Lasertec

HYBRID LASER MICROSCOPE

OPTELICS HYBRID

Optical technology at its best! Performance surpassing laser-scanning microscopes

In 1985, Lasertec released the world's first industrial-quality RGB confocal laser-scanning microscope

Lasertec then released red laser and violet laser microscopes and, in 2001, white light confocal scanning microscopes

1985 World's first

2LM11
The world's first RGB confocal laser scanning microscope for industrial use

1987

1LM21
Red laser-scanning microscope

1999

VL2000D
Violet laser-scanning microscope

2001

HD100D
White light confocal scanning microscope

2003

S130/C130
White light confocal scanning microscope with wavelength selection

2007

H1200WIDE
High-speed and multi-functional white light confocal scanning microscope

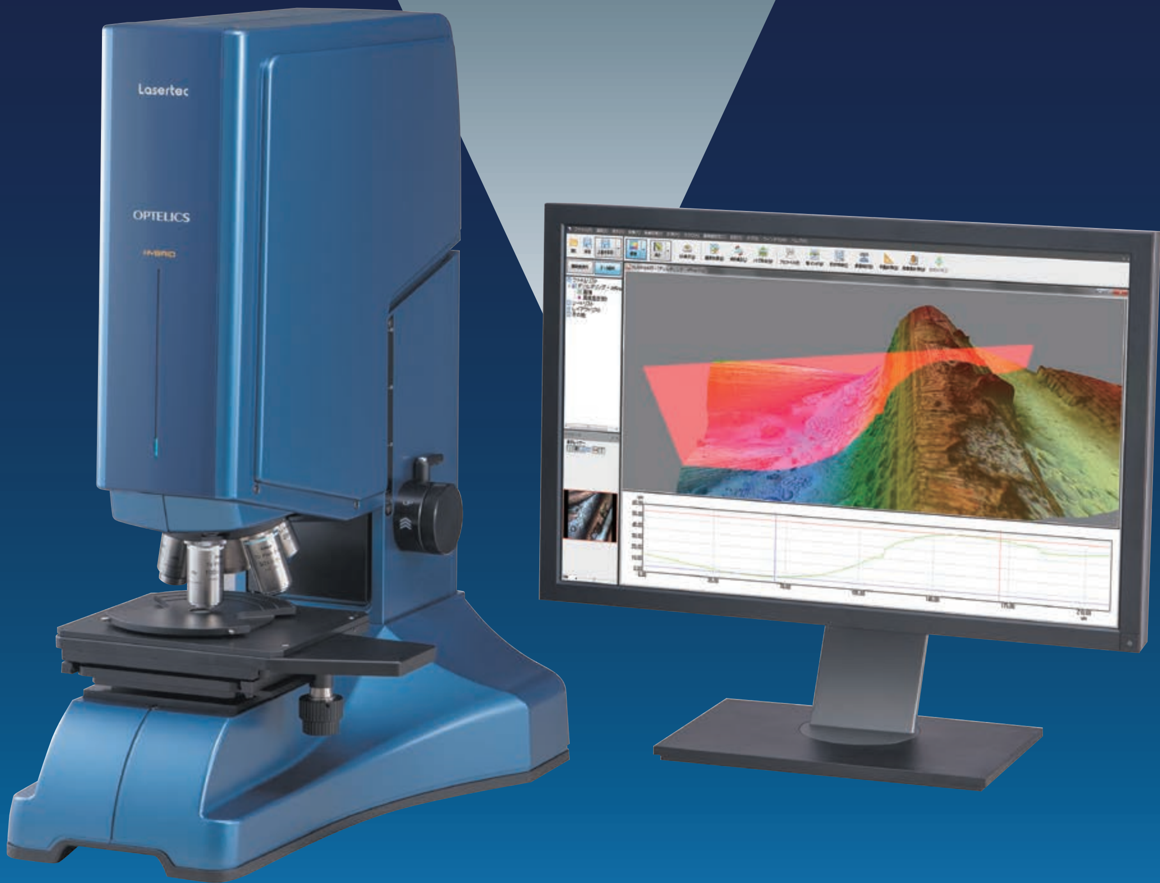
World's first

Today

With laser and white light source combined in one body

Multi-functional high-performance confocal microscope

OPTELICS HYBRID



Multi-functional and high-performance HYBRID

White light confocal + Laser Confocal

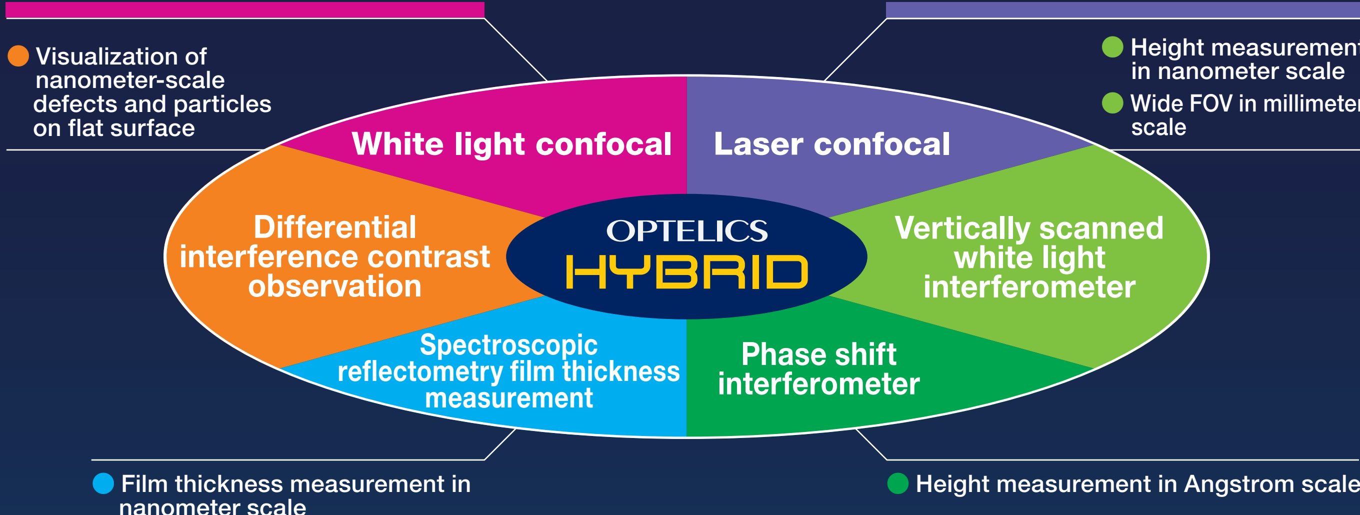
White light confocal and laser confocal

6 functions in one body

Featuring two sets of confocal optics combined with additional functions including interferometer, differential interference contrast observation, and spectroscopic reflectometry film thickness measurement, HYBRID performs multiple tasks that normally require several different tools.

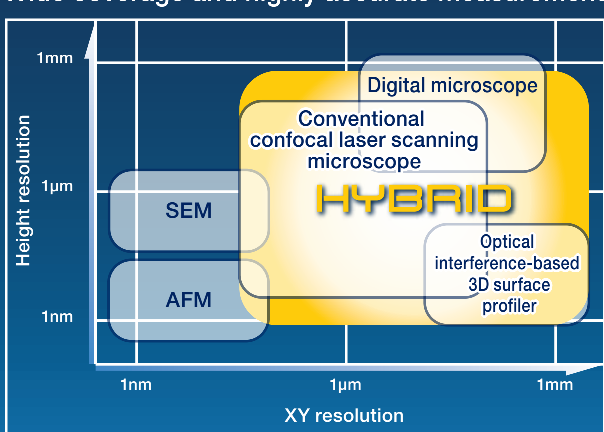
- High-definition 24bit full color observation
- Wide FOV observation/measurement
- Transparent film thickness measurement in micrometer scale

- High magnification
- High resolution
- High contrast



Faster, wider and more accurate

Wide coverage and highly accurate measurement



One-stop solution

Criteria \ Tool	Interferometer surface profiler	Typical CLSM	SEM	Contact-type roughness gauge	AFM	HYBRID
Resolution (XY)	😐	😊	😊	😐	😊	😊
Color image	😠	😐	😠	—	😠	😊
Wide FOV	😊	😐	😐	😊	😠	😊
3D measurement	😊	😊	😐	😐	😊	😊
Nano-scale profile measurement	😊	😐	😠	😊	😊	😊
Sample preparation	😊	😊	😠	😊	😊	😊
Speed	😊	😐	😐	😠	😠	😊

Confocal optics - basic principle of technology

Basic principle

Confocal optics detects only the rays of light focused on the sample surface. Light emitted from the source and reflected by the sample surface reaches the detector only if it is focused at the pinhole in front of it (Figure1). This takes place only for the rays of light focused at the sample surface. The light rays from the sample surface in focal plane reach the detector but all others do not (Figure2). Confocal optics detects in-focus information only.

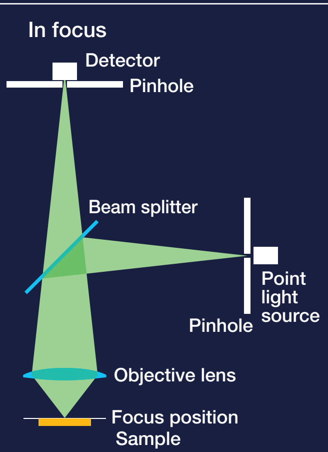


Figure 1

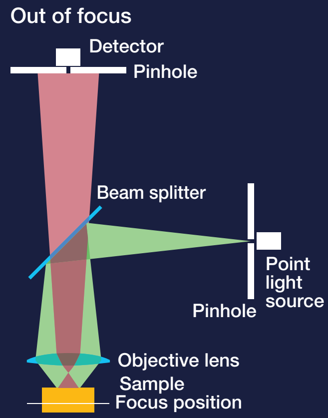
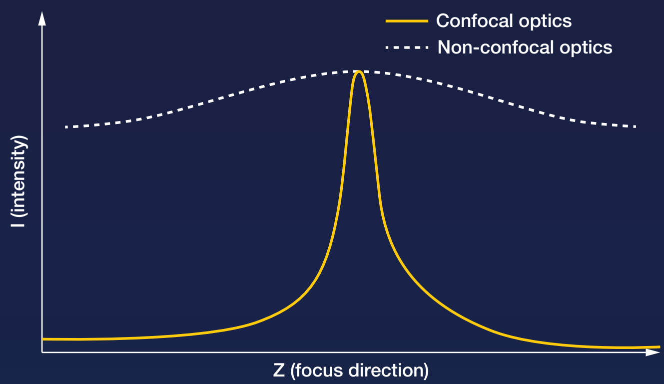


Figure 2

Merits of confocal optics

1. High resolution
2. High-contrast high-definition images without scattered light interference (Figure3)
3. Optical sectioning effect (see below)

These merits enable HYBRID to provide highly accurate measurement in x, y and z directions.



