2017 Edition

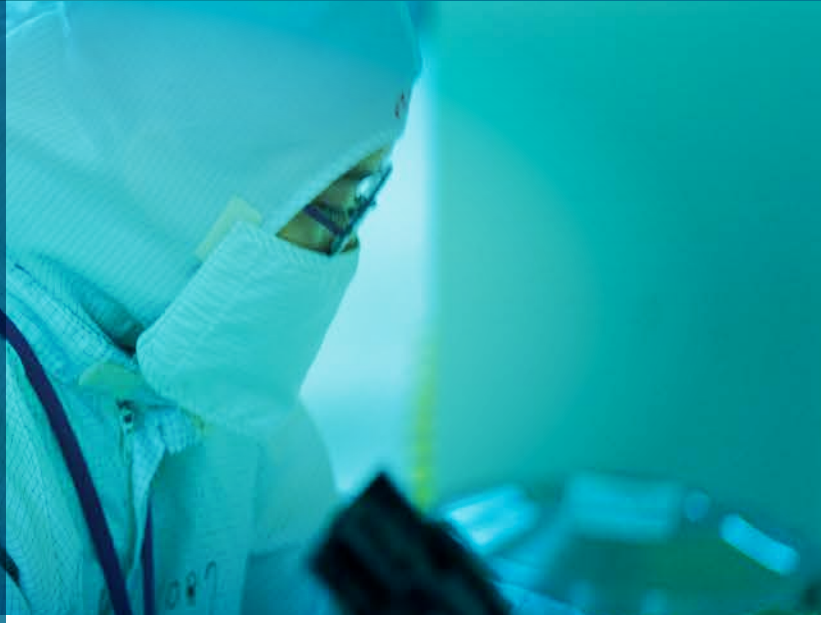
Optical Gauge Series

Optical NanoGauge Thickness measurement system
Optical MicroGauge Thickness measurement system

HAMAMATSU

PHOTON IS OUR BUSINESS

INDEX



HAMAMATSU develops unique high-accuracy thickness measurement systems based on cutting edge spectroscopic technology.

Our lineup includes the Optical NanoGauge for thin film measurement in nano meter order and the Optical MicroGauge for thickness measurement in micro meter order.

We offer a variety of integrated models for OEMs focused on their incorporation into inline equipment, models that allow multipoint measurement, models for microscopic ranges, and other equipment to satisfy the diverse needs of our customers – everything from measuring ultrathin and multilayer coating films to measuring the substrate thickness of semiconductor wafers.

Line-up

Optical NanoGauge

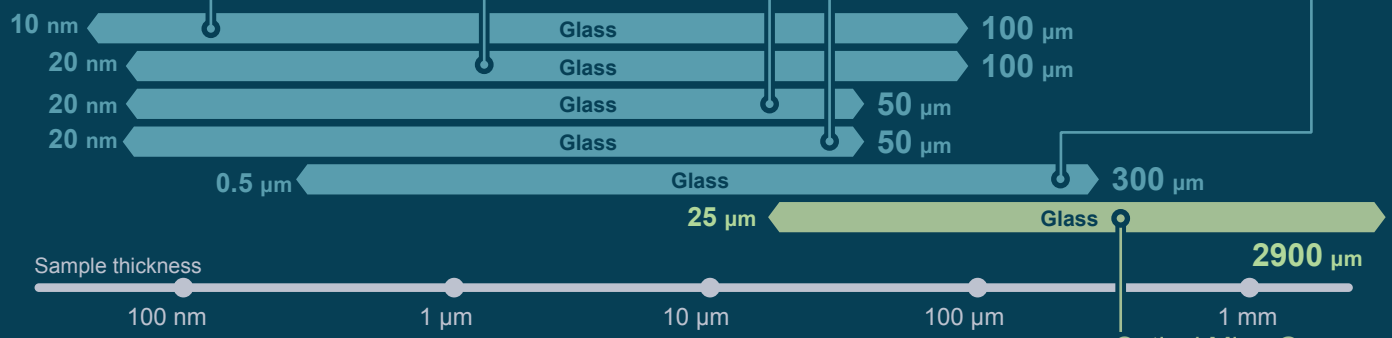
C13027
Ultrathin film measurement with high speed

C11295
Multipoint measurement

C10178
Extensibility type for research laboratory

C10323
Microscope type NanoGauge

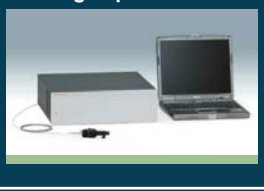
C12562
Embedded type in 1Box unit



* The refractive indices in this catalog are 1.5 for glass and 3.67 for silicon.

Optical MicroGauge

C11011
Thick film measurement with high speed



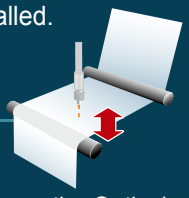
Benefits

Optical Gauge Series excels at defocus and angular dependence. The series offers the following benefits when installed.

- No difficulty involved in designing a measurement system
- Short down time for maintenance
- No adjustment jig necessary
- Cost reduction

Stability for focus

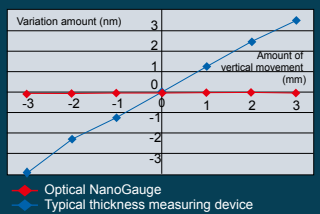
Example when measuring glass 700 nm thick



At a vertical movement of 6 mm, the Optical NanoGauge has variations **less than 0.1 nm**, while a typical thickness measuring device exhibits variations up to 8 nm.

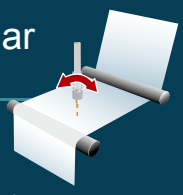
● Focus dependence versus reference point: ±3 mm (1 mm pitch), WD of reference point: 10 mm

Position	Optical NanoGauge	Typical thickness measuring device
-3 mm	701.59 nm	698.39 nm
-2 mm	701.63 nm	699.92 nm
-1 mm	701.66 nm	701.13 nm
Reference point	701.65 nm	702.37 nm
+1 mm	701.66 nm	703.51 nm
+2 mm	701.67 nm	704.74 nm
+3 mm	701.65 nm	705.91 nm



Stability for angular fluctuations

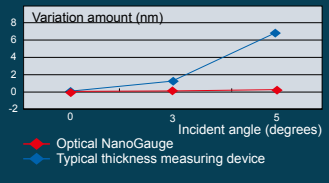
Example when measuring glass 700 nm thick



During angular movement from 0 degree to 5 degrees, the Optical NanoGauge has variations **0.39 nm** (0.047 %) while a typical thickness measuring device exhibits variations up to 5 nm or more.

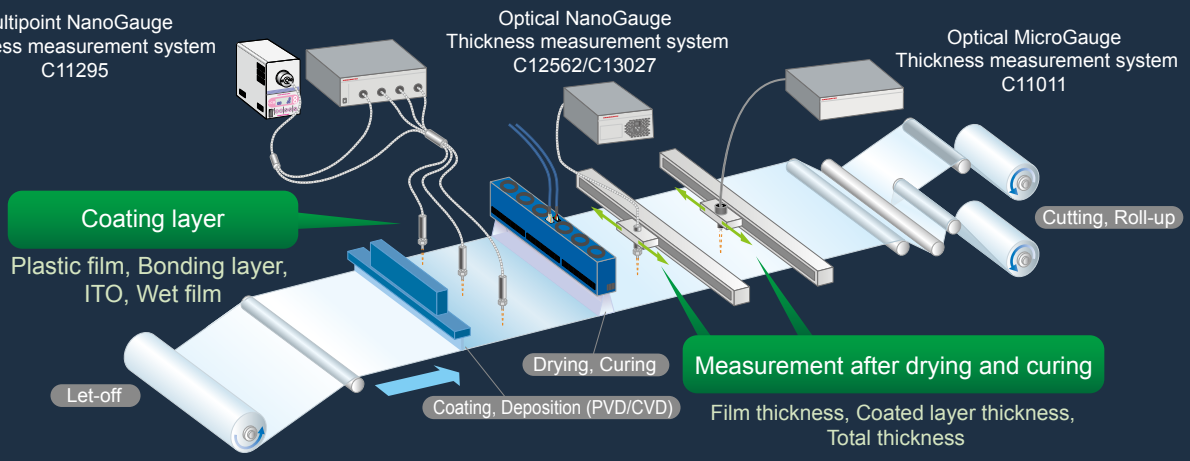
● Angular dependence versus reference point: 0 degrees to 5 degrees, WD of reference point: 10 mm

Incident angle	Optical NanoGauge	Typical thickness measuring device
0 degrees	702.23 nm	702.47 nm
3 degrees	702.29 nm	703.70 nm
5 degrees	702.62 nm	709.38 nm



Roll-to-roll film production

In-line measurement for coating equipment



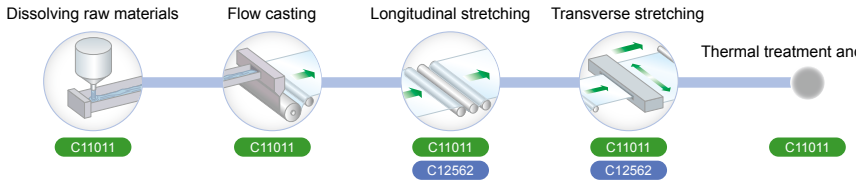
Example applications

The Optical Gauge series can be used in each process in a variety of manufacturing settings.

Film

Highly functional films are becoming ever more essential to cutting-edge industries that make liquid crystal displays, rechargeable batteries, solar panels, and a host of other products. These industries use Optical Gauge Series in various inspection processes to increase performance and productivity.

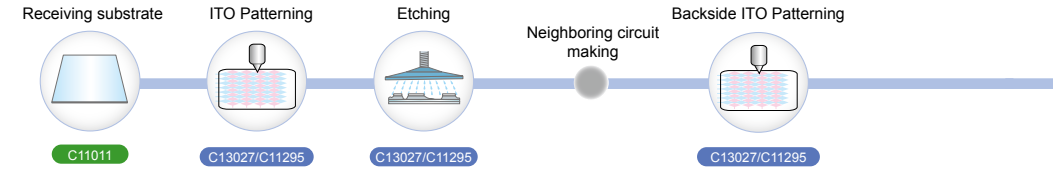
Film production pre-process



Touch panel

A touch panel is the key factor in today's hottest digital products such as smart phones, tablets, digital cameras' liquid crystal displays, and advanced gaming systems. Although there are various detection schemes for touch panels, the resistive film manufacturing process is used here as an example to show how the Optical Gauge series is used in such a process.

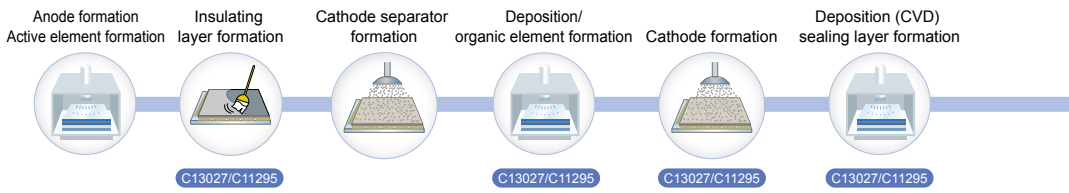
Glass substrate production process (Electrostatic Capacitive touch panel)



FPD (organic EL)

The Optical Gauge series can be used in a wide range of processes in the manufacture of FPD (flat-panel display) such as liquid crystal, LED, and organic EL.

