µm 150mm stroke: (3+3L/150)µm [L: measuring length (mm)]		
Counter display		Minimum readout	0.5µm	0.1µm/0.5µm (selectable)	0.1µm
Power consumption			100-120/220-240V∼0.7/0.4A 50/60Hz		100 -120/220-240V∼1.6/0.8A 50/60Hz
Dimensions *3			465(W) x 437(D) x 596(H)mm	465(W) x 437(D) x 592 (H)mm	465(W) x 437(D) x 696(H)mm
Weight *4			Approx. 94kg	Approx. 95kg	Approx. 97kg

*1: With objective lenses for metallurgical microscope
*2: With objective lenses for measuring microscope
*3: STM6 microscope stand + MM6C-CS100 stage combination
*4: STM6 microscope stand + MM6C-CS100 stage + integrated unit combination

STM6-LM

Measuring Microscope

Motorized focusing as standard, for fast, high-precision measurement of large specimens.
Counter display: minimum readout 0.1µm or 0.5µm selectable.



STM6-LM Specifications

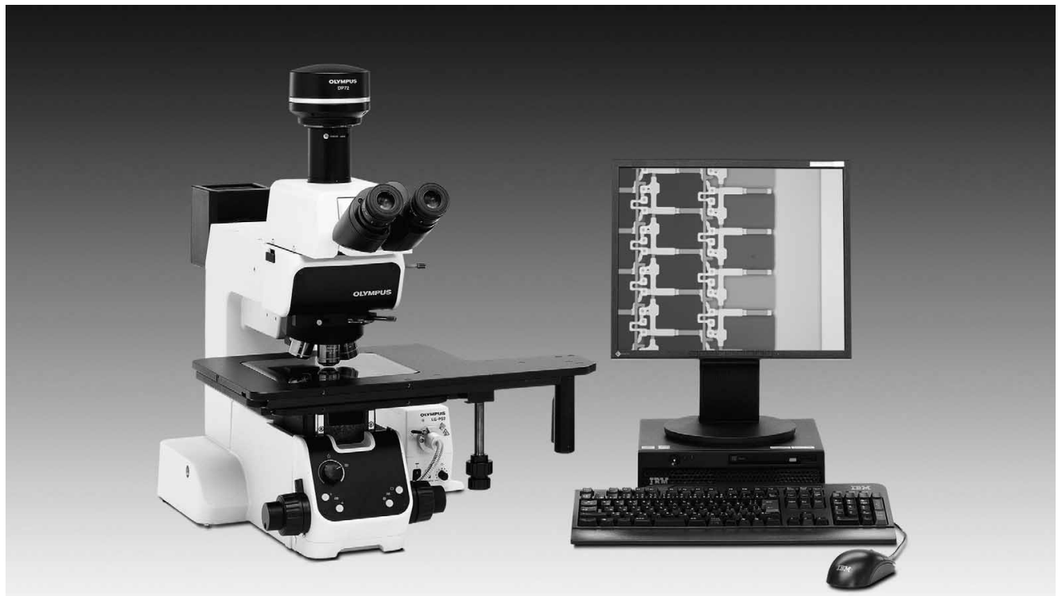
Objective lenses		For measuring microscope	MM6-OB series
		For metallurgical microscope	MPLFLN series, LMPLFLN series, MPLFLN-BD series, LMPLFLN-BD series
Eyepiece			MM6-OCC10x (with cross hairs, F.N. 22), MM6-OC10x (F.N. 22)
Microscope body	Focus	Vertical movement range	205mm
		Maximum accepted specimen height	205mm *1, 150mm *2
		Z-axis measurement range	205mm *1, 150mm *2
		Coarse focusing speed	4.8mm/s
		Fine focusing speed (variable)	800µm/400µm/200µm/50µm (full rotation of knob) 4 steps
	Illumination	LED illumination	White: for reflected light illumination, green: for transmitted light illumination Max. power consumption: 10W
Observation tube			Erect image monocular tube, erect image trinocular tube (100:0/0:100)
Stage		Stroke	MM6-CS250=X-axis: 250mm, Y-axis: 150mm
		Measuring accuracy	X-axis: (3+5L/250) µm, Y-axis: (3+5L/150)µm [L: measuring length (mm)]
Counter display		Minimum readout	0.1µm/0.5µm (selectable)
Power consumption			100 -120/220-240V∼1.6/0.8A 50/60Hz
Dimensions *3			684(W) x 579 (D) x 843(H)mm
Weight *4			Approx. 170kg

*1: With objective lenses for metallurgical microscope
*2: With objective lenses for measuring microscope
*3: STM6-LM microscope stand + MM6-CS250 stage combination,
*4: STM6-LM microscope stand + MM6-CS250 stage + integrated unit combination

DP72

Digital Camera

Rapid high-resolution image acquisition — 12.8 million pixels in only 2.5 seconds.
High sensitivity, low noise design captures even dim fluorescence images.