IZ curve

Figure 3

Optical sectioning effect

HYBRID continuously captures in-focus images of a sample being moved in z direction by taking advantage of the confocal optics principle that reflected light has its maximum brightness when it is in focus (Figure 4).

Effect1

By recording maximum brightness at each pixel, all-focused images can be captured (Figure 5).

Effect2

By recording the z position of each pixel at its peak brightness, 3D measurement such as shape and surface roughness measurement is possible (Figure6).

Figure 4

Figure 5

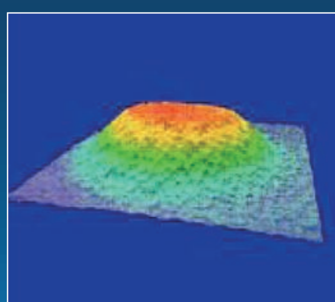
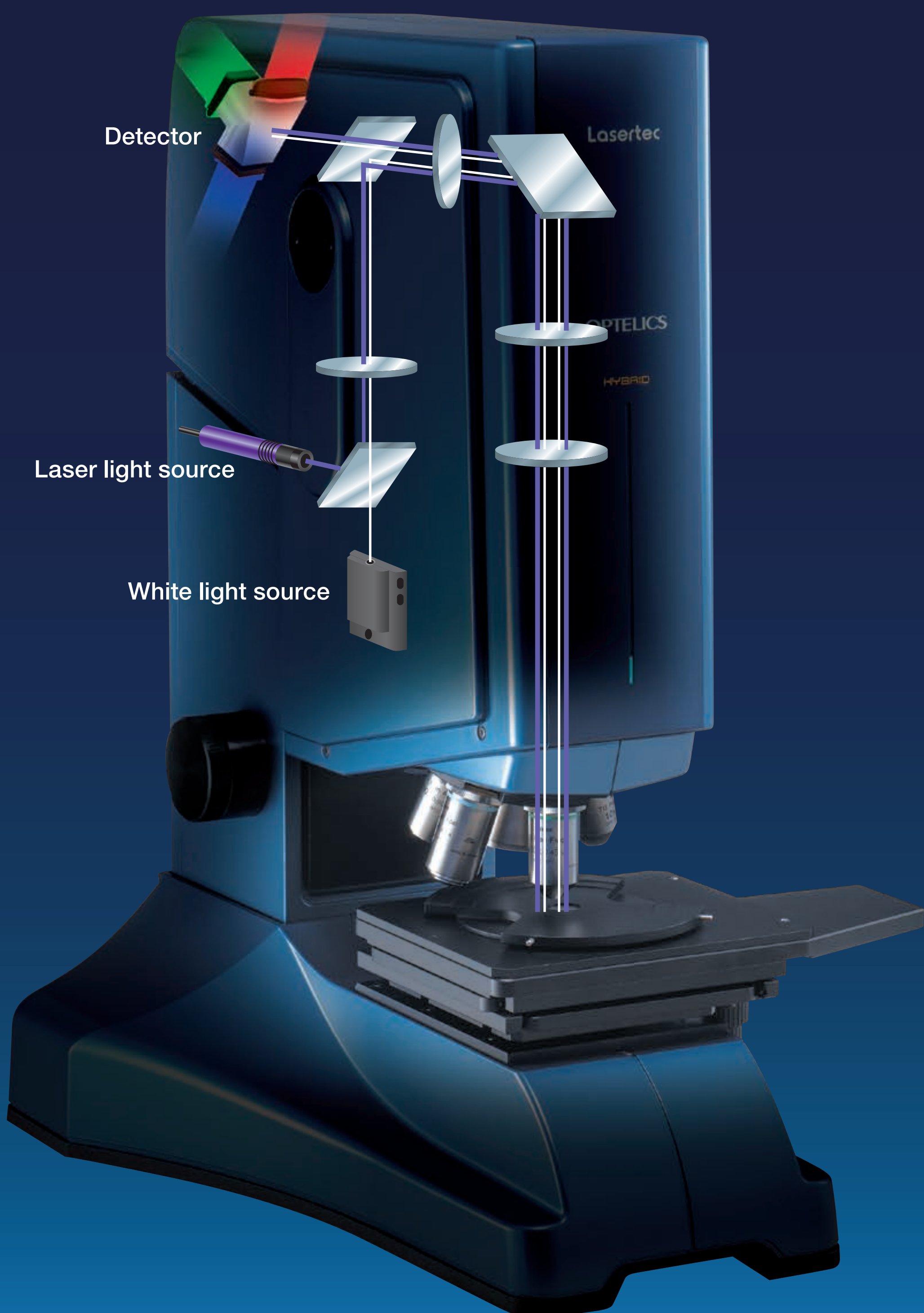


Figure 6

Unique confocal optics of HYBRID

Unique confocal optics of HYBRID

1	Two types of light source - white light and violet laser	Multiple functions and high-definition 24bit full color imaging
2	Detectors that detect each of RGB wavelengths simultaneously and separately	Detection channel switching function
3	Proprietary light scanning method that maximizes the performance of large-aperture low magnification objective lens	Up to 15mm wide FOV



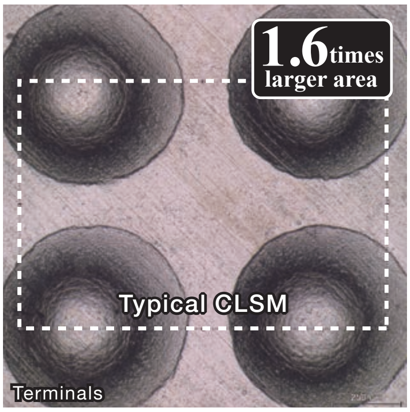
OPTELICS HYBRID means

White light confocal

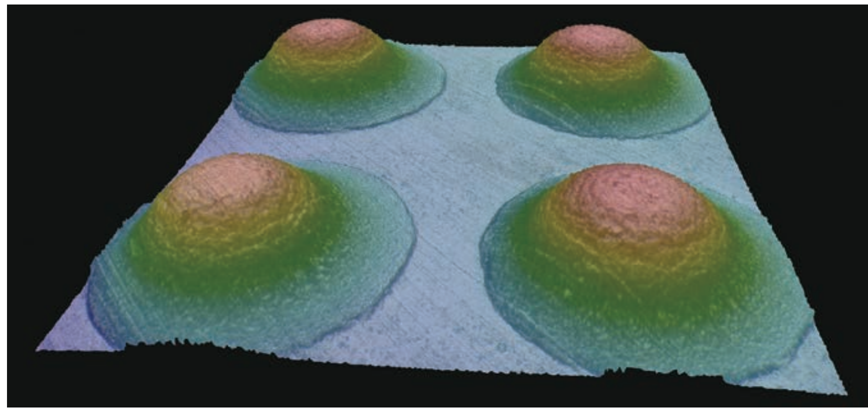
Wide FOV for efficient observation

FOV 1.6 times wider than a typical CLSM ※ When objective lens of the same magnification is used

■ 10x objective lens (FOV 1,500um)



3D image



High precision measurement at low magnification

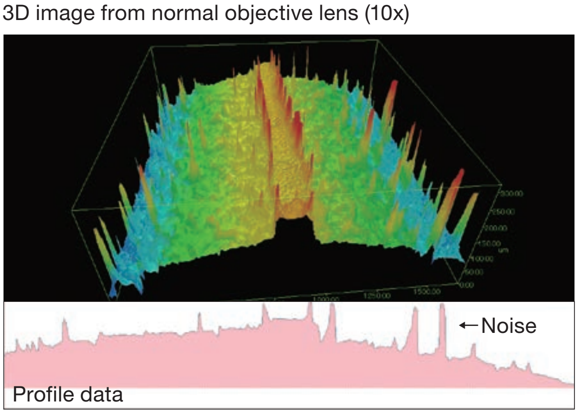
With the use of our special objective lens, high precision measurement at low magnification, which CLSM is hard to achieve, is made possible.

Objective lens designed especially for wide FOV and high precision measurement

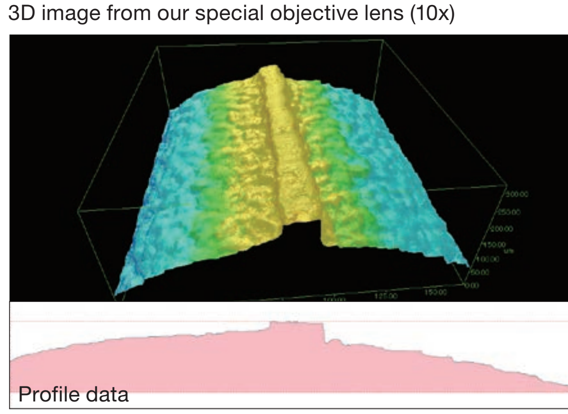
High-NA objective lens available for 5x, 10x, 20x magnification

Magnification	Normal objective lens NA	Special objective lens NA	FOV
5×	0.15	0.25	3,000×3,000µm
10×	0.30	0.50	1,500×1,500µm
20×	0.45	0.75	750×750µm

■ 3D image from normal objective lens (10x)



■ 3D image from our special objective lens (10x)

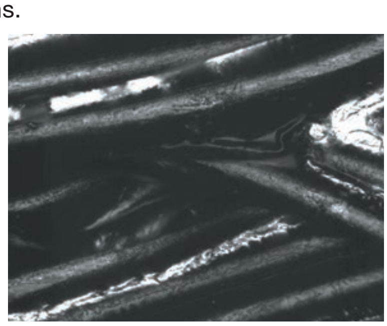


Wide FOV and high precision

FOV 6.5 times wider than typical CLSM is possible, thanks to HYBRID's wide FOV and the use of special high-NA low magnification objective lens.