Upstream process

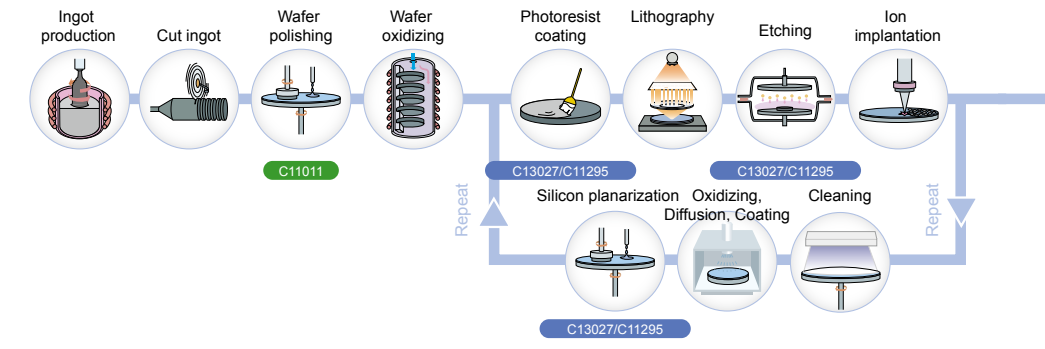


Semiconductor

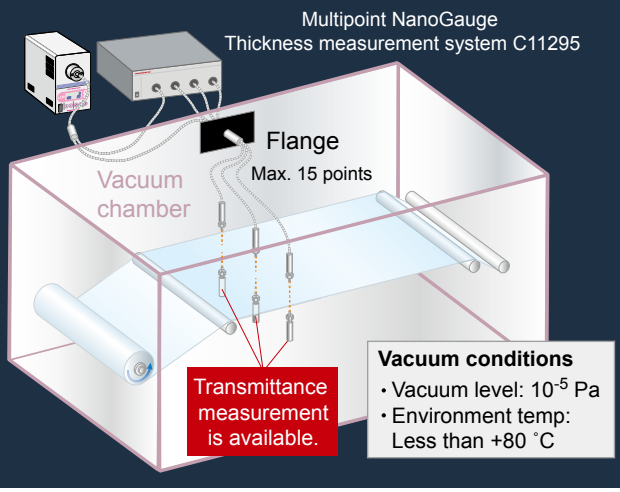
The Optical Gauge series is used in the various manufacturing processes of semiconductor devices in which metal wiring is more multilayered, processes are increasingly miniaturized, and lower voltage is used. This contributes to improvement in the yield and shortens the time required to start a process.

Wafer production process

Pre-process



In-line measurement for vacuum deposition equipment



Vacuum conditions
- Vacuum level: 10^{-5} Pa
- Environment temp: Less than +80 ˚C

Reflectivity measurement
Transmission measurement

Chromaticity

Film thickness measurement

Evaporation film (PVD/CVD)

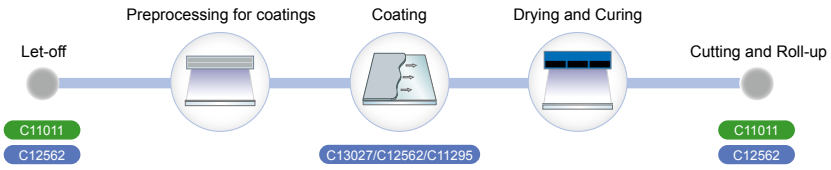
ITO, SiOx, NbO

Both surface analysis

Inside/outside of vacuum chamber is isolated by vacuum flange. Inside vacuum chamber, up to 15 vacuum fibers with 3 m max length can be installed.
* Please consult us for more details.

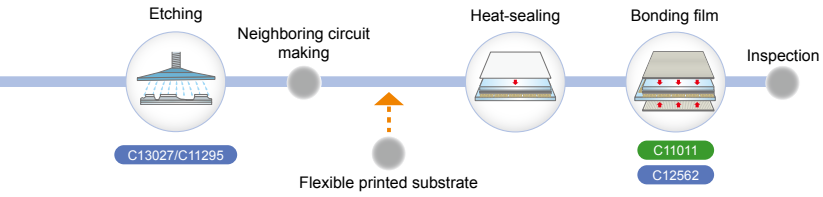
* The bending radius of the fiber in a vacuum is R100 mm or more.

Film production back end process

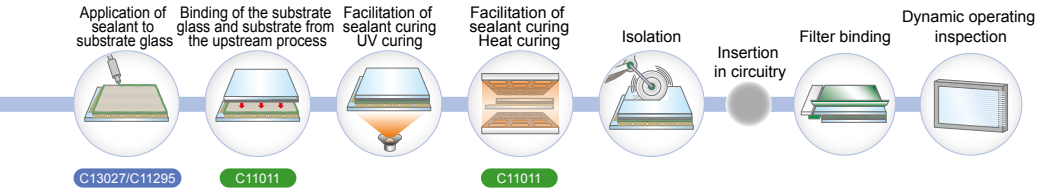


Glass substrate production process

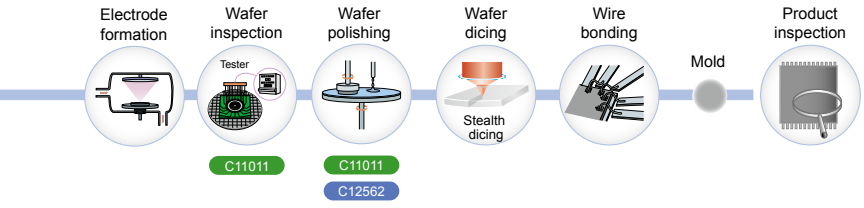
Production process



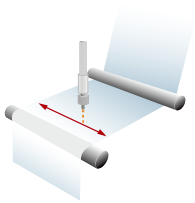
Downstream process



Back end process



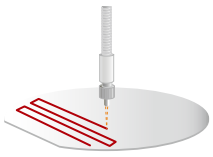
Film



- Coating film
- Plastic film
- Object color

AR coating, PET, Coating layer, PE, PMMA, Coating film, Evaporation film, Functionality film, Ag Nanowire, Acrylic resin, Video head

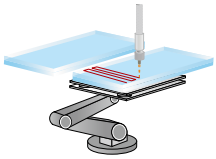
Semiconductor material



- Film on a wafer
- Thin film

Metal-oxide coating such as SiO_2, SiC, Si and TiO_2, Nitride coating, Wet film, Resist coating, Polished silicon, Optical disk, DLC, Carbon

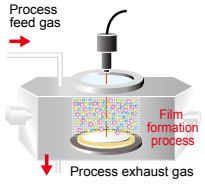
FPD



- Film thickness and color measurement of flat panel

Cell gap, Organic EL film, Alignment film, TFT, Ag Nanowire,ITO, MgO, Resist film on glass substrate, Polyimide, High-functioning film and Color film for FPD

In-situ measurement



- Film formation process monitor
- Dry and wet etching measurement

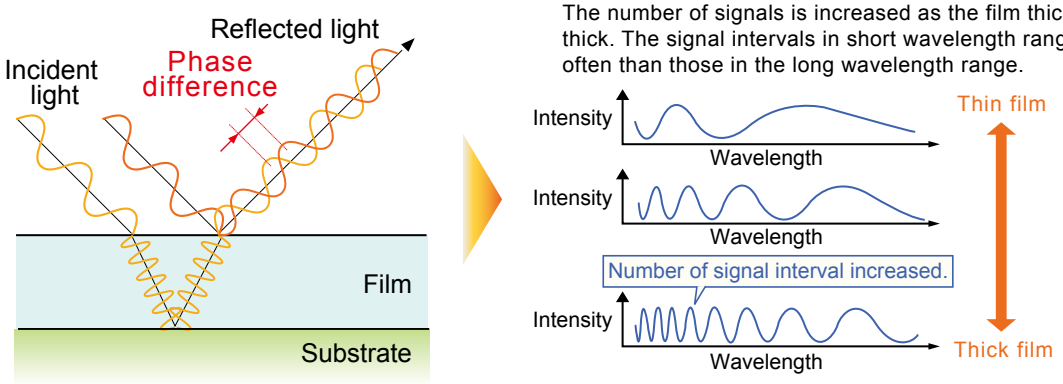
Metal-oxide coating such as SiO_2 and Si

Measurement principle

Spectral interferometry is used to measure film thickness.

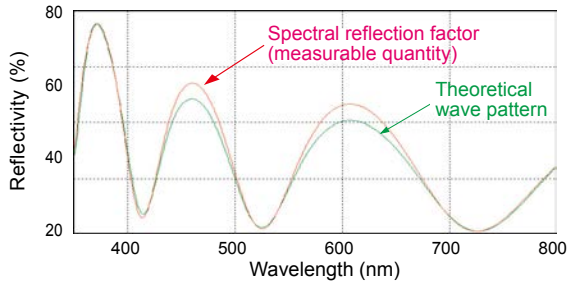
When light enters a thin film sample, multiple reflections occur inside the thin film. These multiple-reflection light waves boost or weaken each other along with their phase difference. The phase difference of each multiple-reflection light is determined by the light wavelength and optical path length (= distance that light moves back and forth in the thin film multiplied by the film refractive index).

This phase difference allows the spectrum reflected from or transmitted through the sample to produce a unique spectrum that depends on the film thickness. Spectral interferometry is a technique for measuring film thickness by analyzing that particular spectrum. The Optical NanoGauge utilizes spectral interferometry to analyze a target spectrum by the curve-fitting or FFT (Fast Fourier Transform) method that matches your application.



Analysis by curve fitting → For measuring less than 1 µm film thickness

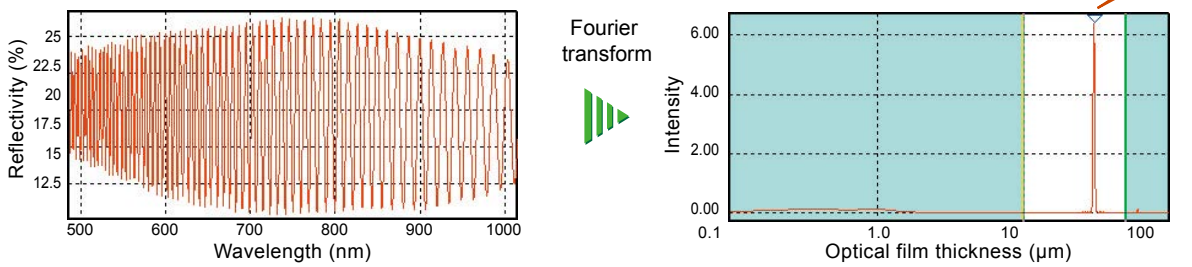
■ Interference spectrum measurement of transparent electrode (ITO film: 350 nm)



The analyzed film thickness is the theoretical value, which is the least RMS (Root Mean Square) value of the theoretical wave pattern and measurement reflection pattern.

Analysis by FFT (Fast Fourier Transform) → For measuring more than 1 µm film thickness

■ Measurement of etalon (30 µm)



Both surface analysis

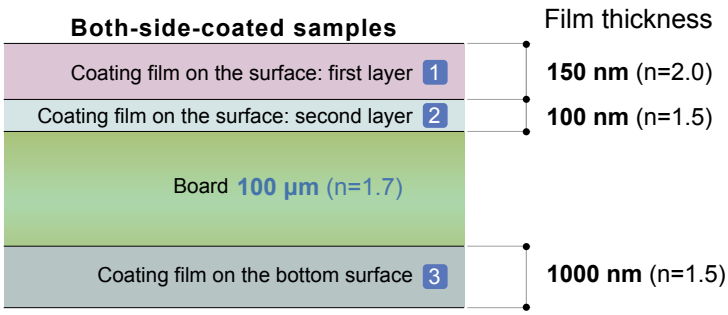
The analysis is performed using the film thickness measurement software for both surface U12708-01. (Patent pending)

Both surface analysis for both-side-coated samples

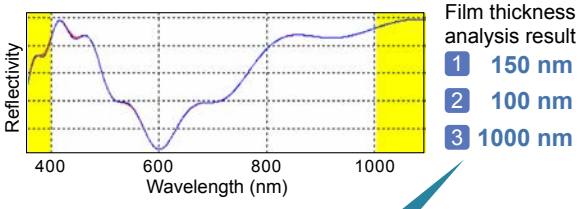
In some cases, a coating film is applied to the back side of thin film samples. If such both-side-coated samples are measured by an ordinary method, the fitting cannot be consistent as the effect of the film on the back side is not taken into account, and therefore accurate values cannot be obtained. In addition, if the thickness of the film on the back side changes, the system cannot follow the change during the measurement and this may largely affect measured values.