DP72+MX61L configuration

DP72 Specifications

Camera	Type: Single CCD (Pixel shifting) Peltier cooling (max Ta-10°C)
Image sensor	Size: 2/3-inch Effective pixels: 1.45 megapixels (total pixels: 1.5 megapixels) Scanning method: Progressive scanning
Lens mount	C mount
Image sizes	4140 x 3096, 2070 x 1548, 1360 x 1024, 680 x 512, 340 x 250
Sensitivity	Equivalent to ISO 200/400/800/1600
A/D	12bits
Metering modes	Full image, 30%, 1%, or 0.1% spot metering (user-definable location)
Exposure control	Exposure modes: Auto, Auto SFL, manual AE lock: Available Exposure adjustment: ±2.0 EV, step: 1/3 EV Exposure time: 1/44,000s to 60s
Image integration	Mode: Integral/average Number: 64 (maximum)
Binning	2 x 2, 4 x 4
Color modes	Color/ standard gray scale/ custom gray scale
White balance	Range setting auto/manual
Black balance	Range setting auto/manual
Image file format*1	JPEG/ JPEG2000/ TIFF/ BMP/ AVI/ PNG/ VSI/ PSD
Time-lapse photography	Interval duration: 1 s ~ 24 hr 59 min 59 s Number of images: 3000 (max)
Image transfer time	Approx. 2.5 s*2 (Max resolution of 4140 x 3096, from start to display)
Motion image display	Max 15 frames/s (image size of 1360 x 1024)
Preview image quality mode	Standard/ Medium image quality/ High image quality
OS	Windows Vista Business SP1 32bit, Windows XP Professional SP2 32bit
Dimensions & weight	Camera head: 112(ø)x87.8(H) mm (not including attachment), approx. 1,150 g
	PCI interface board: 181 (W) x 121 (D) x 21.6 (H) mm, approx. 200 g
	Camera interface cable: Approx. 2.7 m
	Trigger I/O cable: Approx. 0.2 m

*1 In combination with DP2-BSW software.
*2 Image acquisition time may take longer if several tasks are active in the background.

Recommended specifications for PC controller

CPU	Intel Pentium4 620 2.8 GHz or higher, Intel Core2 DUO 1.8 GHz or higher [Core2 Duo E6400 2.13 GHz or higher recommended]
Chipset	Intel 945 or later
RAM	DDR2/DDR3 512MB or more (1GB or more for Windows Vista) [PC2-4200 or greater, Dual-channel DDR2 1GB or more recommended]
HDD	Free space 500MB or more
Graphic	VGA card for PCI Express x16 with display of 1280 x 1024 or better, 32-bits color per pixel *Onboard graphic also available
Extension slot	PCI Express x1 Rev.1.0a or later Compatible with half size or LowProfile PCIe board (106.7mmx174.6 mm)
OS	Windows Vista Business, Ultimate 32bit/64 bit Windows XP Professional SP2 or later (Not compatible with x64 Edition)
Power supply	250 W or more (With CE marking)

PC is not included in DP72 system

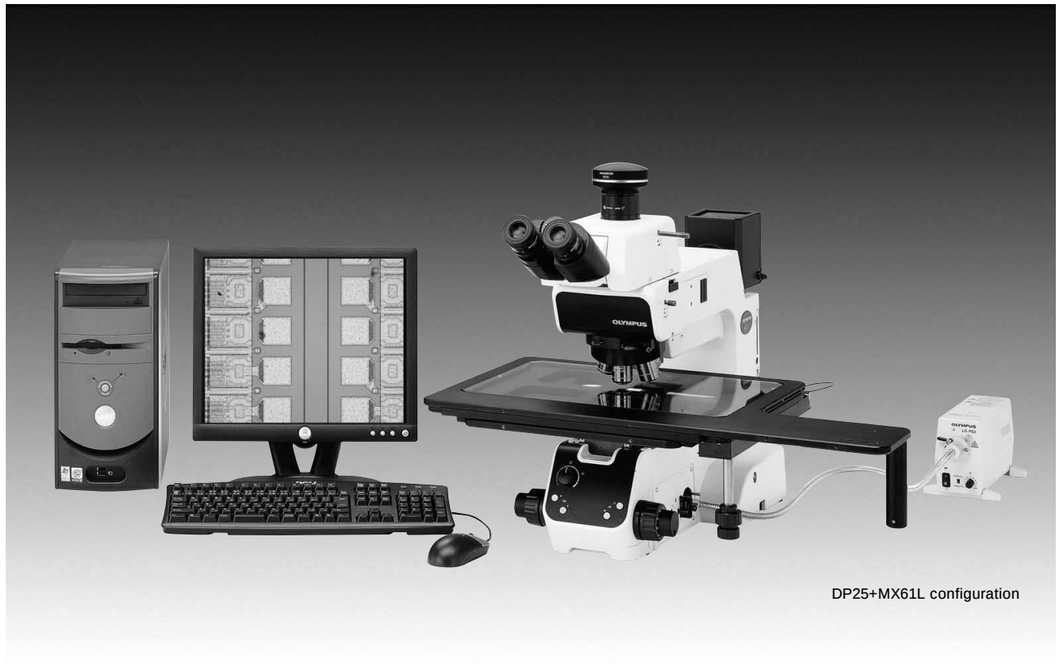
Recommended specifications for laptop PC