■ Image from typical CLSM

20x objective lens (NA 0.46)

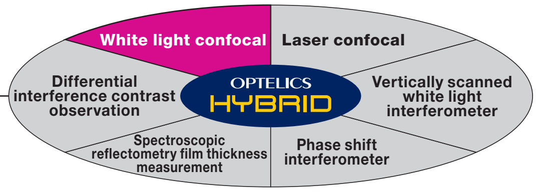


Copper wire (FOV 670µm×500µm)

■ High-definition wide-FOV image available with HYBRID

10x objective lens (NA 0.50)

(FOV 1,500µm)



High-definition images of white light confocal

With the use of Xenon lamp similar to sunlight as light source, high-definition images with good color separation and high depth of field are available.

■ Black and white image from CLSM

Butterfly scales

■ Color image from CLSM

Composite image with non-confocal color image

■ Color image from HYBRID

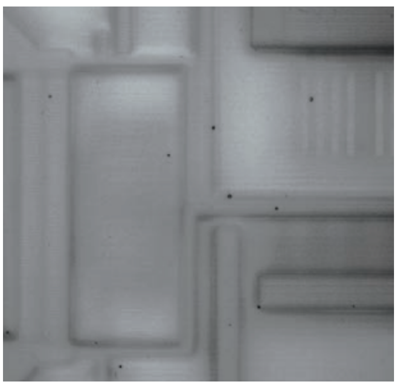
High definition image of white light confocal

Widening applications with detector channel switching

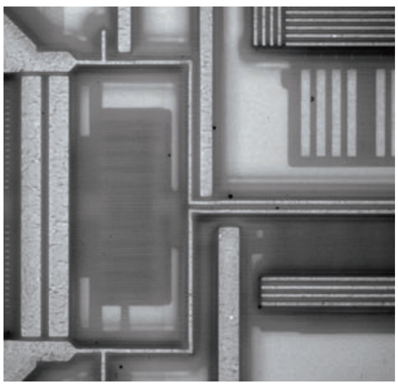
Detector channel switching allows observation and measurement to be performed in the most suitable wavelength.
It also widens your applications to samples for which laser light cannot provide a clear picture.

■ Different observation result of each channel

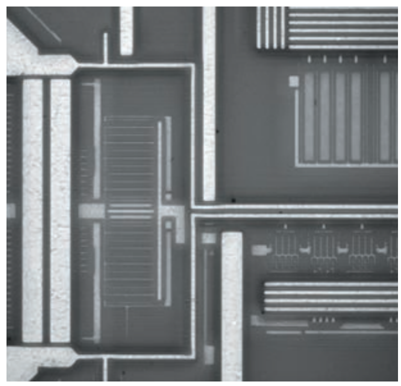
Upper layer observation: blue channel



Middle layer observation: green channel



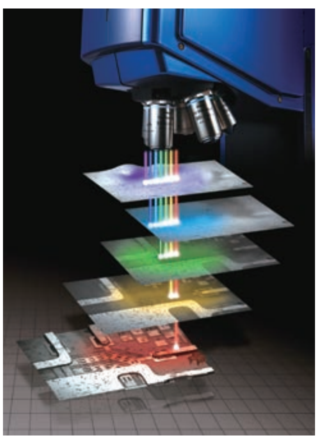
Lower layer observation: red channel



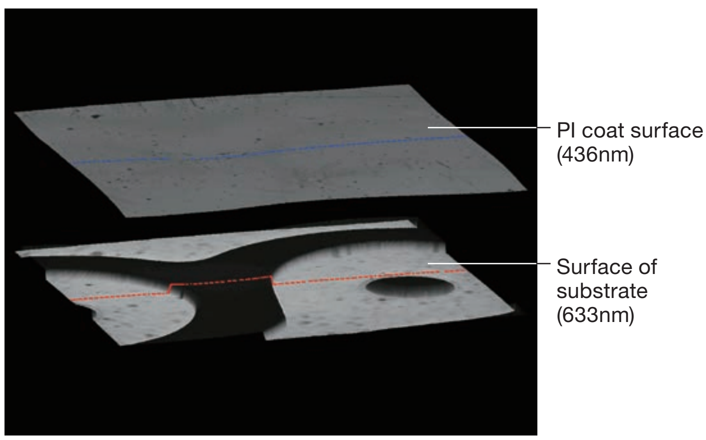
PI-coated communication device

Widening applications with light wavelength selection

The selection of 6 different wavelengths of light source is available. It allows you to select the best wavelength for your observation and measurement and widens your applications to samples susceptible to damage in a particular wavelength of light, such as resist film or UV curable resin, and samples that absorb a particular wavelength of light.



Multi layer observation using wavelength selection (concept illustration)



PI-coated flexible printed circuit board

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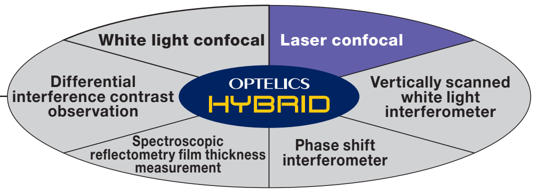
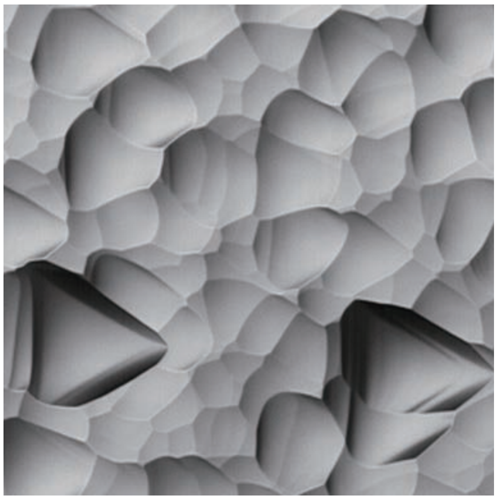
Laser confocal



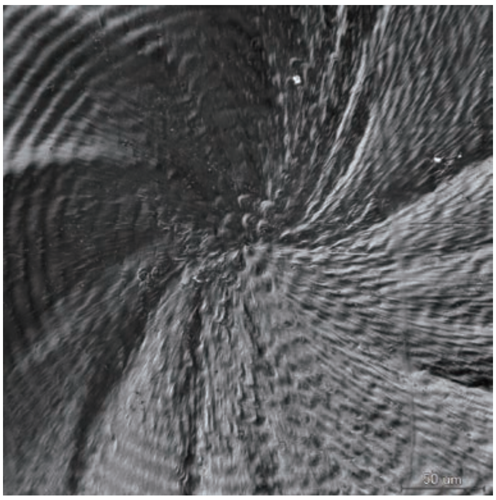
High-magnification, high-resolution observation

The 405nm-laser light source allows you to capture the nanometer-scale world in an instant. Ultrafine structures can be visualized clearly.

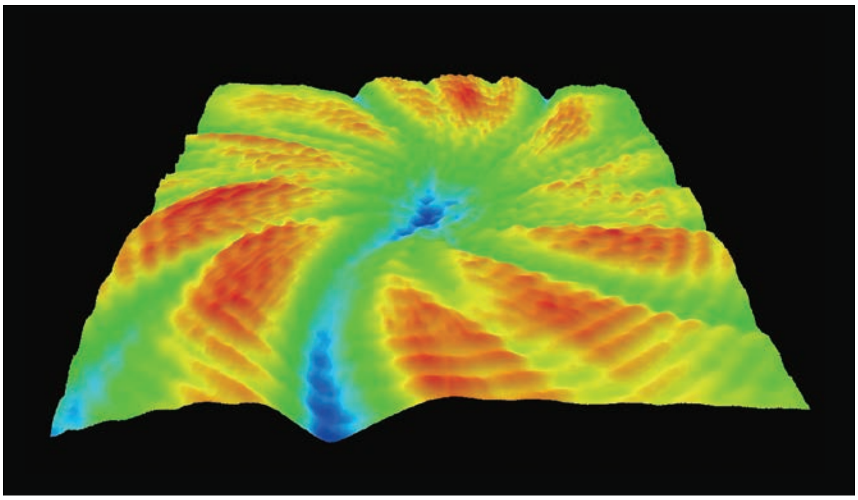
Sodium niobate domain observation
(FOV 25um, 11,000x magnification on monitor)



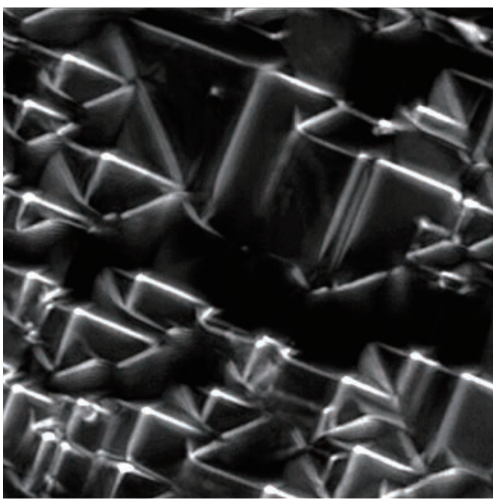
Si wafer backside
(FOV 75um, 3,700x magnification on monitor)