Since the Optical Gauge is equipped with the both surface analysis function as an option, which makes it possible to measure both-side-coated samples accurately measurement of both-side-coated samples.

(For Optical NanoGauge Thickness measurement system C13027 and C12562)

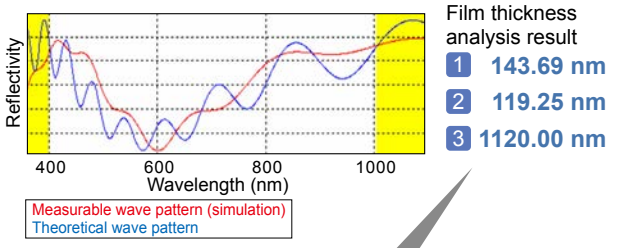


Both side analysis



Thickness of coating film not only on the surface but also on the back side is measured with high accuracy.

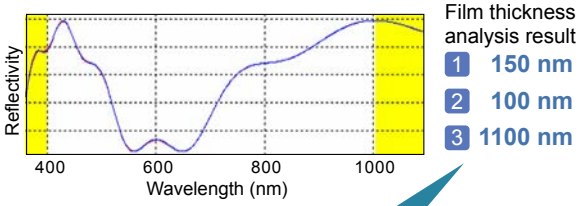
Standard measurement



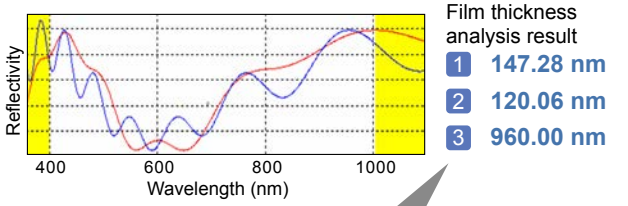
Errors in measured values are large.

*This is the result of a simulation using an analysis model.

When the thickness of the coating film on the back side is increased by 100 nm



Thickness is measured with high accuracy, even back side film thickness is changed.



Measurement errors are large, and the values are inaccurate as changes in the coating film on the back side cannot be followed.

*This is the result of a simulation using an analysis model.

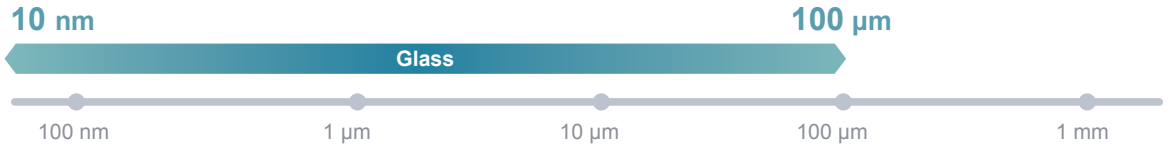
Optical NanoGauge
Thickness measurement system
C13027

This model supports connections to a PLC and easily installs in production equipment

Ultrathin film measurement with high speed

The Optical NanoGauge Thickness measurement system C13027 is a non-contact film thickness measurement system utilizing spectral interferometry. The C13207 not only supports PLC connections but is also designed more compact than our other models for easy installation into equipment. Our Optical Gauge series is capable of measuring the thickness of extremely thin films down to 10 nm as well as covering a wide range of film thickness from 10 nm up to 100 µm. The Optical Gauge series also makes rapid measurements up to 200 Hz and so is ideal for measurements on high-speed production lines.

Measurable range



10 nm to 100 µm thin film high speed measurement

Features

- Supports PLC connections
- Shortening of cycle time (max. 200 Hz)
- Capable of measuring 10 nm thin films
- Simultaneously measure thickness and color
- Downsized (30 % less installation area compared to C12562)
- Covers broad wavelength range (400 nm to 1100 nm)
- Simplified measurement is added to the software
- Capable of both surface analysis
- Precise measurement of fluctuating film
- Analyze optical constants (n, k)
- Mapping function

Specification

Type number		C13027-12
Measurement film thickness range (glass) *1		10 nm to 100 µm
Measurement reproducibility (glass) *2 *3		0.02 nm
Measurement accuracy *3 *4		±0.4 %
Light source		Halogen light source
Measurement wavelength range		400 nm to 1100 nm
Spot size *3		Approx. ϕ1 mm
Working distance *3		10 mm
Number of measurable layers		Max. 10 layers
Analysis		FFT analysis, Fitting analysis, Optical constant analysis, Color analysis
Measurement time *5		3 ms/point
External communication interface		RS-232C, Ethernet
Output signal	Analog output	0 V to 10 V / High impedance 3-channel (up to 3 layers)
	Alarm output	TTL / High impedance 1-channel
	Warning output	TTL / High impedance 1-channel
Input signal	Measurement start signal	TTL / High impedance 1-channel
Power supply voltage		AC100 V to 240 V, 50 Hz/60 Hz
Power consumption		Approx. 80 VA
Light guide connector shape		FC

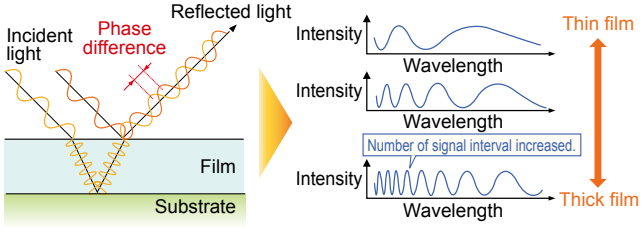
*1: When converted with the refractive index of glass = 1.5.
*2: Standard deviation (tolerance) when measuring 400 nm thick glass film.
*3: Depending on optical system or objective lens magnification to be used.
*4: Range of measurement guarantee as recorded in the VLSI Standards measurement guarantee document.
*5: Shortest exposure time

Principle

Spectral interferometry is used to measure film thickness.

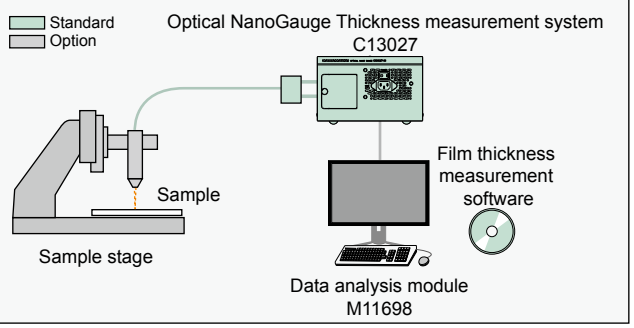
White light incident on a sample will display a characteristic spectrum that is dependent on the film thickness. Spectral interferometry is a way of measuring film thickness by analyzing this spectrum.

[Diagram outlining principle]

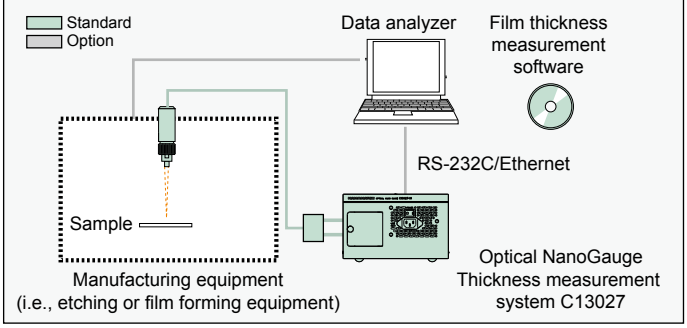


Configuration example

C13027 Example of system configuration (off-line)



C13027 Example of system configuration (in-line)



Option

☐ Sample stage for Optical NanoGauge
A10192-10

This stage accommodates samples up to ϕ200 mm in diameter. Light condenser not included. This is a pen type model of the A10192-04, designed to view samples more easily.
WD: approx. 10 mm
Measurement spot diameter: ϕ1 mm
Conventional model A10192-04 is available.
(Refer to page 11)

☐ Sample stage FC connector type for VIS
A10192-05

This stage accommodates samples up to ϕ200 mm in diameter. It comes with a visible-light condenser lens with corrected chromatic aberration.
WD: approx. 35 mm
Measurement spot diameter: ϕ1.5 mm

☐ Macro optics FC connector type for VIS
A10191-03

Visible light condenser lens for A10192-05.
WD: approx. 35 mm
Measurement spot diameter: ϕ1.5 mm

☐ FC Receptacle A12187-02
This receptacle is a tool for setting a fiber probe in a mount.

☐ Lamp unit L12839-01
This receptacle lamp unit for C12562 and C13027.

☐ Mapping stage ϕ200 mm C8126-31
Mapping stage ϕ300 mm C8126-32

- Measurement time : 2 s/point
- Measurement area : Up to 140 mm square (C8126-31) <4 inch to 8 inch wafer>
  : Up to 200 mm square (C8126-32) <4 inch to 12 inch wafer>
- Stage movement resolution: 0.1 mm
- Stage movement repeatability: ±0.01 mm

☐ Data analysis module
M11698

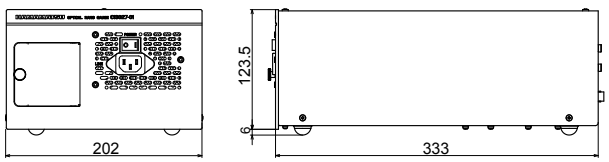
Unit with just monitor, mouse, and keyboard.

☐ Film thickness measurement software for both surface U12708-01
Analysis software for both surface.

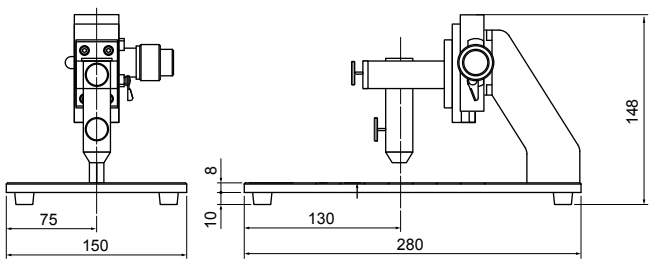
☐ Traverse system C13800-011505
You can combine it with the C13027 to create a simple inline film thickness measurement system. (Refer to page 22 for details.)

Dimensional outline (Unit: mm)

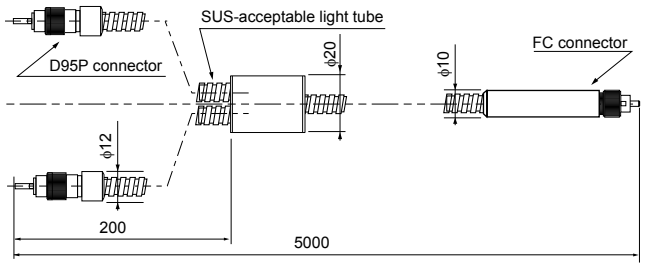
■ Main unit (Approx. 4.7 kg)



■ Sample stage for Optical NanoGauge A10192-10



■ Two split light guide * The bending radius of the fiber is R75 mm or more.