CPU	Intel Core2 DUO series 1.8 GHz or higher [Core2 Duo T7300 2.0 GHz or higher recommended]
Chipset	Intel 945 or later
RAM	DDR2 512MB or more (1GB or more for Windows Vista) [PC2-5300 or greater, Dual-channel DDR2 recommended]
HDD	Free space 500MB or more
Graphic	Onboard graphic with display of 1280 x 1024 or better, 32-bits color per pixel
Card slot	PCI Express x1 Rev.1.0a or later
OS	Windows Vista Business, Ultimate 32bit/64 bit Windows XP Professional SP2 or later (Not compatible with x64 Edition)

Laptop PC is not included in DP72 system

DP25
Digital Camera

This outstanding, high-resolution 5 megapixel color CCD camera includes accurate color reproduction and advanced color control among a wealth of features.
It's also versatile enough for work with all types of specimens.



DP25+MX61L configuration

DP25 Specifications

Camera	Type	Single chip color CCD camera
Image sensor	Model	Sony ICX282AQF Interline CCD image sensor
	Size	2/3 inch, 9.74 x 9.74 mm
	Pixel size	3.4 x 3.4 µm
	Color filter	RGB Bayer primary color filter
	Scanning modes	Progressive Interlaced
Microscope camera mount		C-mount
Effective image resolution		2560 x 1920 pixel, 1280 x 960 pixel, 854 x 640 pixel, 640 x 480 pixel
Exposure mode		Auto, manual
Exposure time		1 ms -16 s
Display frame rates		Binning 1x1 (Full resolution): 8.4 fps, Binning 2 x 2: 8.4 fps, Binning 3 x 3: 24fps, Binning 4 x 4: 32 fps
White balance	Mode	Auto, manual
Partial read out		Supported
Sharpness filter		Supported
Interface	PC Interface	FireWire™ (IEEE1394A)
Operating system		Microsoft Windows XP SP2
Camera system		Camera head, interface cable
Dimensions & weight	Camera head	ø86 x 48 mm, approx 350g
	Interface cable	Approx. 4.5 m
Online features		Online shading correction
		Pseudo coloring of live image
		Live image adjustment (contrast, brightness...)
		Image on complete screen

System requirements for DP25

CPU	Required	Pentium 4, 2.4 GHz or higher, Pentium IV, 1.4GHz or higher
	Recommended	Pentium D930, 3.0Ghz, Dual Core, Pentium M, 2.6GHz
Hard disk storage	Required	5 GB or more
	Recommended	20 GB
Memory	Required	512 MB or more
	Recommended	1024 MB
Operating system		Microsoft Windows XP Pro SP2
Ports		IEEE 1394a (FireWire ™), 6 pin type, required power supply Capacity: 12V, 0.2 A (PCI FireWire ™ card included with DP25)
Application program		Application program that supports TWAIN

PC is not included in DP25 system.

DP2-BSW specifications

Hardware support	Dual & multiple screen support
Image acquisition	Live, snapshot, simple time lapse recording
	Auto calibration of magnification
	User defined image naming
	Automatic saving descriptive data to each image
Image handling	Image format: TIFF, BMP, JPEG, JPG2000, Photoshop, AVI
	Extract and separate multi-dimensional image data
	Annotations (drawing elements, scale bar, info stamp)
	Memory management for large image handling
	Synchronize multiple images
Image processing	Online shading correction
	Interactive measurements (Point, arbitrary line, polyline...)
	Image geometry (resize, rotate, mirror...)
	Image enhancement (colors brightness, contrast, gamma)
	Post acquisition shading correction (flat field and background)
	Image filtering & sharpening filters

DP21
Digital Camera

Smooth, high-resolution live image display — ideal for fast, efficient inspections on production lines.