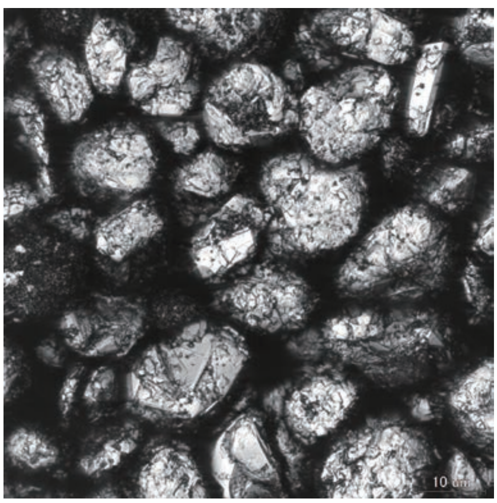
Polymer blend crystal
(FOV150um, 1,850x magnification on monitor)



3D image of polymer blend crystal
(FOV150um)



Solar cell texture
(FOV50um, 5,500x magnification on monitor)



Active material of lithium ion battery
(FOV75um, 3,700x magnification on monitor)

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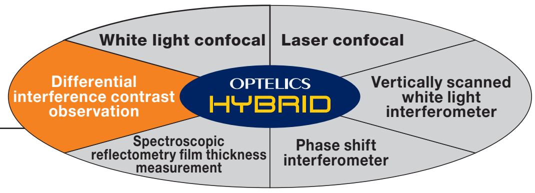
Differential interference contrast observation / In-situ observation

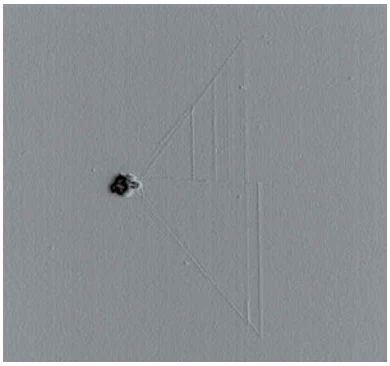


Nanometer-scale surface morphology visualization

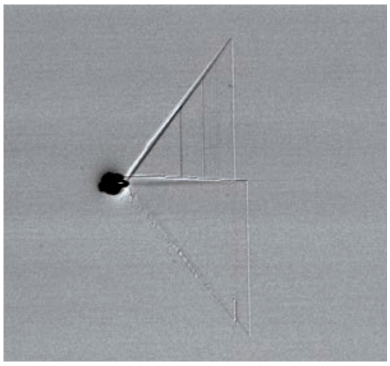
High contrast visualization of nanometer-scale surface morphology based on the combination of confocal and differential interference contrast (DIC) optics.

■ Without DIC ■ Digitally-processed DIC image ■ Optical DIC image from HYBRID

Epitaxial defects on S : C (FOV 1,500um) not visible



Not clear



Clearly visible

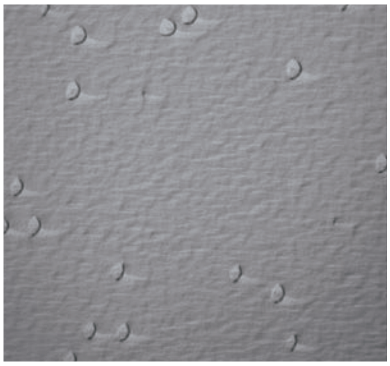
Step bunching on SiC wafer (FOV 1,500um) not visible

Not clear

Clearly visible

GaN epitaxial defects (FOV 1,500um) not visible

Not clear



Clearly visible

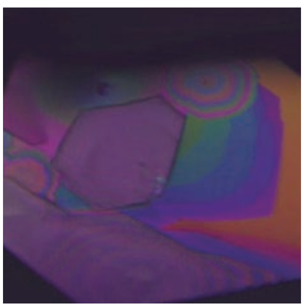
In-situ observation

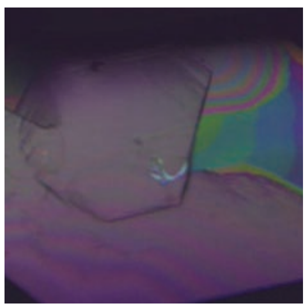
Real-time observation of liquid and other samples

Typical usages

- Observation of phase transition of metal and inorganic samples under changing temperature conditions
- Video capture of crystal growth or phase transition in liquids

■ Before transition ■ In transition ■ After transition





Crystal growth and transition in a cadmium iodide liquid (high-definition video capture and playback at high speeds up to 15 frames per second is available)

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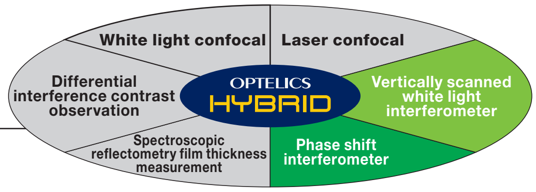
Optical interference measurement



Nanometer-scale height measurement in a wide FOV

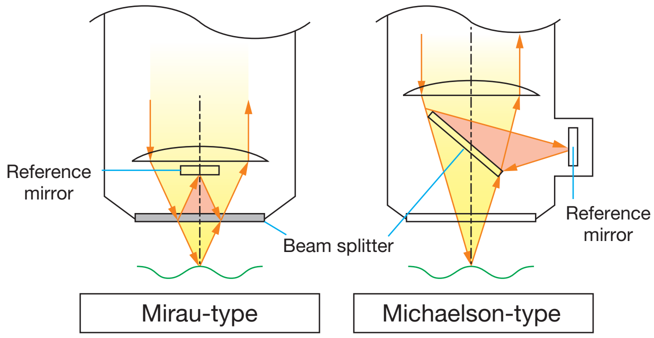
Nanometer-scale precise height measurement in a millimeter-scale FOV is possible.

Features

The resolution in height measurement using optical interference is independent from objective lens NA. It is therefore possible to have high resolution even in a wide FOV. This is suitable for measuring ultrafine concave/convex, surface roughness and unevenness while maintaining a millimeter-scale wide FOV. You can dramatically broaden a range of measurement applications by complementing this method with confocal, which is more suited to measure slopes and rough surfaces.

Basic principle of optical interference measurement

Surface profiles are measured in nanometer-scale resolution from the analysis of interference patterns generated by interference objective lens. Light is split into two arrays by a beam splitter inside the objective lens. One of the arrays is reflected by the sample surface while the other array goes to the reference mirror and reflected there. Both reflected beams are superimposed in the objective lens to form interference patterns caused by optical path differences. As the tool is adjusted to have no optical path difference in a focus position, interference fringes indicate concaves and convexes on sample surface.



Typical interferometer objective lens

Two types of interference measurement method

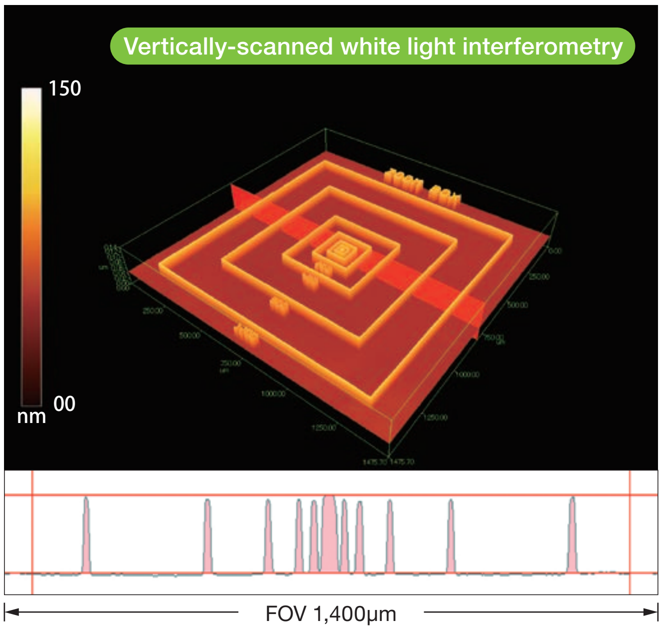
Vertically-scanned white light interferometry

Interference fringes have the strongest contrast at in-focus plane. The peak of brightness in interference fringe is detected to measure height with the operability of confocal microscope.

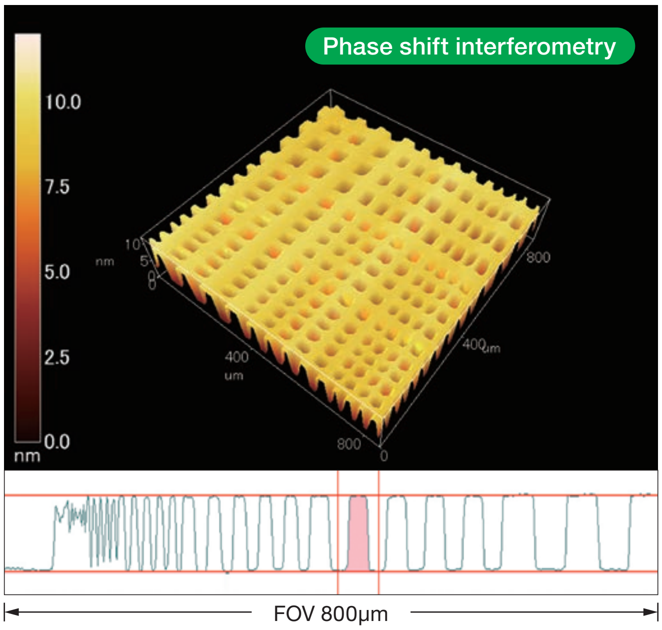
Phase shift interferometry

Height measurement in Angstrom-scale accuracy is available from the phase analysis of interference fringes in a single wavelength of light (546nm) that are obtained as the phase is being changed in multiple steps. The measurement range is limited within a half wavelength but the merit is its short measurement time, which is a few seconds.

■ Example of measurement (45nm height)



■ Example of measurement (8nm in height)



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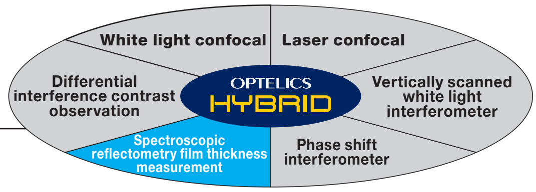
Spectroscopic reflectometry film thickness measurement



Transparent film thickness measurement

You can measure the thickness of transparent films using the capability to select 6 wavelengths in white light. Measurement area is user-settable. This function is applicable to either all surface coated films or patterned films.