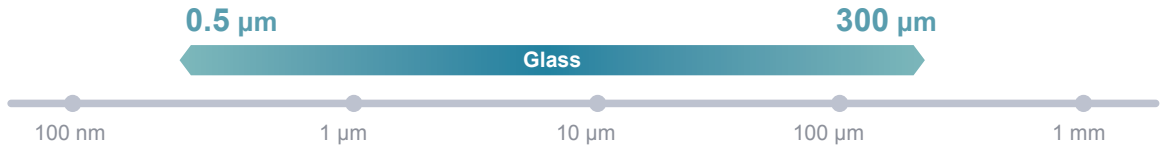
Optical NanoGauge
Thickness measurement system
C12562

An integrated type designed for installation into equipment and ideal for measuring a wide diverse range of objects from thin films to substrates and more

Embedded type in 1Box unit

The Optical NanoGauge Thickness measurement system C12562 is a compact, space-saving, non-contact film thickness measurement system designed to easily install in equipment where needed. In the semiconductor industry, measuring silicon thickness is essential due to the spread of through-silicon via technology; and in the film production industry, adhesion layer films are being made ever thinner to meet product specifications. So these industries now require even higher accuracy in thickness measurements ranging from 1 µm to 300 µm. The C12562 allows making accurate measurements across a wide thickness range from 0.5 µm to 300 µm that include the thin film coating and film substrate thickness as well as the total thickness. The C12562 also offers rapid measurements up to 100 Hz making it ideal for measurements on high-speed production lines.

Measurable range



One unit measures a wide variety of materials from thin films to silicon substrates in thicknesses from 0.5 µm to 300 µm

Features

- Makes measurement ranging from thin film thickness to the total thickness
- Shortening of cycle time (max. 100 Hz)
- Precise measurement of fluctuating film
- Analyze optical constants (n, k)
- External control available
- Enhanced external triggers (accommodates high-speed measurement)
- Simplified measurement is added to the software
- Capable of both surface analysis

Specification

Type number	C12562-04
Measurement film thickness range (glass) *1	500 nm to 300 µm
Measurement reproducibility (glass) *2 *3	0.2 nm
Measurement accuracy *3 *4	±0.4 %
Light source	Halogen light source
Spot size *3	Approx. ϕ1 mm
Working distance *3	10 mm
Number of measurable layers	Max. 10 layers
Analysis	FFT analysis, Fitting analysis, Optical constant analysis
Measurement time *5	3 ms/point
External communication interface	RS-232C, Ethernet
Power supply voltage	AC100 V to 240 V, 50 Hz/60 Hz
Power consumption	Approx. 80 VA
Light guide connector shape	FC

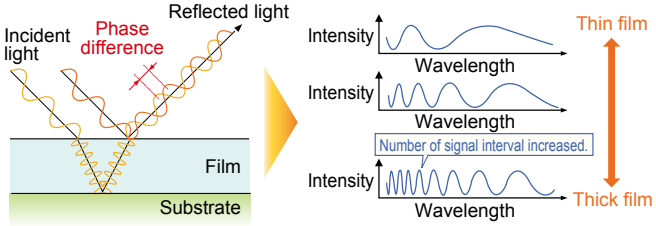
*1: When converted with the refractive index of glass = 1.5.
*2: Standard deviation (tolerance) when measuring 1 µm thick glass film.
*3: Depending on optical system or objective lens magnification to be used.
*4: Range of measurement guarantee as recorded in the VLSI Standards measurement guarantee document.
*5: Shortest exposure time

Principle

Spectral interferometry is used to measure film thickness.

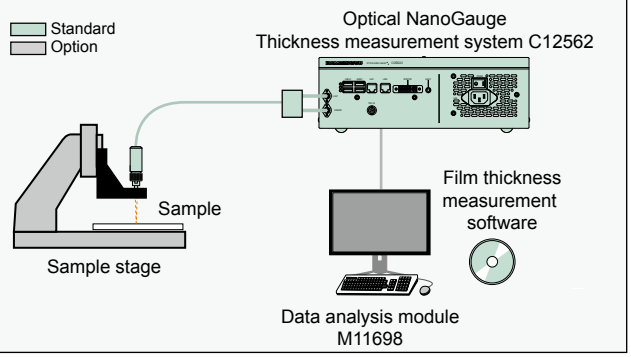
White light incident on a sample will display a characteristic spectrum that is dependent on the film thickness. Spectral interferometry is a way of measuring film thickness by analyzing this spectrum.

[Diagram outlining principle]

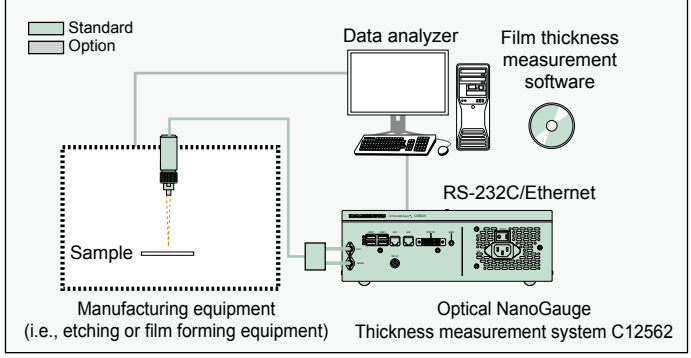


Configuration example

C12562 Example of system configuration (Off-line)



C12562 Example of system configuration (In-line)



Option

☐ Sample stage FC connector type for VIS
A10192-04

This stage accommodates samples up to ϕ200 mm in diameter. Light condenser not included.
WD: approx. 10 mm
Measurement spot diameter: ϕ1 mm
Pen type model A10192-10 is available.
(Refer to page 9)

☐ Sample stage FC connector type for VIS
A10192-05

This stage accommodates samples up to ϕ200 mm in diameter. It comes with a visible-light condenser lens with corrected chromatic aberration.
WD: approx. 35 mm
Measurement spot diameter: ϕ1.5 mm

☐ FC Receptacle A12187-02
This receptacle is a tool for setting a fiber probe in a mount.

☐ Lamp unit L12839-01
This receptacle lamp unit for C12562 and C13027.

☐ Film thickness measurement software for both surface
U12708-01
Analysis software for both surface.

☐ Macro optics FC connector type for VIS
A10191-03

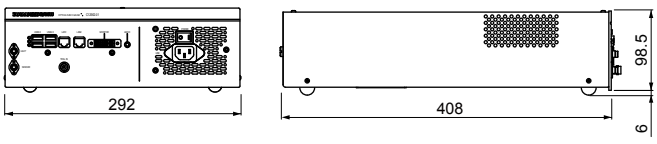
Visible light condenser lens for A10192-05
WD: approx. 35 mm
Measurement spot diameter: ϕ1.5 mm

☐ Data analysis module
M11698

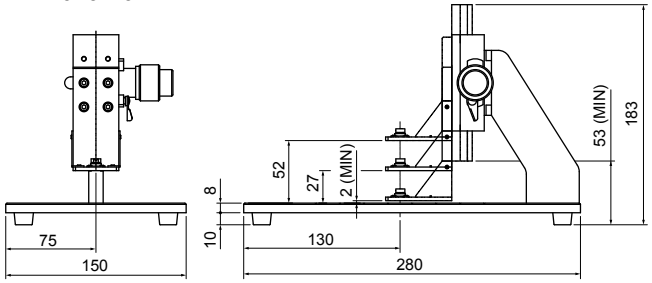
Unit with just monitor, mouse, and keyboard.

Dimensional outline (Unit: mm)

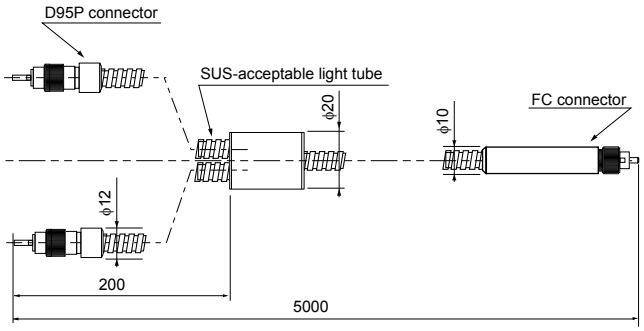
■ Main unit (Approx. 7.0 kg)



■ Sample stage FC connector type for VIS
A10192-04



■ Two split light guide



* The bending radius of the fiber is R75 mm or more.

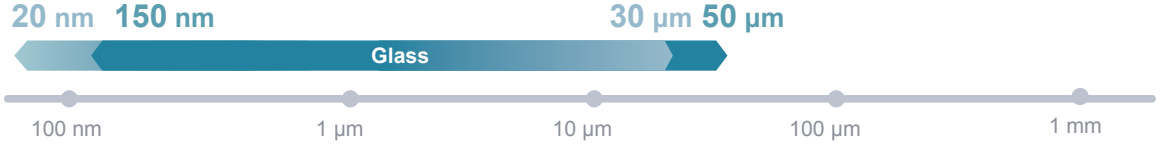
Optical NanoGauge
Thickness measurement system
C10178

Versatile standard type for basic research

Extensibility type forresearch laboratory

The Optical NanoGauge Thickness measurement system C10178 is a non-contact film thickness measurement system utilizing spectral interferometry. Film thickness is measured quickly with high sensitivity and high accuracy through spectral interferometry. Our products use a multichannel spectrometer PMA as detectors, which allows for measurement of quantum yields, reflection, transmission/absorption, and a various other points while simultaneously measuring the thickness of various optical filters and coating films, and more.

Measurable range



Highly accurate and real time measurement of thin film from 20 nm to 50 µm thickness

Features

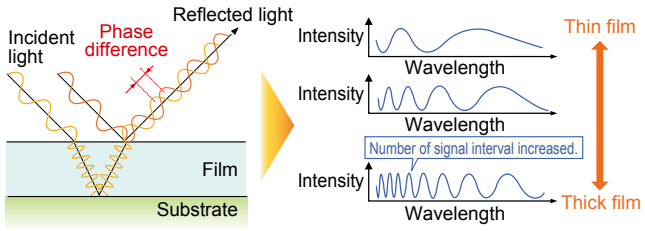
- High speed and high accuracy
- Real time measurement
- Precise measurement of fluctuating film
- Analyze optical constants (n, k)
- External control available
- Quantum yield, reflectance, transmittance and absorption can be measured with specific accessories.

Principle

Spectral interferometry is used to measure film thickness.

White light incident on a sample will display a characteristic spectrum that is dependent on the film thickness. Spectral interferometry is a way of measuring film thickness by analyzing this spectrum.

[Diagram outlining principle]



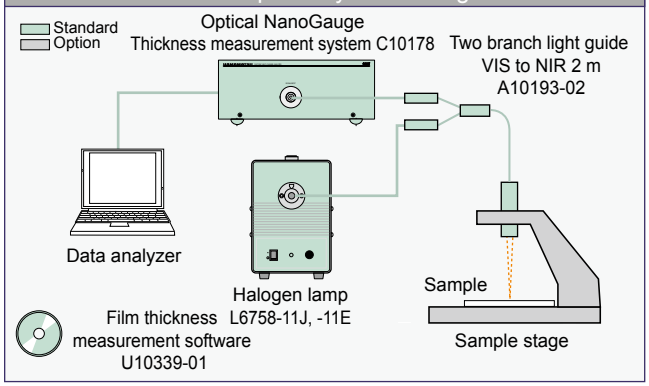
Specification

Type number	C10178-02 (supports UV)	C10178-03J (supports NIR)	C10178-03E (supports NIR)
Measurement film thickness range (glass) *1	20 nm to 30 µm	150 nm to 50 µm	
Measurement reproducibility (glass) *2 *3	0.02 nm	0.05 nm	
Measurement accuracy *3 *4	±0.4 %		
Light source	D2-Halogen light source	Halogen light source	
Measurement wavelength range	200 nm to 950 nm	900 nm to 1650 nm	
Spot size *3	Approx. ϕ1 mm		
Working distance *3	10 mm		
Number of measurable layers	Max. 10 layers		
Analysis	FFT analysis, Fitting analysis, Optical constant analysis		
Measurement time *5	19 ms/point		
External control function	Yes (Option)		
External communication interface	RS-232C, PIPE, Ethernet		
Interface	USB 2.0		
Power supply voltage	AC100 V to 240 V, 50 Hz/60 Hz	AC100 V to AC 120 V, 50 Hz/60 Hz	AC200 V to AC 240 V, 50 Hz/60 Hz
Power consumption	Approx. 210 VA	Approx. 230 VA	
Light guide connector shape	ϕ12 sleeve shape		

*1: When converted with the refractive index of glass = 1.5.
*2: Standard deviation (tolerance) when measuring 400 nm thick glass film.
*3: Depending on optical system or objective lens magnification to be used.
*4: Range of measurement guarantee as recorded in the VLSI Standards measurement guarantee document.
*5: Shortest exposure time

Configuration example

C10178 Example of system configuration



Option

☐ Sample stage Sleeve type A10192-01

This stage accommodates samples up to ϕ200 mm in diameter. Light condenser not included.