DP21+SZ61 configuration

DP21 Specifications

Type		C-mount CCD Camera Head with Control Unit and Handset
Image Sensor	Size	1/1.8 inch Color CCD
	Effective Pixels	2.01 Megapixels (total: 2.11 megapixels)
	Scanning Method	Progressive Scan
	Color Filter	RGB Bayer Primary Color Filter
	Recording Range	7.04 (H) x 5.28 (V) mm, 8.8 mm (diagonal length)
	Maximum Recorded Pixels	1.92 Megapixels (1600 x 1200)
Image Size File Format	Recorded Pixels	TIFF | TIFF | 1600 x 1200 | 5760 kB SHQ | JPEG | 1600 x 1200 | Approx. 2140 kB or Less HQ | JPEG | 1600 x 1200 | Approx. 720 kB or Less SQ-L | JPEG | 800 x 600 | Approx. 535 kB or Less SQ-H | JPEG | 800 x 600 | Approx. 180 kB or Less
Image Display	Resolution	WUXGA | 1920 x 1200 (display area 1600 x 1200) WSXGA | 1680 x 1050 (display area 1280 x 960) WSXGA | 1280 x 854 (display area 1024 x 768) WXGA | 1280 x 768 (display area 1024 x 768) WSVGA | 1024 x 600 (display area 800 x 600) UXGA | 1600 x 1200 SXGA | 1280 x 1024 (display area 1280 x 960) SXGA | 1280 x 960 XGA | 1024 x 768 SVGA | 800 x 600
Storage Media		USB Memory, Network PC
Mount		C-mount
Sensitivity		Equivalent to ISO 100/200/400
Metering Modes		1% Center (spot), 30% Center (average)
Exposure Control		AUTO/MANUAL AE Lock: Possible Only During Auto Exposure Exposure Correction: ±2 EV in 1/3 EV Steps, Possible Only During Auto Exposure
Exposure Time		AUTO: 2 to 1/20,000 sec. MANUAL: 8 to 1/20,000 sec.
Image Display Speed (frame rate)	Live Image Display	Rate: 15 Frames Per Second (resolution: 1600 x 1200) 27 Frames Per Second (resolution: 800 x 600) Magnifications: 1x, 2x (electric zoom) and 4x (electric zoom)
	Reproductive Image Display	Index Display, Magnifications 1x, 2x and 4x
Input/Output		DC Input Camera I/O: IEEE1394b I/F: USB 2.0 Display Output: DVI-I (digital/analog RGB) Wired LAN: 100Base-TX/10Base-T Serial Port: RS-232C D-SUB 9-pin
Scale Display		View Scale/Hide Scale Available Microscope Total Magnification: 0.01x to 9999.99x *Up to 8 Total Magnifications Can Be Set
Measuring Functions		Distance of 2 Points, 3 Points Circle, Distance between 2 Circle Centers, 3 Points Angle, 4 Points Angle, Perpendiculars, Polygon Area, Boundary Length, Distance of Parallel Lines, XY Distance, Count, and Cross Line

System Requirements for DP2-TWAIN (Control Software)

PC	Intel Pentium 4, Intel Xeon, or Intel Core Duo (or equivalent)
Memory	Windows Vista: 2 GB (3 GB recommended), Windows XP: 1024 MB RAM
HDD	Free Space of 1 GB or More (at the time of installation)
Display	1280 x 1024 Recommended (1024 x 768 or larger), 32-bit Video Card
Drive	CD-ROM Drive
IEEE1394a Cable	1394a Port x 1 6-pin IEEE1394a Port for Desktop PC System 4-pin IEEE1394a Port for Laptop PC System (AC adapter connection required to camera head)
PC Input Device	Two-button Mouse or Three-button Mouse (with scroll wheel recommended), Keyboard
OS	Windows Vista Ultimate 32bit SP2, Windows Vista Business 32bit SP2, Windows XP (SP3 or later)
OS Language	Japanese, English
Web Browser	IE6.0 or Later

analySIS® FiVE

ruler/imager/docu/auto/pro

Digital Power Analyzing — analySIS FiVE software provides sophisticated solutions for all applications involving materials analysis, industry and quality assurance, ensuring efficient and successful results.

Sample combination with an industrial microscope and a digital camera

analySIS® FIVE Specifications

Function/type	ruler	imager	docu	auto	pro
Camera control/microscope control*	✓	✓	✓	✓	✓
Measurement	✓	✓	✓	✓	✓
Stitching images		⋆	✓	✓	✓
Extended focus		⋆	✓	✓	✓
3D image		✓	✓	✓	✓
Particle analysis		⋆	⋆	✓	✓
Database		✓	✓	✓	✓
Report generator		✓	✓	✓	✓
Fourier Transformation		⋆	⋆	⋆	✓
Pattern measurement		⋆	⋆	⋆	✓

* For acceptable cameras and microscopes, please consult your Olympus dealer.
✓: standard ⋆: Can be extended using special expansion software "add-ins". For details, please consult your Olympus dealer.