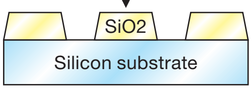
Features

Spectroscopic reflectometry is available to measure transparent film thickness in nanometer scale. It compensates for the shortcoming of confocal optics, which cannot detect a focus position for a film with thickness close to the wavelength of light, thus failing to measure the thickness. HYBRID offers this spectroscopic reflectometry to broaden its applications to such a thin film measurement.

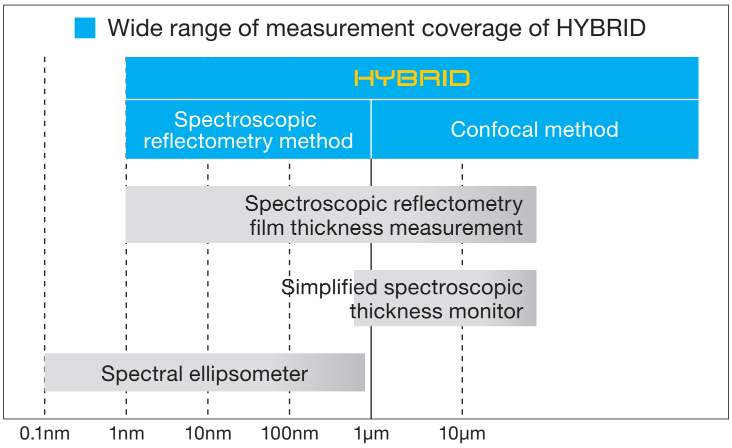
Samples

- Oxidized film
- SOI multi-layer film
- Other transparent film
- Residue from etching

Thin film thickness measurement in narrow area is possible



■ Wide range of measurement coverage of HYBRID



※Confocal's XZ cross section measurement is suitable for measuring film thicknesses more than 1um.

Principle of spectroscopic reflectometry

Spectroscopic reflectometry

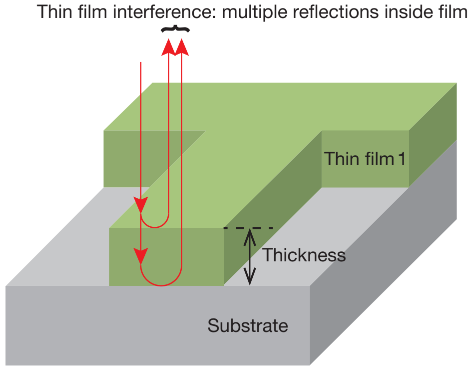
Film thickness can be measured using the reflectance spectrum obtained from spectroscopic reflectometry after parameter fitting with optical simulation model.

Reflectance spectrum

It shows the relation between absolute reflectance and wavelength. It varies depending on film thicnknesses and optical constants.

Absolute reflectance

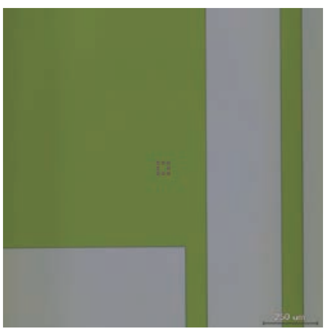
It is determined by thin film interference caused by multiple reflections of light between film surface and substrate.



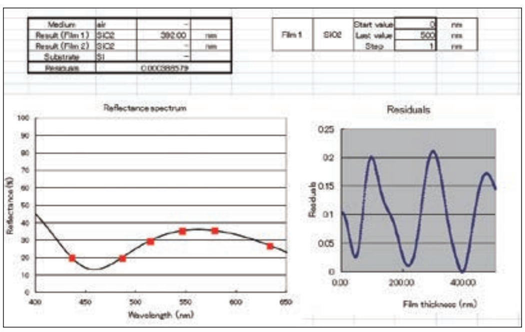
Spectroscopic reflectometry of HYBRID

Six wavelengths are selected from white light to obtain a reflection image for each and to calculate reflectance.
Optical constants (refractive index and extinction coefficient) for thin film and substrate are used in optical model to calculate absolute reflectance from Fresnel coefficient and to measure film thickness after parameter fitting.

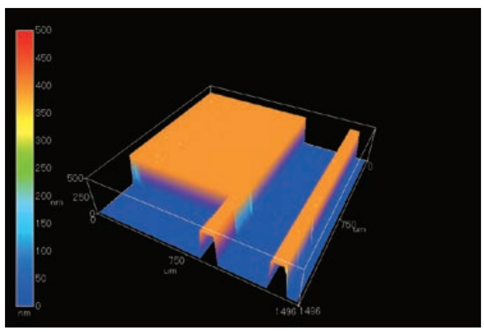
■ Example of measurement (Oxide film patterns on Si wafer)



Observed image ■ Oxide film ■ Si



Film thickness analysis (parameter fitting)
Film thickness: 392nm



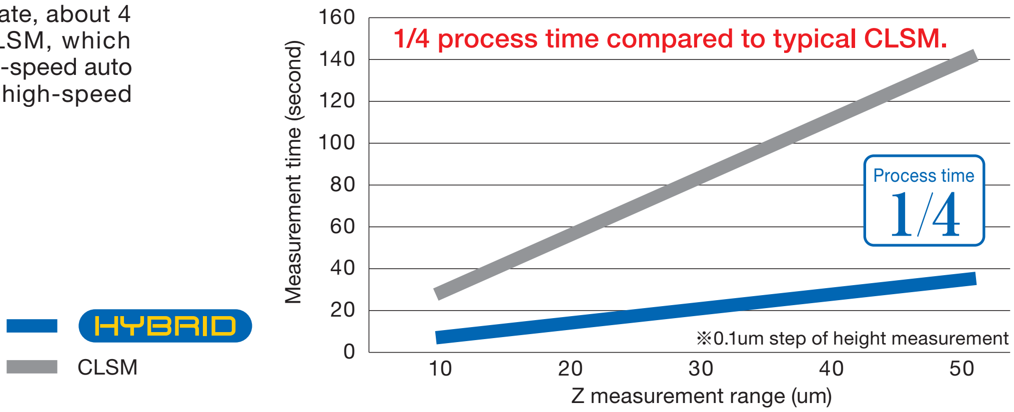
Film thickness measurement (distribution)
Z scale: 500nm

High speed and high precision measurement

Industry-leading speed

Industry-leading measurement speed

HYBRID achieves 15Hz frame rate, about 4 times faster than a typical CLSM, which makes it a powerful tool for high-speed auto measurement, patchwork and high-speed video observation.



High speed patchwork

This function allows you to stitch a large object as the one shown on the right with ease. It creates a wide FOV image smoothly. The process time is about 1/6 of that required for a typical CLSM. (Number of screens required: 1/1.5, measurement time per screen: 1/4)

Process time
1/6

Patchwork of typical CLSM

Patchwork of HYBRID
(Diameter 22mm)
※Number of shots above simulated

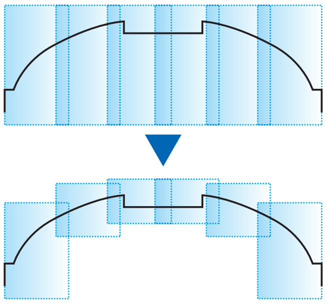
3D image

High-speed automatic optimization of measurement range

In patchwork, height gap within each FOV is automatically detected to adjust measurement range. It prevents image input errors and dramatically shortens scan time.

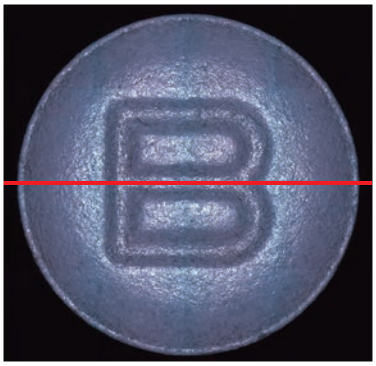
Image capture range in Z axis direction

Auto optimization OFF



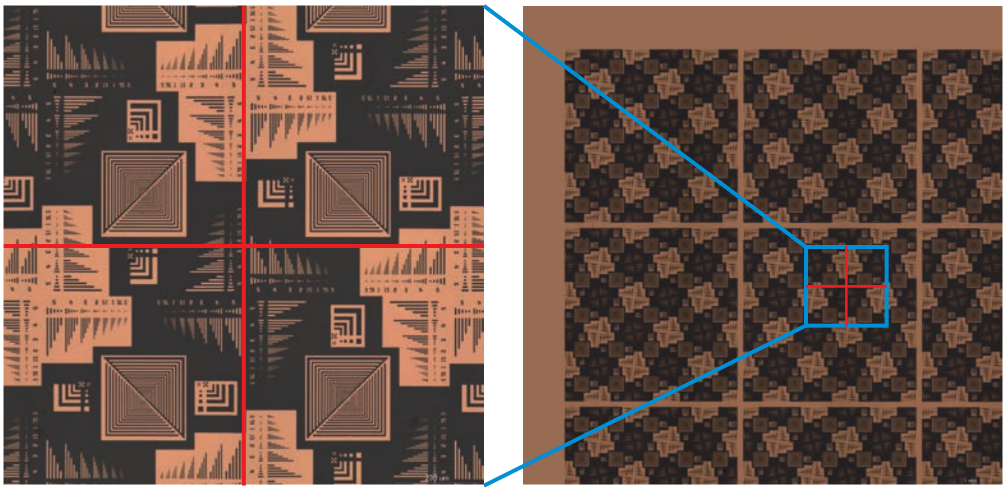
Auto optimization ON

Cross section of patchwork



Area mapping

Current measurement position can be displayed on a wider FOV image. The function also allows you to move to the measurement point with one click, auto patchwork in a specified area on the map and coordinate information control in a specified position.