☐ Macro optics

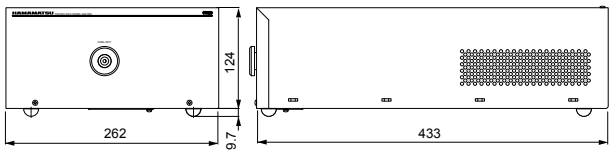
Sleeve type for NIR A10191-02
IR condenser lens for A10192-03.

☐ Sample stage for NIR A10192-03

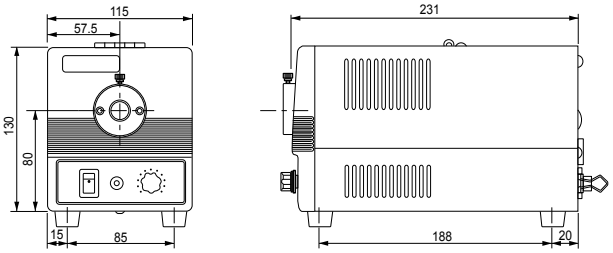
This stage accommodates samples up to ϕ200 mm in diameter. It comes with a condenser lens covering the UV to near infrared light range.
WD: approx. 35 mm, Measurement spot diameter: ϕ1.5 mm

Dimensional outline (Unit: mm)

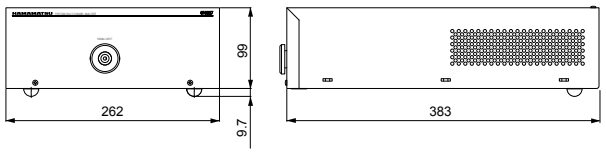
■ Optical NanoGauge film thickness gauge C10178-03J, -03E Main unit (Approx. 5 kg)



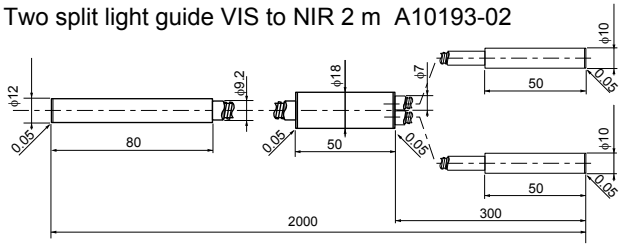
■ Halogen lamp L6758-11J, -11E (Approx. 2.6 kg)



■ Optical NanoGauge film thickness gauge C10178-02 Main unit (Approx. 5 kg)

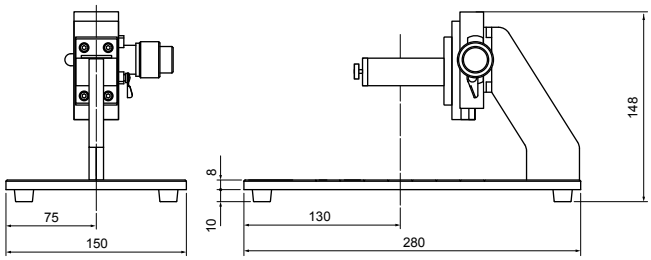


■ Two split light guide VIS to NIR 2 m A10193-02



* The bending radius of the fiber is R150 mm or more.

■ Sample Stage for Optical NanoGauge A10192-01



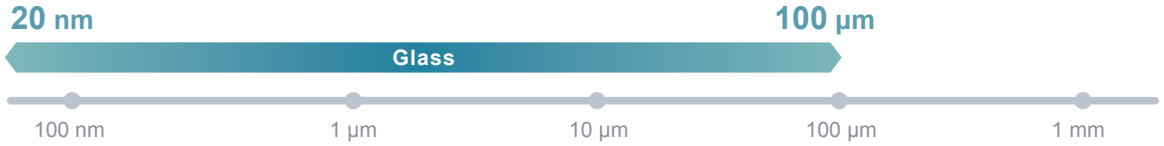
Multipoint NanoGauge
Thickness measurement system
C11295

Multipoint measurement model for real time simultaneous measurements

Multipoint measurement

The Multipoint NanoGauge Thickness measurement system C11295 is a film thickness measurement system utilizing spectral interferometry. It is designed to measure film thickness as part of the semiconductor manufacturing process, as well as for quality control of the APC and films that are mounted on semiconductor manufacturing equipment. Allows multichannel measurement in real time, which provides simultaneous multichannel measurement and multipoint measurement on film surfaces. At the same time it can also measure reflectivity (transmittance), object color, and their changes over time.

Measurable range



Enables simultaneous measurements in multiple chambers in thin film production lines and multipoint measurements in film production lines

Features

- Simultaneous film thickness measurement up to 15 points
- Reference-free operation
- Stable long-term measurement by correction of light intensity fluctuation
- Alarm and warning function (pass/fail)
- Reflectance (transmittance) and spectrum measurements
- High speed and high accuracy
- Real time measurement
- Precise measurement of fluctuating film
- Analyze optical constants (n, k)
- External control available

Specification

Type number	C11295-XX*1
Measurement film thickness range (glass) *2	20 nm to 100 µm
Measurement reproducibility (glass) *3 *4	0.02 nm
Measurement accuracy *4 *5	±0.4 %
Light source *6	Xenon light source
Measurement wavelength range	320 nm to 1000 nm
Spot size *4	Approx. ϕ1 mm
Working distance *4	10 mm
Number of measurable layers	Max. 10 layers
Analysis	FFT analysis, Fitting analysis
Measurement time *7	19 ms/point
External interface	Ethernet
Interface	USB 2.0 (Main unit - Computer) RS-232C (Light source - Computer)
Power supply voltage	AC 100 V to AC 240 V, 50 Hz/60 Hz
Power consumption	At 2ch: Approx. 330 VA, at 15ch: Approx. 450 VA
Light guide connector shape	SMA
Measurement points	2 to 15

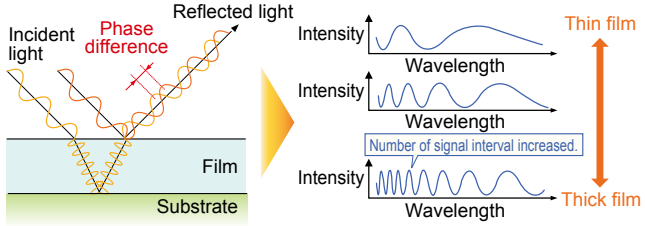
*1: -XX indicates the number of measurement points.
*2: When converted with the refractive index of glass = 1.5.
*3: Standard deviation (tolerance) when measuring 400 nm thick glass film.
*4: Depending on optical system or objective lens magnification to be used.
*5: Range of measurement guarantee as recorded in the VLSI Standards measurement guarantee document.
*6: The halogen light source model is C11295-XXH.
*7: Shortest exposure time

Principle

Spectral interferometry is used to measure film thickness.

White light incident on a sample will display a characteristic spectrum that is dependent on the film thickness. Spectral interferometry is a way of measuring film thickness by analyzing this spectrum.

[Diagram outlining principle]

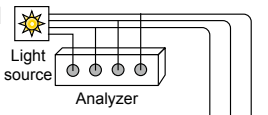


Multipoint measurement method

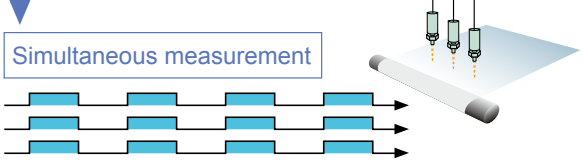
Concept view comparing multidetector and fiber branch method

Multipoint Optical NanoGauge

■ Multidetector method

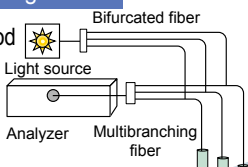


Simultaneous measurement

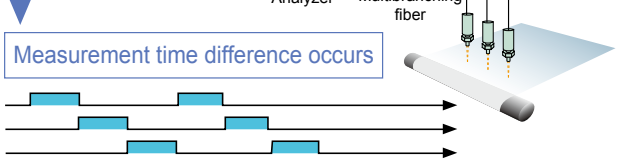


Typical thickness measuring device

■ Fiber branching method

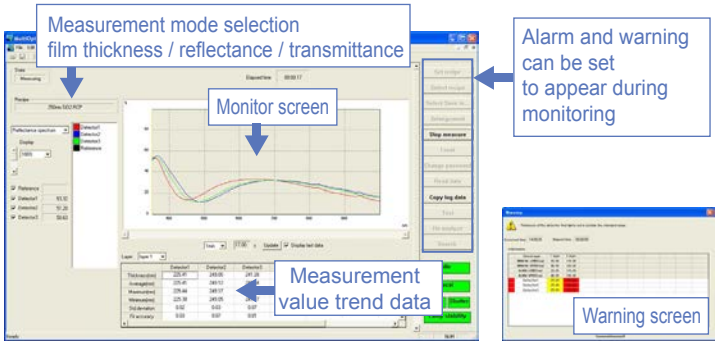


Measurement time difference occurs

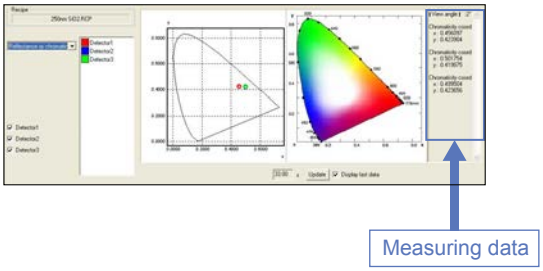


Measurement screen

Film thickness monitor

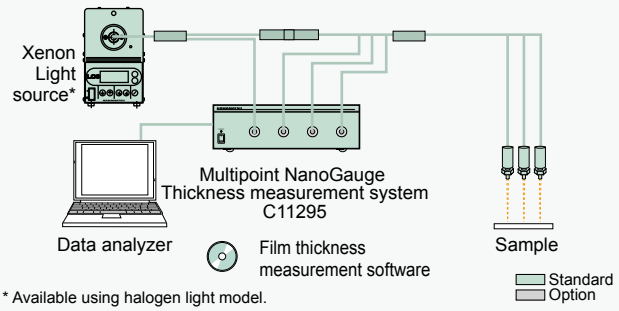


Color monitor



Configuration example

C11295-03 Example of system configuration



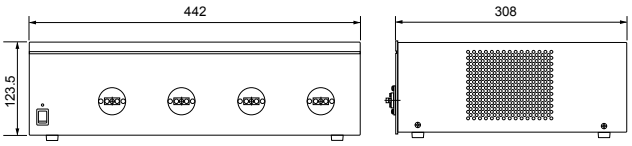
Option

☐ SMA Receptacle A12187-01

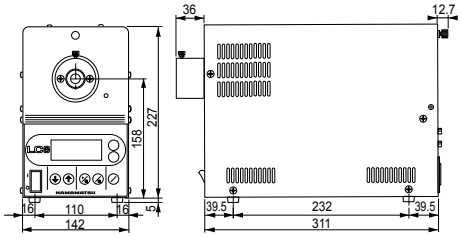
This receptacle is a tool for setting a fiber probe in a mount.