Hardware requirements

OS	Windows 2000 SP4 Windows XP SP2
Memory	256MB or higher (512MB and more recommended)
CPU	Pentium III 500MHz or higher (Pentium 4 1.8GHz or higher recommended)
Hard disk	200MB or higher
Display	1024 X 768 resolution or higher, 1280 X 1024 resolution, 16.77 million color recommended
Browser	Internet Explorer 3.02 or later (version 6.0 or higher recommended)
Others	CD-ROM drive or DVD-ROM drive

Note: The different models might be available in some areas.

UIS2/UIS Objective Lenses

Universal Infinity System

UIS2/UIS optical characteristics of objective lenses for industrial and metallurgical applications.

MPLAPON series
This is a Plan Apochromat objective lens series for brightfield observation with chromatic aberration corrected at high level. Olympus has assured that this series has the optical performance (wavefront aberration) with a Strehl ratio*1 of 95% or more*2 first in the world as a universal objective lens. This series is also compatible with a differential interference contrast or simple polarized observation.

MPLAPON100xO
This is a Plan Apochromat objective lens of the oil-immersion type*3 that features a numerical aperture of 1.4. It provides the highest level of chromatic aberration correction and a high resolving power.

MPLFLN (-BD) series
These Plan SemiApochromat objective lenses completely eliminate chromatic aberration at high level, which is perfect for a wide range of microscopic methods including brightfield darkfield, fluorescence, Nomarski DIC*4 and simple polarized observation. All 50x or higher objective lenses have 1 mm working distance to fulfill safe approach to the specimen. Since exit pupil positions from 5x through 150x are standardized, no switching of the DIC prism lever position is necessary when the objective lens power changes.

MPLFLN-BDP series
The Plan SemiApochromat POL design ensures through compensation for coma aberration. Distortion is also minimized, which makes these objective lenses the best choice for Nomarski DIC microscopy.

SLMPLN series
This Ultra long working distance Plan objective lens series minimizes a risk of collision between the specimen and the objective lens and it also delivers high contrast imaging.

LMPLFLN (-BD) series
Long working distance Plan SemiApochromat objective lenses provide more free space between the objective lens and the specimen so that it can prevent from collision between objective lens with the stepped specimen. Since exit pupil positions from 5x through 100x are standardized, no switching of the DIC prism lever position is necessary when the objective lens power changes . Use the BD series in brightfield and darkfield observation.

MPLN (-BD) series
Plan Achromat objective lenses with excellent flatness up to F.N. 22. Use the BD series in brightfield and darkfield observation.

LCPLFLN-LCD series
The perfect objective lenses for imaging specimen through glass plate like an LCD application. Aberration correction matched to the glass thickness is possible by using a correction ring.

LMPlan-IR, MPlan-IR series
Plan Achromat objective lenses which compensate for aberrations from visible to near infrared light.

UIS2

Lens optical character	Magnification	N.A.	W.D. (mm)	Cover glass thickness*5 (mm)	Resolution*6 (μm)
MPLAPON	50x	0.95	0.35	0	0.35
	100x	0.95	0.35	0	0.35
MPLAPON	100xO*3	1.4	0.1	0	0.24
MPLFLN	1.25x*7*8	0.04	3.5	—	8.39
	2.5x*8	0.08	10.7	—	4.19
	5x	0.15	20.0	—	2.24
	10x	0.30	11.0	—	1.12
	20x	0.45	3.1	0	0.75
	40x*4	0.75	0.63	0	0.45
	50x	0.80	1.0	0	0.42
	100x	0.90	1.0	0	0.37
MPLFLN-BD*9*10	5x	0.15	12.0	—	2.24
	10x	0.30	6.5	—	1.12
	20x	0.45	3.0	0	0.75
	50x	0.80	1.0	0	0.42
	100x	0.90	1.0	0	0.37
	150x	0.90	1.0	0	0.37
MPLFLN-BDP*9*10	5x	0.15	12.0	—	2.24
	10x	0.25	6.5	—	1.34
	20x	0.40	3.0	0	0.84
	50x	0.75	1.0	0	0.45
	100x	0.90	1.0	0	0.37
SLMPLN	20x	0.25	25	—	1.34
	50x	0.35	18	0	0.96
	100x	0.6	7.6	0	0.56
LMPLFLN	5x	0.13	22.5	—	2.58
	10x	0.25	21.0	—	1.34
	20x	0.40	12.0	0	0.84
	50x	0.50	10.6	0	0.67
	100x	0.80	3.4	0	0.42
LMPLFLN-BD*9*10	5x	0.13	15.0	—	2.58
	10x	0.25	10.0	—	1.34
	20x	0.40	12.0	0	0.84
	50x	0.50	10.6	0	0.67
	100x	0.80	3.3	0	0.42
MPLN*7	5x	0.10	20.0	—	3.36
	10x	0.25	10.6	—	1.34
	20x	0.40	1.3	0	0.84
	50x	0.75	0.38	0	0.45
	100x	0.90	0.21	0	0.37
MPLN-BD*7*9*10*	5x	0.10	12.0	—	3.36
	10x	0.25	6.5	—	1.34
	20x	0.40	1.3	0	0.84
	50x	0.75	0.38	0	0.45
	100x	0.90	0.21	0	0.37
LCPLFLN-LCD	20x	0.45	8.3-7.4	0-1.2	0.75
	50x	0.70	3.0-2.2	0-1.2	0.48
	100x	0.85	1.2-0.9	0-0.7	0.39