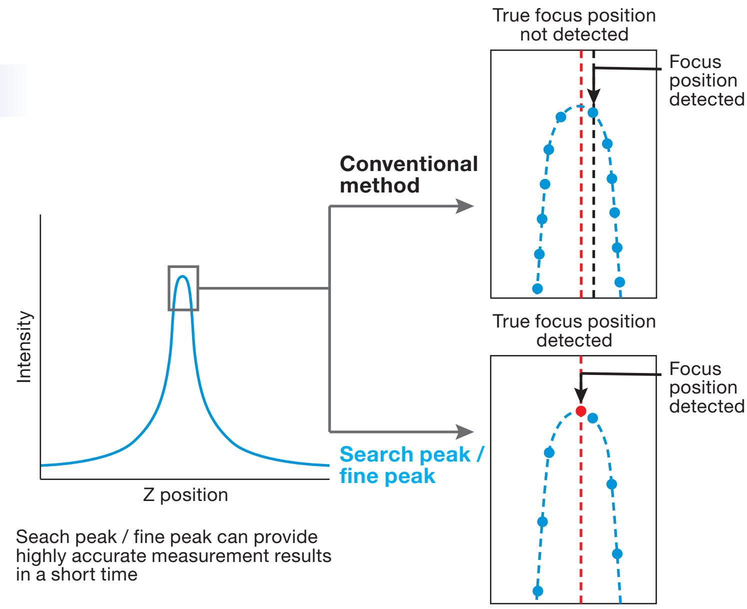
Industry-leading measurement accuracy

Industry-leading measurement accuracy and repeatability

High accuracy required for measurement tools

High accuracy

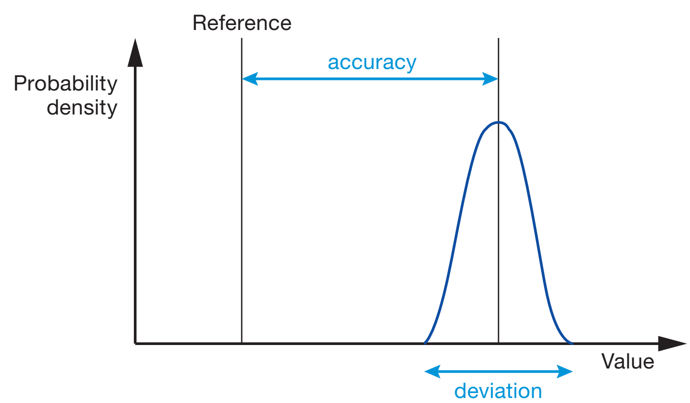
Line width: ±[0.02x(100 / objective)+L/1000] μm
Height measurement: ±(0.11+L/100) μm
Both at industry-leading level



Seach peak / fine peak can provide highly accurate measurement results in a short time

High level of repeatability

Line width measurement 3σ：10nm
Height measurement σ：10nm
HYBRID achieves an industry-leading repeatability and detects a true peak located in a measurement gap based on IZ curve calculated with a special algorithm.

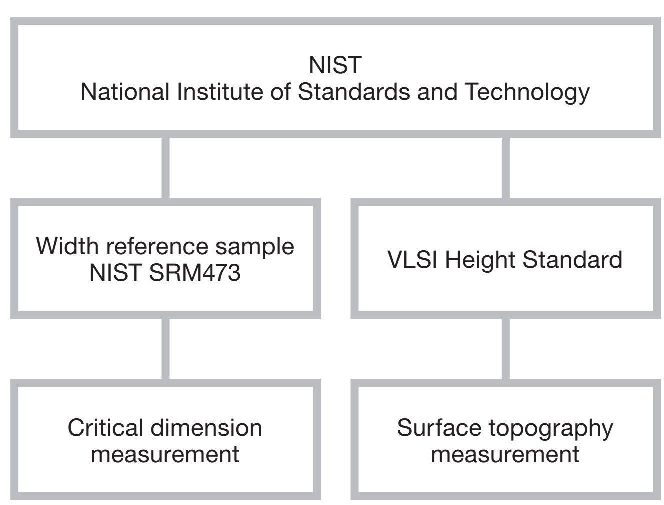


Reliability

Outgoing inspection is performed on HYBRID using reference samples with correct traceability to ensure strict quality assurance.

Traceability system

OPTELICS HYBRID is calibrated conforming to the standards traceable to National Institute of Standards and Technology



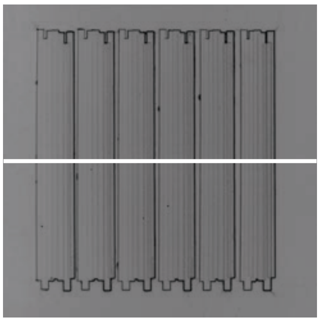
Various measurement and analytical functions

Applicable to various usages

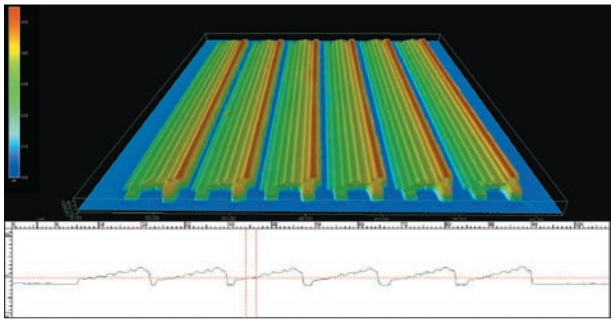
Profile / comparison measurement

Surface shape measurement on a user-specified line. Comparison measurement is available for measuring the difference in multiple lines.

- Measurement criteria: width, height, angle, proximate radius, deviation



Nanoimprint mold

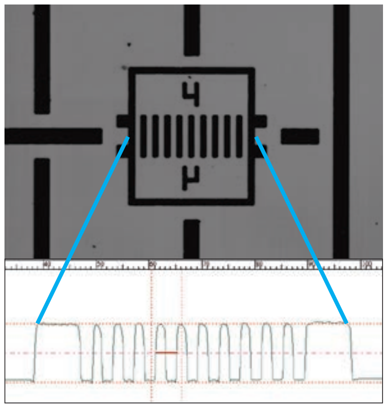


3D profile / step height: 45nm

Width and pitch measurement

Ideal for measuring semiconductor pattern line widths. Industry-leading accuracy and repeatability is achieved with unique optics and detectors.

- Accuracy: ±[0.02×(100/ objective magnification)+L/1000]µm (Ex. ±0.025µm for 5µm line width)
- Repeatabilty: $3\sigma = 0.01$µm



Line width standard

Brightness graph

Surface roughness measurement

Surface roughness measurement conforming to JIS and ISO parameters. High resolution roughness measurement is possible for any type of samples thanks to its non-contact measurement.

2 dimensional roughness

Surface roughness: Ra,Rp,Rv, Rc,Rt,Rq,Rsm,Rk,Rpk,Rvk, etc.

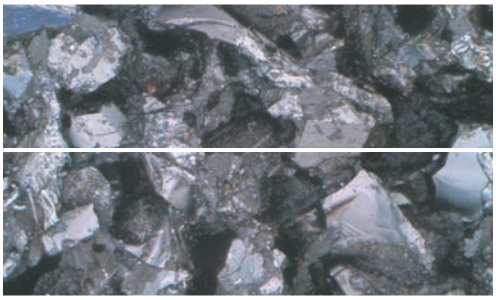
JIS B0671：Rk,Rpk,Rvk,Mr1, Mr2,A1,A2, etc.

Rmr

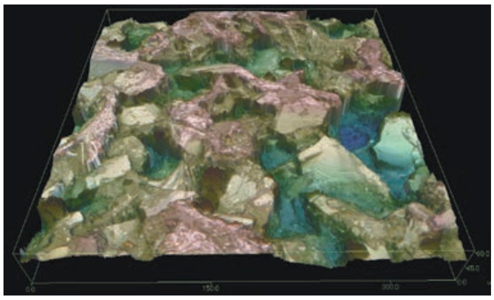
3D roughness

Roughness parameters：Sa,Sp, Sv,Sz,Sq, etc.

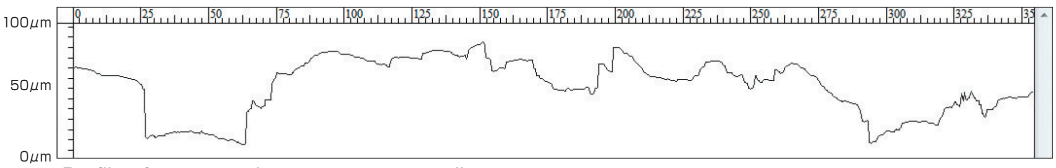
Volume parameters：Sk,Spk,Svk, Smr1,Vvc,Vvv, etc.



Diamond grinding stone



3D image

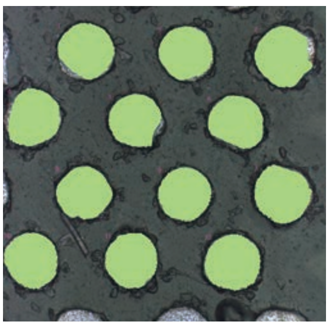


Profile of cross section at measurement line

Analysis of geometric properties

HYBRID analyzes more than 20 properties including area, volume, center of gravity, etc. Output of analysis result is available in a spreadsheet format.