Dimensional outline (Unit: mm)

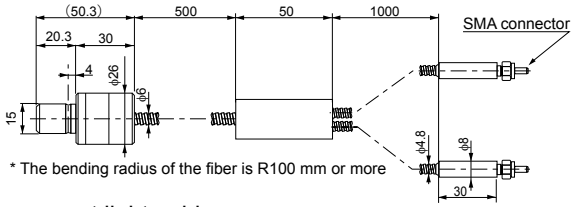
■ Main unit (Approx. 6 kg)



■ Xenon Light source (Approx. 6.4 kg)

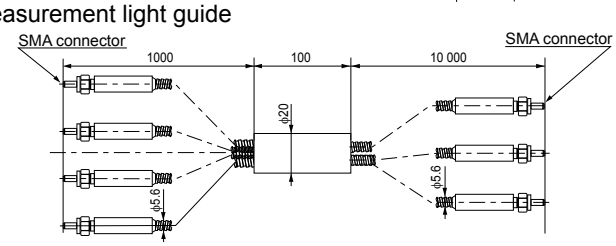


■ Light source light guide



* The bending radius of the fiber is R100 mm or more

■ Measurement light guide



* The bending radius of the fiber is R100 mm or more

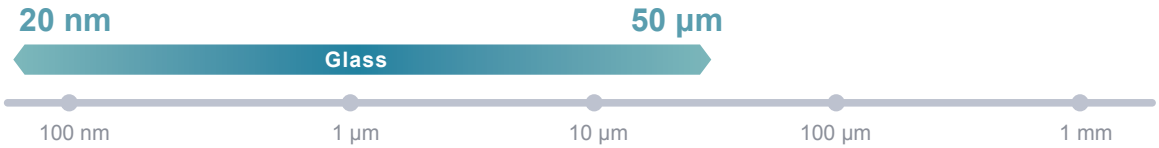
Optical NanoGauge
Thickness measurement system
C10323

Microscopic type for measuring thin film in small area

Microscope type NanoGauge

The Optical NanoGauge Thickness measurement system C10323 is a microscopic thickness measurement systems. Objects with irregular surfaces that would produce high level of scattered light cannot be measured at the macro level. For these types of objects, measuring a small area reduces scattered light making measurement possible.

Measurable range



Highly accurate and real time measurement of thin film in micro field of view through microscope

Features

- Thickness measurement in micro field of view
- High speed and high accuracy
- Analyze optical constants (n, k)
- External control available

Specification

Type number	C10323-02	C10323-02E
Measurement film thickness range (glass) *1	20 nm to 50 µm	
Measurement reproducibility (glass) *2 *3	0.02 nm	
Measurement accuracy *3 *4	±0.4 %	
Light source	Halogen light source	
Measurement wavelength range	400 nm to 1100 nm	
Spot size *3	ϕ8 µm to ϕ80 µm	
Working distance	Refer to objective lens list	
Number of measurable layers	Max. 10 layers	
Analysis	FFT analysis, Fitting analysis, Optical constant analysis	
External control function	Yes (Option)	
External communication interface	RS-232C, PIPE or Ethernet	
Interface	USB 2.0	
Power supply voltage	AC100 V to AC 120 V, 50 Hz/60 Hz	AC200 V to AC 240 V, 50 Hz/60 Hz
Power consumption	Approx. 250 VA	

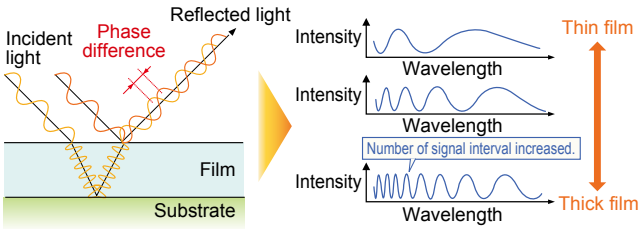
*1: When converted with the refractive index of glass = 1.5.
*2: Standard deviation (tolerance) when measuring 400 nm thick glass film.
*3: Depending on optical system or objective lens magnification to be used.
*4: Range of measurement guarantee as recorded in the VLSI Standards measurement guarantee document.

Principle

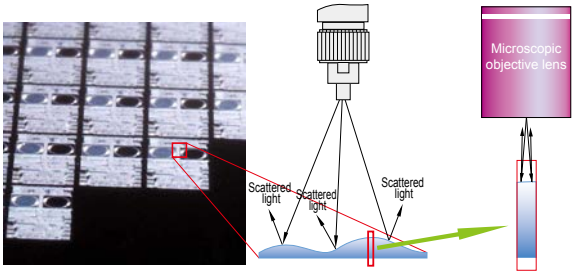
Spectral interferometry is used to measure film thickness.

White light incident on a sample will display a characteristic spectrum that is dependent on the film thickness. Spectral interferometry is a way of measuring film thickness by analyzing this spectrum.

[Diagram outlining principle]



Principle of microscopic system measurement and benefits

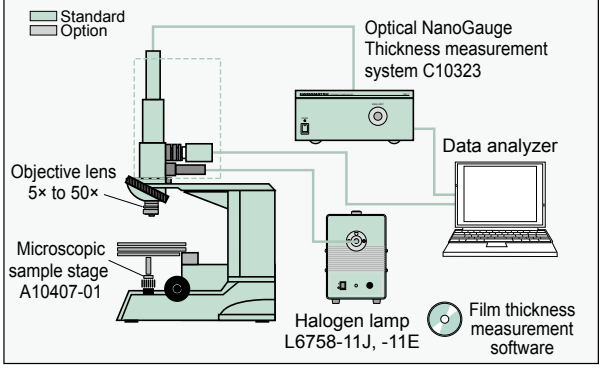


Macro measurement　　Micro measurement with microscope

Samples which are difficult to measure with the conventional macro system, such as a wafer with irregular patterns and MEMS, can be measured with a microscopic system. Samples with irregular surfaces may not be able to be measured at the macro level due to high level of scattered light. In the micro measurement with a microscopic system, the measurement point can be narrowed down to a flat area with little scattered light, that makes measurement possible.

Configuration example

C10323-02 Example of system configuration



Option

☐ Objective lens

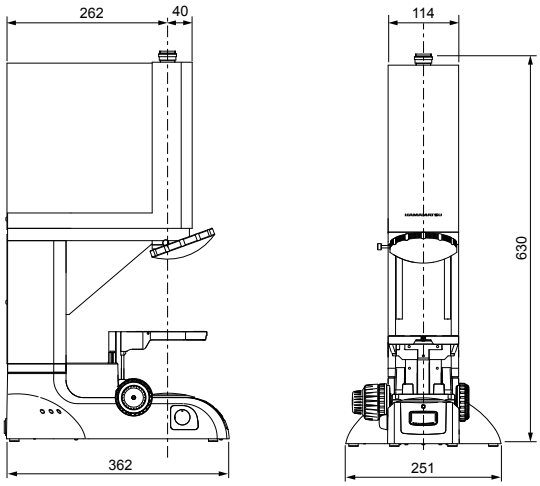
Lens	Measurement spot size	NA	Working distance
5×	ϕ80 μm	0.14	37.5 mm
10×	ϕ40 μm	0.26	30.5 mm
20×	ϕ20 μm	0.40	20.0 mm
50×	ϕ8 μm	0.42	17.0 mm

☐ Microscopic sample stage A10407-01
(Stage moving area: 75 mm × 50 mm)

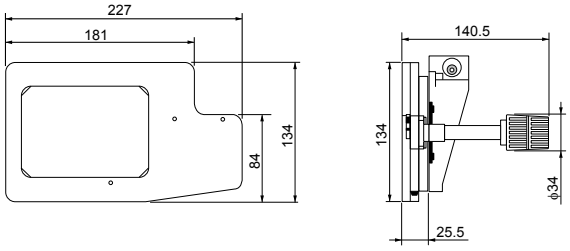
☐ Microscopic sample stage for 6 inch wafer A10407-02
(Stage moving area: 150 mm × 150 mm)

Dimensional outline (Unit: mm)

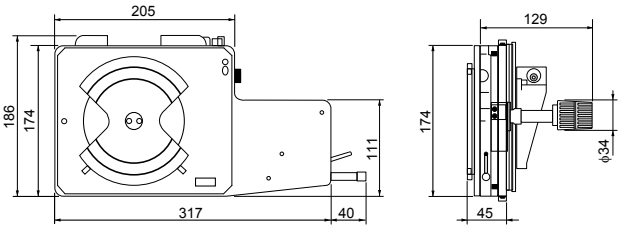
■ Microscopic optics A10406-02 (Approx. 15 kg)



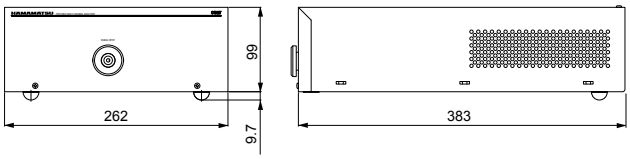
■ Microscopic sample stage A10407-01



■ Microscopic sample stage for 6 inch wafer A10407-02



■ Main unit (Approx. 5 kg)



* For outline dimensions of halogen light source L6758-11J, -11E, please refer to page 13.

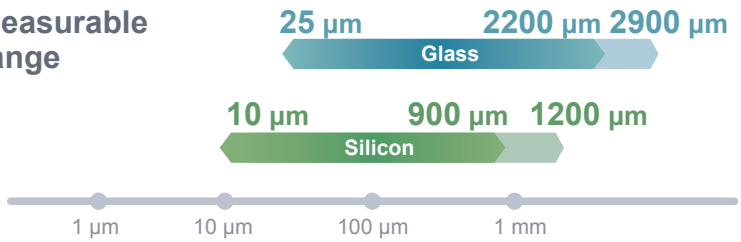
Optical MicroGauge
Thickness measurement system
C11011

High speed measurement model compatible with in-line systems, capable of measuring up to 2.9 mm

Thick film measurement with high speed

The Optical MicroGauge Thickness measurement system C11011 series is a film thickness measurement system utilizing laser interferometry. Allows for high speed measurement at 60 Hz, so it can also be used inline measurement in factories. Combine with the optional mapping system to allow for prototype thickness distribution measurement. It can be used in a wide variety of applications, from monitoring manufacturing processes to quality control.