UIS

Lens optical character	Magnification	N.A.	W.D. (mm)	Cover glass thickness*5 (mm)	Resolution*6 (μm)
LMPlan-IR*7	5x	0.10	20.0	—	—
	10x	0.25	18.5	—	—
	20x	0.40	8.1	—	—
	50x	0.55	6.0	—	—
	100x	0.80	3.4	—	—
MPlan-IR*7	100x	0.95	0.3	—	—

*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 F.N. 22. No compliance with F.N. 26.5.
*8 Analyzer and polarizer are recommended to the usage with MPLFLN1.25x or 2.5x.
*9 BD: Brightfield/darkfield objective lenses.
*10 Slight vignetting may occur in the periphery of the field when MPLN-BD series objective lenses are used with high-intensity light sources such as mercury and xenon for darkfield observation.

*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 (OLYMPUS in-house equipment) •Temperature : 23 ± 1 centigrade •Measurement Area : 97% in pupil diameter
*3 Specified oil: IMMOIL-F30CC *4 The MPLFLN40x objective lens is not compatible with the differential interference contrast microscopy.

UIS2/UIS Eyepieces

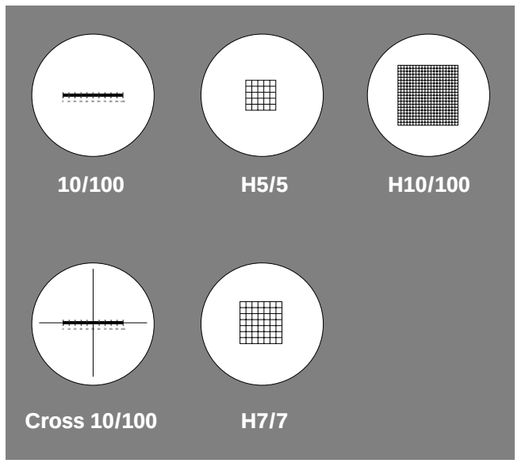
Universal Infinity System

Product	F.N.	Diopter (1/m)	Micrometer (mm)	Remarks
WHN10x	22	—	24	—
WHN10x-H	22	-8 - +2	24	with helicoid
CROSS WHN10x	22	-8 - +2	—	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 filed iris diaphragm, the length of the specimen within the field of view can be measured.
Various types are available to choose from depending on the specimen.



OC-M Specifications

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

Optical Terminology

1. Field Number (F.N.) and Practical Field of View

The field number (F.N.) is referred to as the diaphragm size of eyepiece in mm unit which defines the image area of specimen. The diaphragm diameter actually seen through eyepiece is known as the practical field of view (F.O.V.) which is determined by the formula:

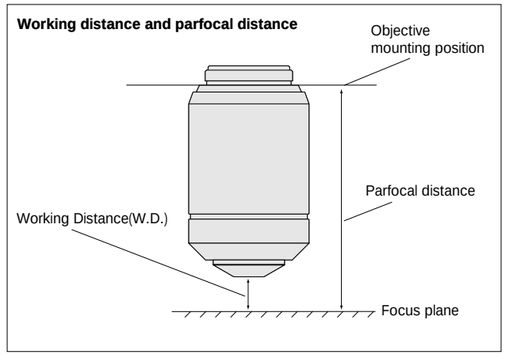
$$\text{F.O.V.} = \frac{\text{Eyepiece F.N.}}{\text{Objective lens magnification}} \text{ (mm)}$$

2. Working Distance (W.D.)

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

3. Parfocal Distance

It is the distance between the objective lens mounting plane and the specimen. In UIS2/UIS objective lenses, the parfocal distance is designed at 45mm.