Binary image



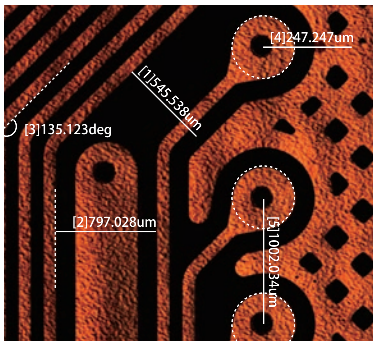
Bump

	Area	Volume	Maximum height
No. 1	17037.588	70413.92	6.6
No. 2	18619.303	63011.302	6.924
No. 3	16053.775	56333.613	5.431
No. 4	16992.801	71030.903	6.489
No. 5	15471.548	62414.267	6.174
[illegible]	[illegible]	[illegible]	[illegible]
Maximum	18619.303	71030.903	6.956
Minimum	15471.548	38180.167	4.062
Total	200524.013	691960.245	71.52
Average	16710.334	57663.354	5.96
Standard deviation	952.076	11291.086	0.919

Analysis result

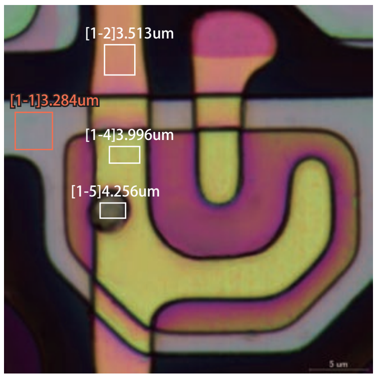
2D measurement

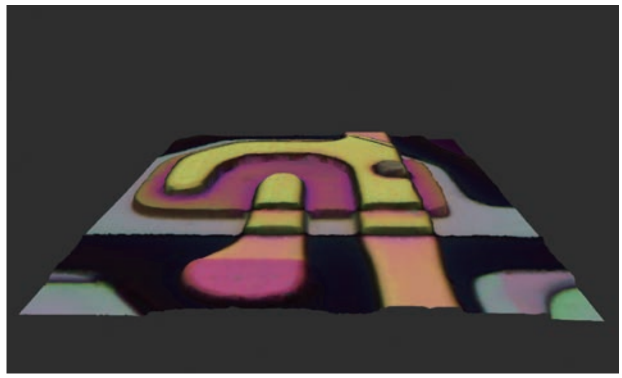
Measurement of 2 dimensional features such as length, angles, radius and counting of features



Height difference measurement

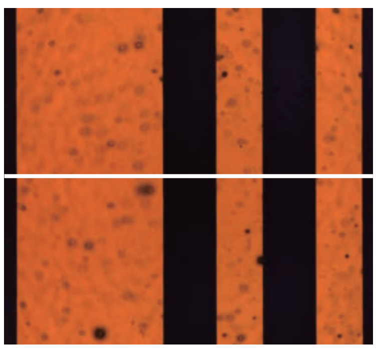
Measurement of height difference in a user-specified area

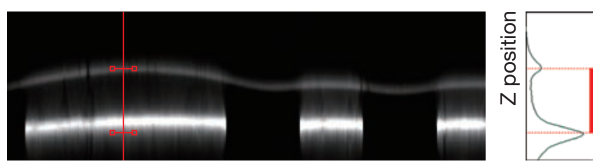




Film thickness measurement (XZ cross section measurement)

Film thickness is obtained by optically calculating the distance between film surface and substrate surface using reflected light.





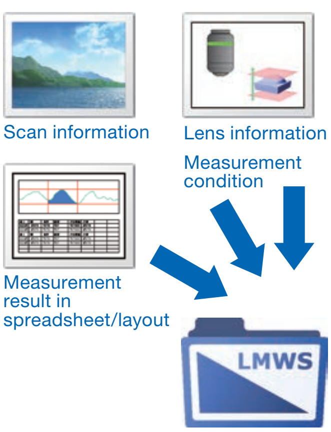
Film thickness 26.460µm

Brightness

Data management

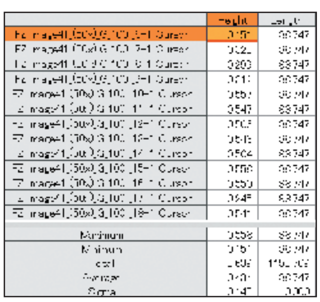
LMWS file

A dedicated file for storing measurement conditions, results, etc.



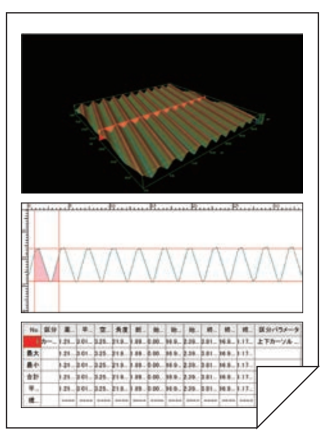
Spreadsheet

A spreadsheet for storing multiple measurement data



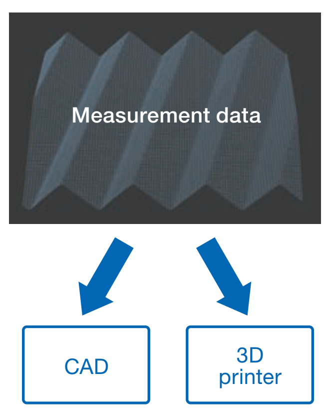
Layout report

Capability to generate reports containing images and measurement data charts



Data output

Output in image file, CSV file and CAD data (STEP file) is available



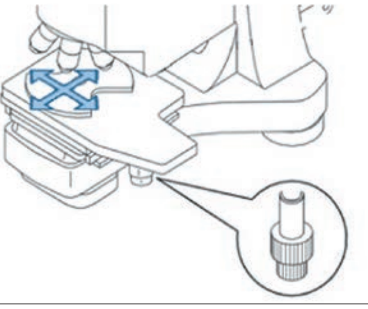
Ease of use and high skills for all users

Expert mode and Bigginner's mode

Example of operation guidance in Beginner's mode

1.Adjusting XY of the observation position

Move the observation position to the center of the screen. Use the UP, DOWN, LEFT and RIGHT buttons of the XY control or click on the screen to move the stage.



Expert mode

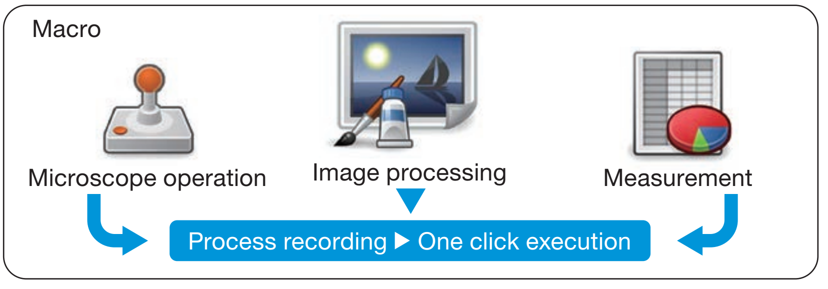
Use this mode for advanced operation and detailed setting.

Beginner's mode

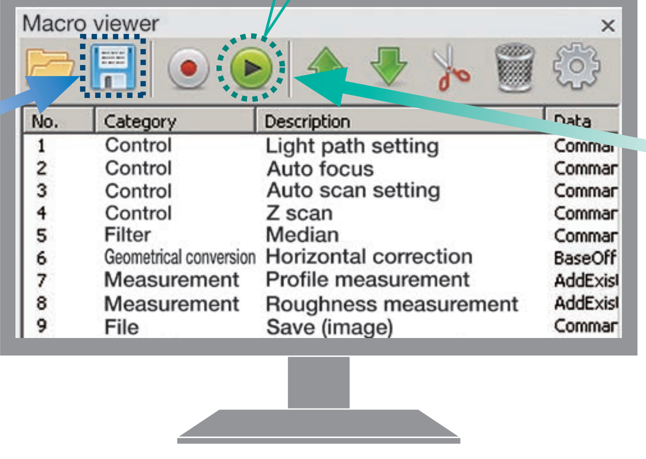
"Operation Guidance" gives you step-by-step instructions to walk you through the measurement process.

Sample setting ▸ One click ▸ Start measuring ▸ Complete

Macro



One click on Play button does it all!



Expert

Operate a measurement sequence or analysis process while saving commands in a macro.

Operator

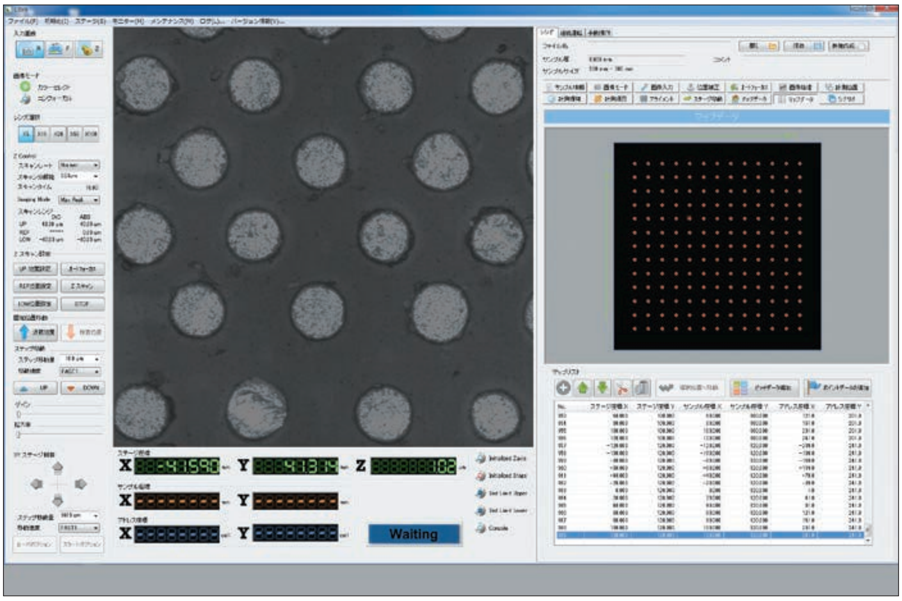
Perform the expert's measurement and analysis with one click that recalls the saved commands.

Options

Software programs for automated operation

Auto-measurement software

This software is used with a motorized stage to automatically perform pre-set recipes, for example, on the measurement of semiconductor pattern dimensions and surface roughness.