Measurable range



High speed measurement of film, glass and wafer

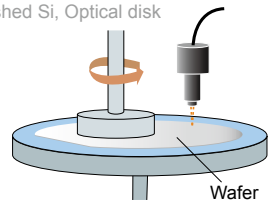
Features

- Measurement of non-transparent (white color) sample by infrared photometry
- High speed measurement at 60 Hz
- Measurement of pattern-formed wafer or wafer with protective film
- Long working distance
- Mapping function
- External control available

Examples of installation in various manufacturing facilities

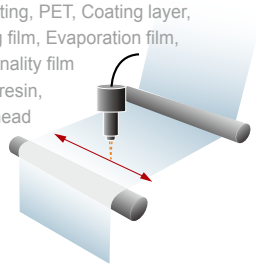
Semiconductor

Wafer
Si for PV panel
SiC coat, Si coat, Wet coat,
Polished Si, Optical disk



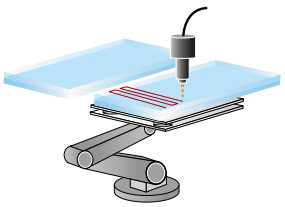
Film

Optical film
AR coating, PET, Coating layer,
Coating film, Evaporation film,
Functionality film
Acrylic resin,
Video head



FPD

Panel
Cell gap, Glass thickness,
DLC, High-function film

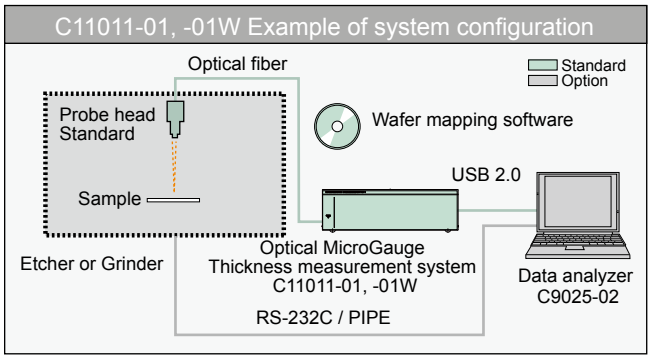


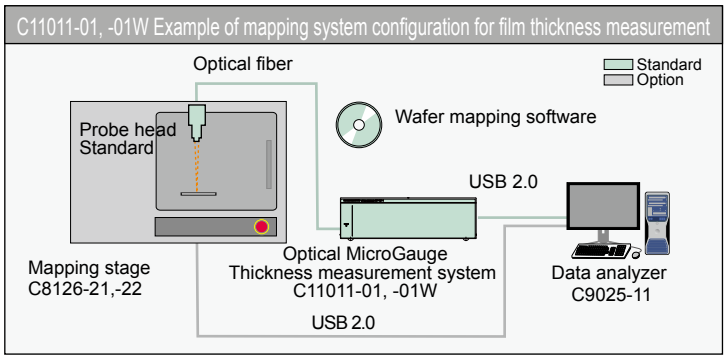
Specification

Type number	C11011-01	C11011-01W	C11011-21	C11011-21W
Measurement film thickness range (glass) *1	25 µm to 2200 µm	25 µm to 2900 µm	25 µm to 2200 µm	25 µm to 2900 µm
Measurement film thickness range (silicon) *2	10 µm to 900 µm	10 µm to 1200 µm	10 µm to 900 µm	10 µm to 1200 µm
Measurement reproducibility (silicon) *3	100 nm			
Measurement accuracy *3	< 500 µm: ±0.5 µm, ≥ 500 µm: ±0.1 %			
Light source	Infrared LD (1300 nm)			
Spot size	Approx. ϕ60 µm			
Working distance *4	155 mm			
Number of measurable layers	1 layer		Max. 10 layers	
Analysis	Peak detection			
Measurement time *5	16.7 ms/point	22.2 ms/point	16.7 ms/point	22.2 ms/point
External communication interface	RS-232C, PIPE		RS-232C, Ethernet	
Interface	USB 2.0 (Main unit - Computer)			
Power supply voltage	AC100 V to AC240, 50 Hz/60 Hz			
Power consumption	Approx. 50 VA			

*1: Glass refractive index equivalent.
*2: Silicon refractive index equivalent.
*3: Standard deviation when measuring Silicon
*4: Optional model with 1000 mm working distance is available. (Type number C11011-01WL)
*5: Shortest exposure time

Configuration example

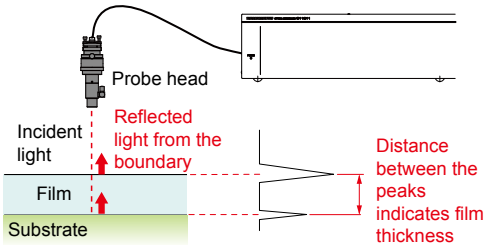




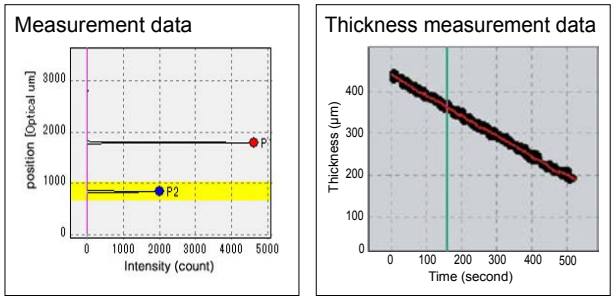
Principle

Use laser interferometry to measure film thickness.

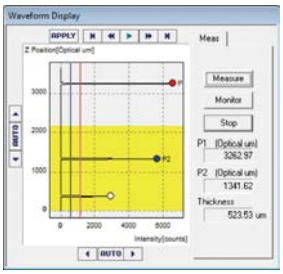
The probe head irradiates sample with near infrared light which reflects back from the film front surface. Some of the light transmits through the film and reflects back from the boundary on the opposite side. The controller internally processes each reflected light to detect the position where light was reflected or in other words the position on the film boundary. The controller then calculates the film thickness from the distance between the detected peaks.



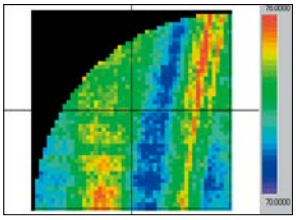
In-situ monitoring of thickness (during wet etching)



Measurement of bonded wafer (multilayer)



Thickness distribution of a wafer



▲Display from 70 µm to 76 µm
Sample: 8-inch Si bare wafer
(Protective film / after grinding process)

Option

☐ Mapping stage ϕ200 mm C8126-21
Mapping stage ϕ300 mm C8126-22

- Measurement time: 1 s/point
- Measurement area: to 140 mm square (C8126-21)
  (4 inch wafer to 8 inch wafer)
  : to 200 mm square (C8126-22)
  (4 inch wafer to 12 inch wafer)
- Stage movement resolution: 0.1 mm
- Stage movement repeatability: ±0.01 mm

☐ Data analyzer C9025-01
Desktop data analyzer.

☐ Data analyzer for Mapping system C9025-11
Desktop data analyzer for wafer mapping measurement.

☐ Probe head Acid resistance A8653-02

This probe head is surface-treated to make it acid-resistant and is recommended for use while mounted in wet etching equipment.

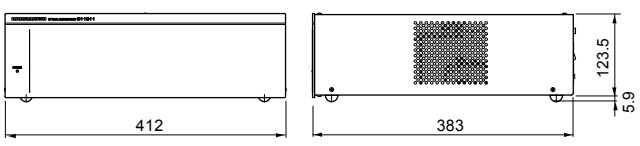
☐ Horizontal setting optics A9925-01

This optical system is designed to connect to the probe head and is useful when installing the probe head in narrow locations with little working distance.

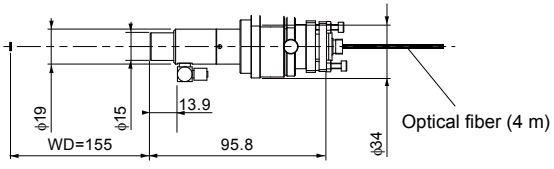
☐ Data analyzer C9025-02
Laptop data analysis unit.

Dimensional outline (Unit: mm)

■ Main unit (Approx. 8.5 kg)



■ Probe head Standard A8653-01



* The bending radius of the fiber is R30 mm or more.

Questions Answers

Q & A

Optical Gauge Series **Q&A**

The following is a collection of answers to common questions about the Optical Gauge. Refer to this when considering Optical Gauge Series for your equipment.

Q What are some materials that are ideal for measurement, or that cannot be measured?

A You can basically measure any material as long as light can pass through it. It's difficult to measure a sample that light can't pass through, such as a metal film 100 nm or thicker. (Samples less than 50 nm thick have been measured successfully before.) A white material will also scatter light, making measurement difficult. Contact a Hamamatsu Photonics representative for more information on haze rates and other specs.

Q What applications can it be used in?

A It can be used with in-line/off-line applications, mainly inspecting semi-conductor, FPD, and film manufacturing processes (film thickness control).

Q I want to check whether I can measure something. Can you conduct a demonstration measurement?

A We can conduct demonstration measurements on a sample you prepare. We have a Gauge Series demo kit ready. Contact a Hamamatsu Photonics representative for more information.

Q What do you do to confirm the Optical Gauge thickness measurements?

A We measure a sample whose thickness has been guaranteed by a third party institution and judge the measurement results against that reference to confirm thickness. Unfortunately we cannot guarantee measurements of film thickness of samples that we ourselves cannot control and check.

Q What level of precision can I measure to?

A Absolute precision depends on the optical constant (refraction index and absorption coefficient) of a material. If this optical constant is correct, then the absolute thickness precision will be high. The guaranteed range shown in measurement guarantees by VLSI Standards (a third part institution) is our measurement precision. Reproducibility is 0.02 nm of standard deviation on a 400 nm quartz glass sample.

Q The Series is resistant to height fluctuations, but by how much?

A It can handle fluctuations of several mm. See defocus dependencies on page 3 for more information.

Q What sort of questions do you often get after shipping the product?

A We don't get many questions regarding hardware repair, but we get a lot of questions regarding the analysis area (including software), especially about setting recipes. For this, the Series has a recipe setting function that is simple for even the customer to use.

Q Can it measure automatically?

A Products in the Optical Gauge Series can automatically measure using their external communication function. The C13027 enables measurement controls using electrical input/output signals, making it easy to connect a sequencer.

Q Can it measure when the sample and sensor are positioned far apart?

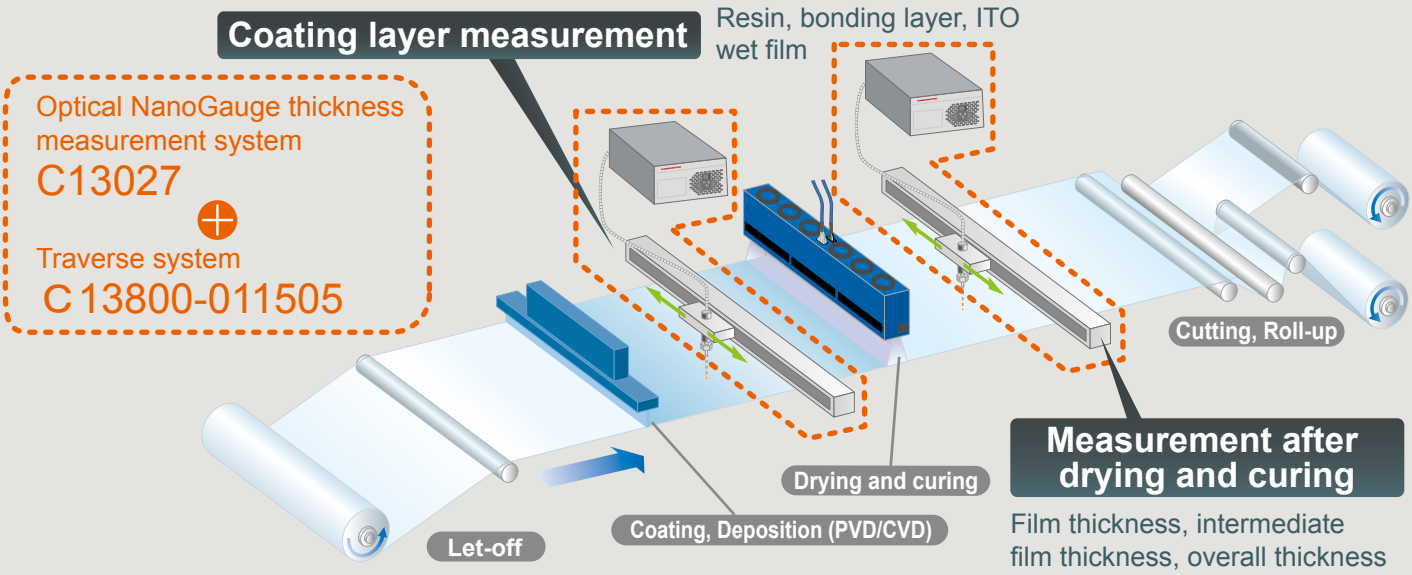
A Normal measurements are taken when the sample and sensor are less than 10 mm apart, but we offer an optical system that can handle a working distance of 35 mm.