For parfocal distance of the LCPLFLN-LCD series objective lenses, refer to the objective lens page.

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

Indicated magnifications of UIS2/UIS objective lenses 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 lens magnification
f: Objective lens's focal length

5. Total Magnification

5.1 Observation through eyepiece (binocular observation)

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

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

5.2 Video monitor observation

● Total magnification for video monitor

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

$M_{(\text{video monitor})}$: Total magnification on the video monitor
$M_{(ob)}$: Objective lens magnification
$M_{(\text{video camera adapter})}$: Projected magnification for video camera adapter *(refer to Figure 1)*

** Refer to Figure 3 for "Monitor magnification"*

● Practical field of view for video monitor observation

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

$M_{(ob)}$: Objective lens magnification
$M_{(\text{video camera adapter})}$: Projected magnification for video camera adapter including photo eyepiece *(refer to Figure 1 for projected magnifications)*

** Refer to Figure 2 for image device size*

Figure 1 Video camera adapter and projection magnifications

Video camera adapter (Projection lens)	Projection magnifications
U-TV1x + video camera mount adapters	1x
U-TV0.63xC	0.63x
U-TV0.5xC	0.5x
U-TV0.35xC	0.35x
U-TV0.25xC	0.25x

Figure 2 Imaging device size

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

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

Figure 3 Imaging device size and monitor magnifications

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

Example
What is total magnifications for video monitor when objective lens is 50x, video camera adapter U-TV0.5xC, 2/3" video camera and 21" monitor are used ?

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

•Practical filed of view for video observation(horizontal side):
$M_{(ob)}$=50×, $M_{(video\ camera\ adapter)}$ is 0.5× from Figure 1 and horizontal side of 2/3" imaging device is 8.8mm from Figure 2

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

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

6. Numerical Aperture (N.A.)

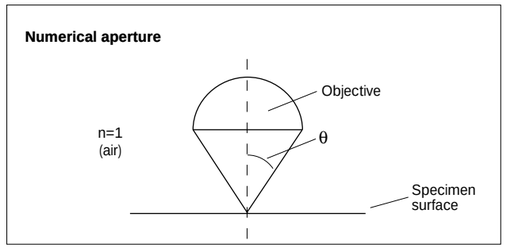
The numerical aperture is a key factor to the performance of objective lens (resolving power, focal depth and brightness).
The N.A. is determined by the following formula:

$$N.A. = n \times \sin\theta$$

n=Refraction rate of the medium between specimen and objective lenses. (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 lens magnification (M). The larger the N.A. and the lower the objective magnification, brightness will increase in the factor of the second power.

$$B \propto \frac{N.A.^2}{M^2}$$



7. Resolving Power

The resolving power of an objective lens 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 N.A., the higher the resolving power.

Resolving power formula

The following formula is generally used for determing resolution.

$$\varepsilon = 0.61 \times \frac{\lambda}{N.A.}$$ (Reyleigh formula)

λ: Wavelength or radiation in use
(λ=0.55µm is used for visible light)
N.A.: Objective lens N.A.

Example
MPLFLN100 × (N.A.=0.90), λ=0.55µm

$$\varepsilon = 0.61 \times \frac{\lambda}{N.A.} = \frac{0.3355}{N.A.} = \frac{0.3355}{0.90} = 0.37\mu m$$

8. Focal depth of Microscope

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

Focal depth formula

Visual observation (Berek formula)

$$\pm \text{D.O.F.} = \frac{\omega \times 250{,}000}{N.A. \times M} + \frac{\lambda}{2\ (N.A.)^2}(\mu m)$$

D.O.F.: Depth Of Focus

ω: Resolving power of eyes 0.0014
(when optical angle is 0.5 degrees)
M: Total magnification
(objective lens magnification x eyepiece magnification)

$$\rightarrow \pm \text{D.O.F.} = \frac{350}{N.A. \times M} + \frac{0.275}{N.A.^2}\ (\lambda = 0.55\mu m)$$

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

Example
With MPLFLN100×(N.A.=0.90), WHN10×:

$$\pm \text{D.O.F.} = \frac{350}{0.90 \times 1{,}000} + \frac{0.275}{0.81} = 0.39 + 0.34 = 0.73\mu m$$

Video camera

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

9. Aberrations

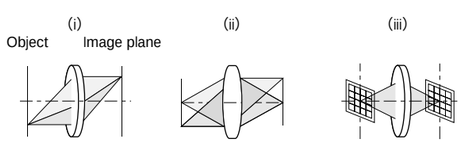
A difference between an ideal image and an actual image that passes through an optical system is called an "aberration."