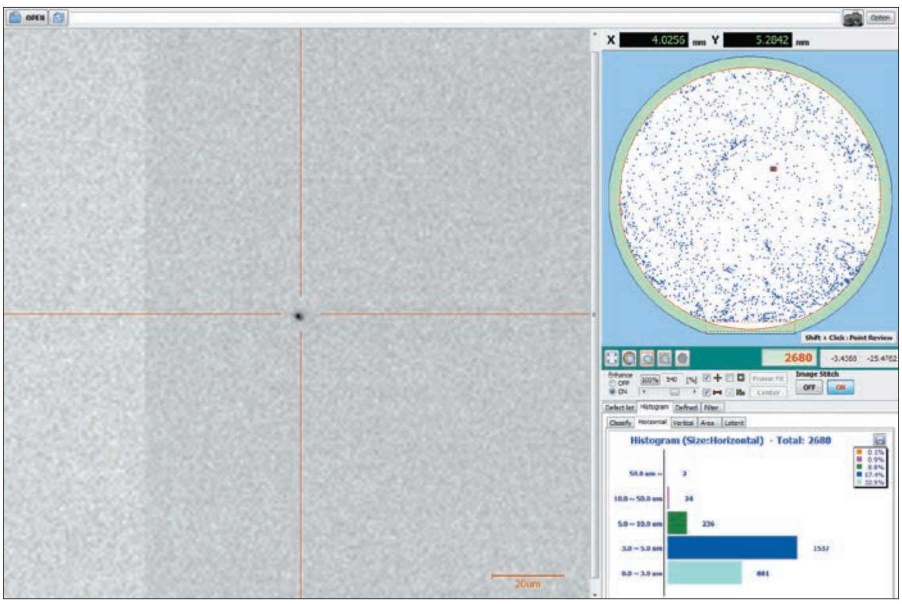


Auto-measurement of bumps

Auto-measurement software: Measurement start ▶ Measurement complete ▶ Data list display

Auto-inspection software

This software is used to inspect a whole wafer or glass substrate for small defects and particles on surface. It also enables you to review defects in an area specified on defect-distribution map and categorize each defect (e.g., by size, white/black, pit/bump).



Whole wafer inspection for 0.5μmPSL

Auto-inspection software: Inspection start ▶ Review ▶ Categorize

Options

Optional features for your specific needs

Motorized stage

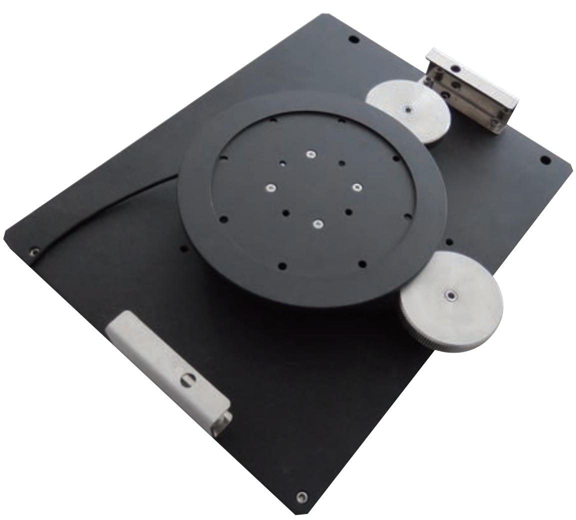
The motorized stage significantly enhances the efficiency of sequential and patchwork measurements. (XY stroke 150mm x 150mm)

Electrostatic holder

This is a stage to hold a film sample with static electricity.

Tilt stage

This is a stage to hold a sample in a tilted position for interference measurement and roughness measurement.



Large / special stage

We can provide specially-designed stages to meet your various needs based on our inspection expertise.

Flexibility

White light confocal + Laser Confocal

White light confocal and laser confocal

Specifications

Model / Specification				Basic functions	Multifunctions	Diverse applications
				Basic model C3 White light confocal	Standard model L3 White light confocal Laser confocal	High-end model L7 White light confocal Laser confocal Differential interference Optical interference measurement Spectroscopic reflectometry film thickness measurement
Light source	Laser			–	405nm	405nm
	Xenon / Hg-Xe			R,G,B	R,G,B	436nm,486nm,514nm,546nm,578nm,633nm,White light
FOV / Magnification		Objective lens	On-screen magnification	FOV (HxV)		
	White light	1×	18.5×	15,000×15,000μm		
		2.5×	46.2×	6,000×6,000μm		
		5×	92.5×	3,000×3,000μm		
		10×	185×	1,500×1,500μm		
		20×	370×	750×750μm		
		50×	925×	300×300μm		
		100×	1,850×	150×150μm		
		150×	2,775×	100×100μm		
	Laser	50×	1,850×	–	150×150μm	
		100×	3,700×	–	75×75μm	
		150×	5,550×	–	50×50μm	
Zooming				1~8×		
Frame memory	Brightness			1,024×1,024×12bit / High definition mode 2,048×2,048×12bit		
	Height			1,024×1,024×16bit / High definition mode 2,048×2,048×16bit		
Frame rate				15Hz~120Hz		
Width measurement	Minimum unit of measurement			0.001μm		
	Accuracy			±[0.02×(100/Objective lens magnification)+L/1000]μm		
	Repeatability (3σ)※1			10nm		
Height measurement	Scale resolution			0.1nm		
	Accuracy			±(0.11+L/100) μm		
	Repeatability (σ)※2			10nm		
	Measurement range※3			7mm		
Z stroke				100mm		80mm
Nosepiece				5-hole motorized revolving nosepiece (with auto lens position recognition)		
XY stage	Manual			○		–
	Motorized			Options		○
Differential interference contrast observation				Options		○
Optical interference measurement				Options		○
Spectroscopic reflectometer measurement				Options		○
Software	Image capture			Patchwork, HDR mode, search peak, first peak, multi-gain, etc.		
	Basic functions			Measurement of height, line width and surface roughness (JIS, ISO), and 3D display		
	Image processing			Filter, tilt correction, binarization, nose elimination, bit depth conversion, size conversion, color balance, etc.		
	Geometric property calculation			About 20 properties including area, volume, surface area, Feret diameter, center, roundness, maximum length, aspect ratio, etc.		
	Report generation			Layout, image database, template, file extension batch conversion		
Utility				AC 100-240V, 50/60Hz, 1,500VA		
Dimensions and weight	Microscope unit			382(W)×511(D)×669(H)mm 41kg		
	Control unit			431(W)×450(D)×106(H)mm 7.1kg		
	Light source unit			142(W)×311(D)×227(H)mm 6.7kg		
	PC			175(W)×417(D)×360(H)mm 9.6kg		
Traceability				○		

※1 Based on reference pattern measurement using 150x (NA0.95) under no vibration condition.
※2 Based on the measurement of VLSI Standards' step height standards using 100x (NA0.95) under no vibration condition.
※3 Up to the maximum distance of objective lens movement

Objective lenses

Parfocal distance 60mm

Objective lens	W.D.(mm)	NA
5×	23.50	0.15
10×	17.50	0.30
20×	4.50	0.45
50× Apo	2.00	0.80
100× Apo	2.00	0.90
150× Apo	1.50	0.90

Objective lens (long working distance)	W.D.(mm)	NA
20× ELWD	19.00	0.40
50× ELWD	11.00	0.60
100× ELWD	4.50	0.80

Objective lens (super long working distance)	W.D.(mm)	NA
10× SLWD	37.00	0.20
20× SLWD	30.00	0.30
50× SLWD	22.00	0.40
100× SLWD	10.00	0.60

Objective lens (glass thickness correction)	W.D.(mm)	NA
20× LCD	10.00	0.45
50× LCD	3.00	0.70
100× LCD	0.85/0.95	0.85

CFI60 series

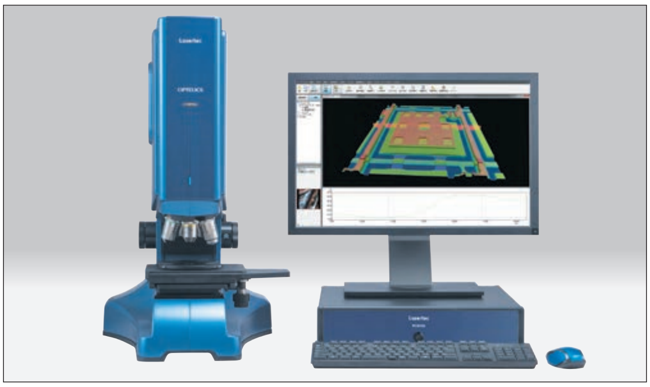
Parfocal distance 45mm

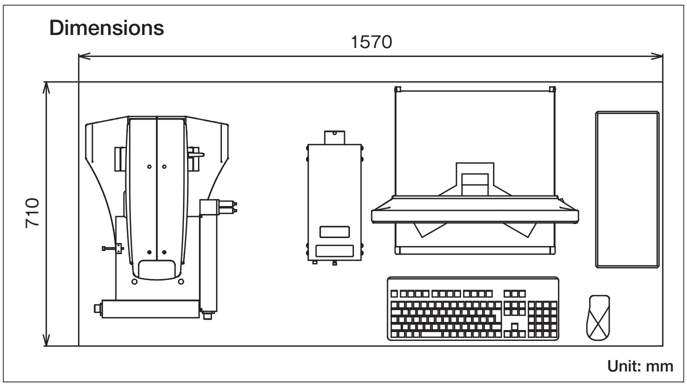
Objective lens (high NA)	W.D.(mm)	NA
50× Apo	0.35	0.95
100× Apo	0.32	0.95

Special objective lens (high NA)	W.D.(mm)	NA
5× LT	10.50	0.25
10× LT	1.60	0.50
20× LT	0.70	0.75

Special objective lens (high NA)

Dimensions, Exterior





Lasertec HQ was certified ISO9001:2008 in June 2009.

⚠ Safety precautions: Read manuals before use. Use properly.

- This catalog provides information as of January 2015.
- The descriptions in this catalog are based on our research as of the product release.
- Product specifications are subject to change without notice. Neither manufacturer nor seller assumes any responsibility for damage caused by specification change.
- Screen images are simulated.

Laser radiation
Do not look into a laser beam.
405nm continuous wave with 100μW maximum
Class 2 laser product
JIS C 6802 : 2011

Lasertec Corporation

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E-mail	Sales@Lasertec.co.jp

15/08-03