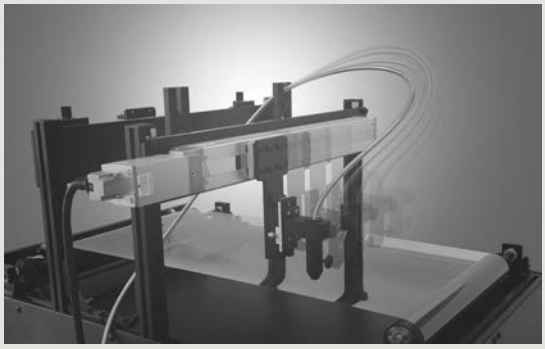
Optical NanoGauge thickness measurement system C13027 supported

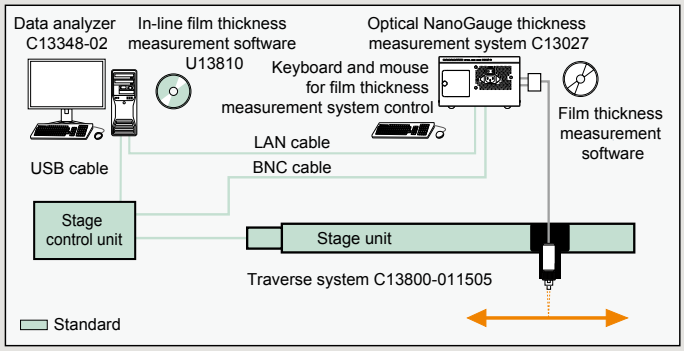
Traverse system **C13800-011505**

An in-line film thickness measurement system can be easily constructed when combined with Optical NanoGauge thickness measurement system C13027.

The traverse system enables in-line measurement of film thickness profiles when combined with the Optical NanoGauge thickness measurement system C13027. Can monitor crosswise film thickness distribution in a sample and sequential changes to film thickness in the direction of line flow. Can also be used to monitor film thickness when combined with manufacturing equipment.







Features

- Easily combinable with manufacturing devices
- I/O control is possible
- Can be used for in-line measurement of width direction profiles or flow direction trend graphs

Specifications

Type number		C13800-011505
Stage unit	Measured film width*1	1500 mm
	Mooving speed	150 mm/s, 300 mm/s
	Position accuracy	During continuous measurement: less than ±0.5 mm, During step measurement: less than ±0.1 mm
	Cable length*1	5 m, 10 m
I/O	Input*2	Inspection start, inspection stop, rewind, Emergency shutdown
	Output*3	Film thickness gauge control signal · Alarm
Software*4	Width direction trend graph	Selected layer trend graph (present + past data)
		Maximum, minimum, average, and standard deviation of selected data
		Number of measuring lines: 1 – 1000 lines
	Flow direction trend graph	Selected layer and selected position trend graph (present + past data)
		Maximum, minimum, average, and standard deviation of selected data
		Max. measurement time*5 0 – 9999 mins
		Max. measurement length*5 0 – 9999 meters

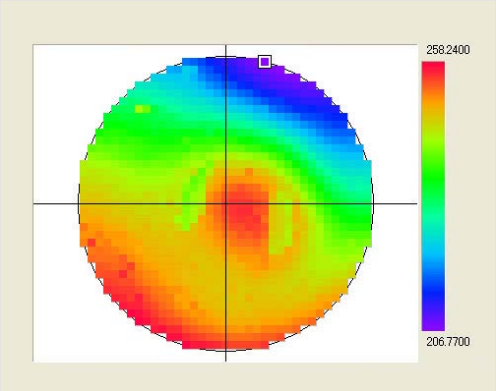
*1: For non-standard lengths, please contact us.
*2: Photocoupler input type
*3: Open collector
*4: Supported operating system: Windows 7 64-bit
*5: Varies depending on conveyance speed and measurement time interval.

Optical NanoGauge thickness measurement system C13027 supported | Optical Micro Gauge thickness measurement system C11011 supported

Mapping stage **C8126 series**

Mapping thickness distribution of wafer and thin film
Compatible with Optical NanoGauge or Optical MicroGauge

The mapping system C8126 series is a mapping system that measures wafer and film thickness distribution when combined with models from Optical Gauge Series. Use to confirm in-plane homogeneity of etching and grinding features and for quality control.



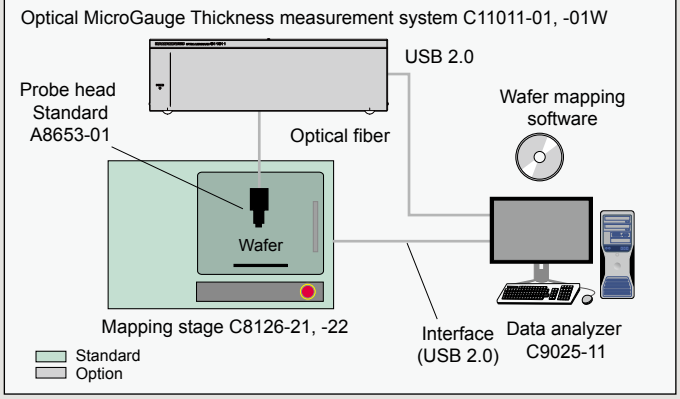
Type number	Measurable range		Compatible with NanoGauge / MicroGauge
	Wafer (inch)	Film*	
Mapping stage ϕ200 mm C8126-21	4 to 8	< 140 × 140	C11011-01 C11011-01W
Mapping stage ϕ300 mm C8126-22	4 to 12	< 200 × 200	
Mapping stage ϕ200 mm C8126-31	4 to 8	< 140 × 140	C13027-12
Mapping stage ϕ300 mm C8126-32	4 to 12	< 200 × 200	

*For more details of the specification, please contact us.

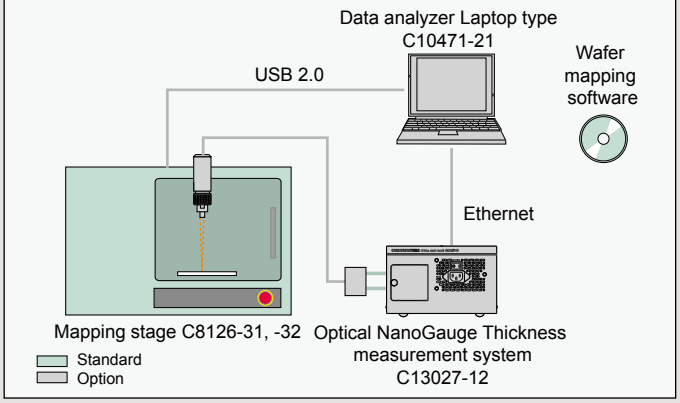
Features

- Thickness distribution measurement
- Mapping thickness distribution of pattern-formed wafer
- Mapping thickness distribution of pattern-formed wafer with protective film

C8126-21, -22 Example of system configuration (For C11011 series)



C8126-31, -32 Example of system configuration (C13027 supported)



Type number	C8126-21, -31	C8126-22, -32
Stage movement resolution	0.1 mm	
Stage movement repeatability	±0.01 mm	
Power requirement *1	AC100 V to AC117 V, AC220 V to AC240 V, 50 Hz/60 Hz	
Power consumption	120 VA (at 100 V), 160 VA (at 200 V)	
Dimensional outline / Weight	820 mm(W) × 550 mm(H) × 600 mm(D) Approx. 67 kg	940 mm(W) × 595 mm(H) × 750 mm(D) Approx. 82 kg

*For more details of the specification, please contact us. *1: Either 100 V system or 200 V system can be selected.

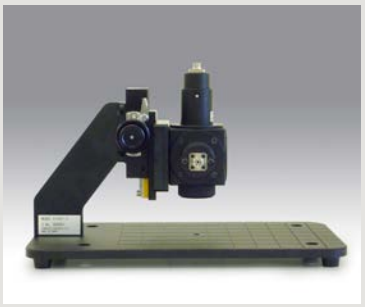
Optical NanoGauge thickness measurement system C13027 supported | Optical NanoGauge film thickness measurement system C12562 supported

Micro optics **A13097**

Spot size can be narrowed down to cope with interface roughness, scattering samples, and uneven film thickness

The A13097 is a micro-optical system for in-line film thickness measurement, designed to measure samples that are difficult or impossible to measure by a wide field of view. When used in combination with an Optical NanoGauge Thickness measurement system C13027 or C12562, the spot diameter can be narrowed down to 100 µm in diameter to allow measuring interface roughness as well as samples with high scattering and very small areas on patterns, which up until now have been difficult to measure. The A13097 is quite stable even when there are variations in height, and so gives reliable measurements at diverse manufacturing sites. A sample stage type is also provided for off-line applications.

Micro optics A13097-01, -02



Micro optics A13097-11, -12
(For off-line use)

Specification

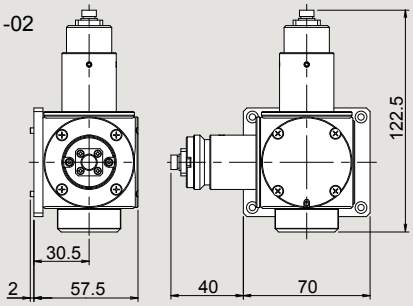
■ Specifications when C13027 and A13097 are combined

Type number	A13097-01, -11	A13097-02, -12
Measurement film thickness range (glass) *1	100 nm to 100 µm	10 nm to 50 µm
Measurement reproducibility (glass) *2 *3	0.2 nm	
Measurement accuracy *3	±0.4 %	
Light source	Halogen light source	
Measurement wavelength range	700 nm to 1100 nm	400 nm to 800 nm
Spot size *3	ϕ100 µm	
Working distance *3	32 mm	
Height fluctuation	±2 mm	
Maximum repetition frequency	200 Hz	
Measurement time	3 ms/point	
Light guide connector shape	FC	

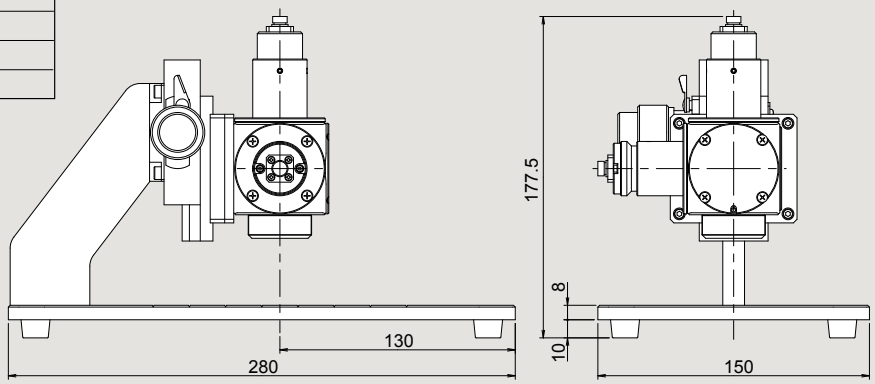
*1: When converted with the refractive index of glass = 1.5.
*2: Standard deviation (tolerance) when measuring 400 nm thick glass film.
*3: Depending on optical system or objective lens magnification to be used.

Dimensional outline (Unit: mm)

■ Micro optics A13097-01, -02



■ Micro optics A13097-11, -12



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