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

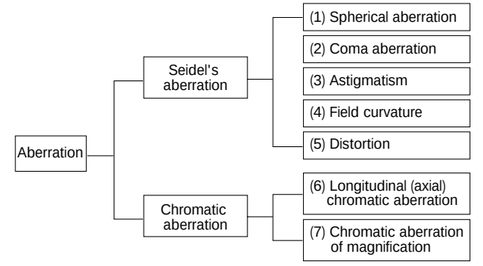


In an actual optical system, however, it is very difficult to strictly meet the requirements for ideal image formation and this causes "aberrations" that interfere with image forming performance.

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"

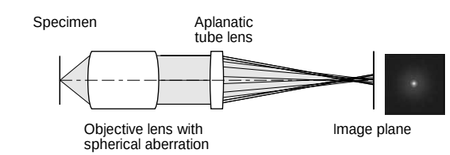
Figure 9-2 Classification of Aberrations



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 "wave-front aberration" that 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 (N.A.) 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 N.A. of axial light rays is called "spherical aberration." ("Spherical aberration" is proportional to the cube of N.A.)

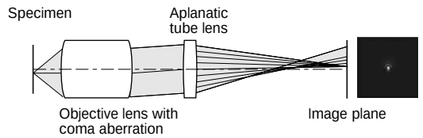
Figure 9-3 Spherical Aberration



It is said that objective lenses with larger N.A. have better resolution but worsen spherical aberration. Our advanced design and manufacturing techniques have realized good optical performance even with large numerical aperture.

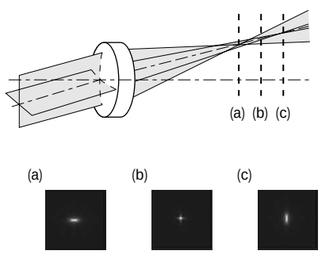
(2) Coma aberration
Even though spherical aberration is compensated to be very small, there are cases where light rays coming out of an off-axis object point are not condensed to a single point on the image plane but generate asymmetric blur just like a comet leaving traces. This is called coma aberration.

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.

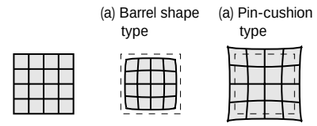
Figure 9-5 Astigmatism and Change in Spot Shape in Different Focus Positions



(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 a 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.

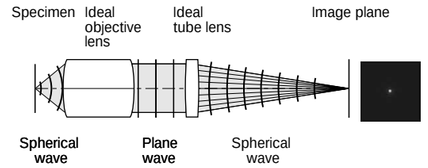
(6) Chromatic aberration
Glasses used for optical systems have different refractive indexes depending on the wavelength. This causes differences in focal length between wavelengths and generates displacement of image forming position. This phenomenon is called "chromatic aberration," which is sometimes 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 (MPlanApo in Olympus), 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

Since a long time ago, 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 adopt "wave optics," which regards light as "waves" and handles the phase information, taking account of the influence of diffraction.

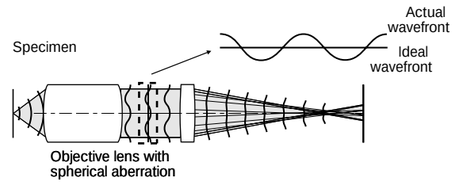
In such a case, "wavefront aberration" is used for evaluation.
As shown below, when requirements for ideal imaging are satisfied in a microscope optical system, the spherical wavefront (spherical waves) coming from a single point on an object (specimen) is converted to plane waves through an ideal objective lens. 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

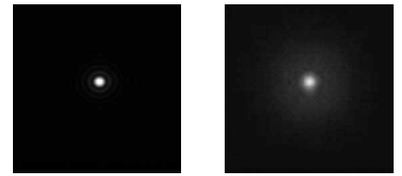


A difference (a degree of disagreement) between the ideal wavefront and the actual wavefront shown above is called "wavefront aberration."

9.4 Strehl ratio

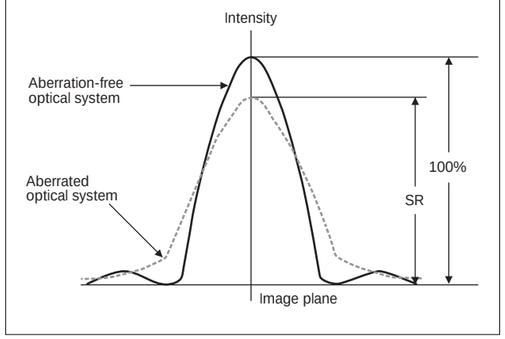
When a point light source is observed with an aberration-free optical system and an aberrated optical system , the former concentrates the focal point to a point at the image formation position. In contrast, the latter fails to produce a focal point, instead causing a spread in the intensity distribution 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 lens. 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 (544nm).

Memo

Memo