Full automated polarimeter
Fullauto StrainEye
LSM-9100W/WS

Luceo Co., Ltd.

May.27, 2019

Contents

■Company profile/Products

■ Polarization
(what is Polarization/ Cross-parallel nicol/Retardation ?）

■ Measurement method

■ About LSM-9100W/WS
・Features
・Applications

Company profile

- In 1966, when liquid crystals did not exist, we took notice of polarizing plates, an optical element, and began our in-house R&D, production and sales.

- Using proprietary technologies, we manufacture our own brand of polarizing plate, optical element of wave plate, optical unit and optical inspection equipment, and sell it to domestic as well as around the world.
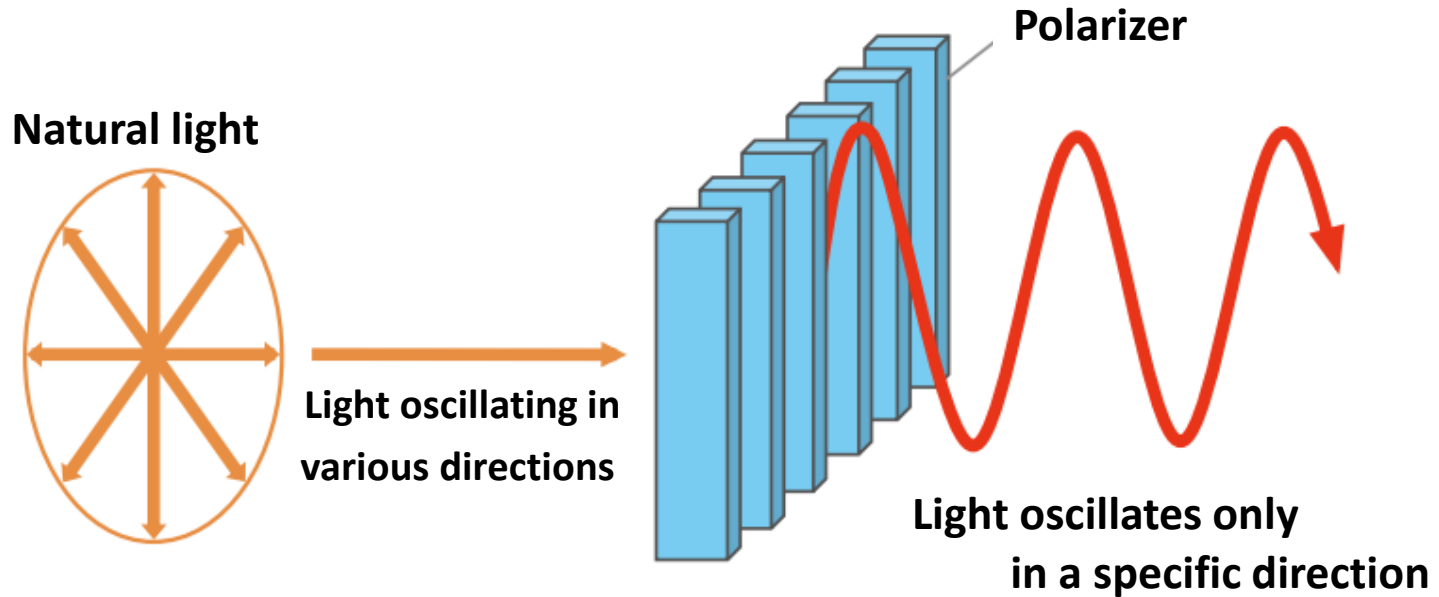
Product
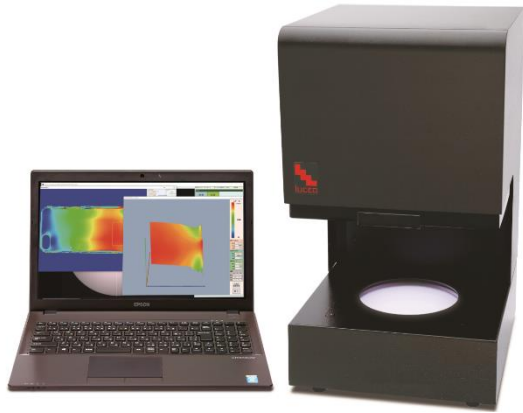
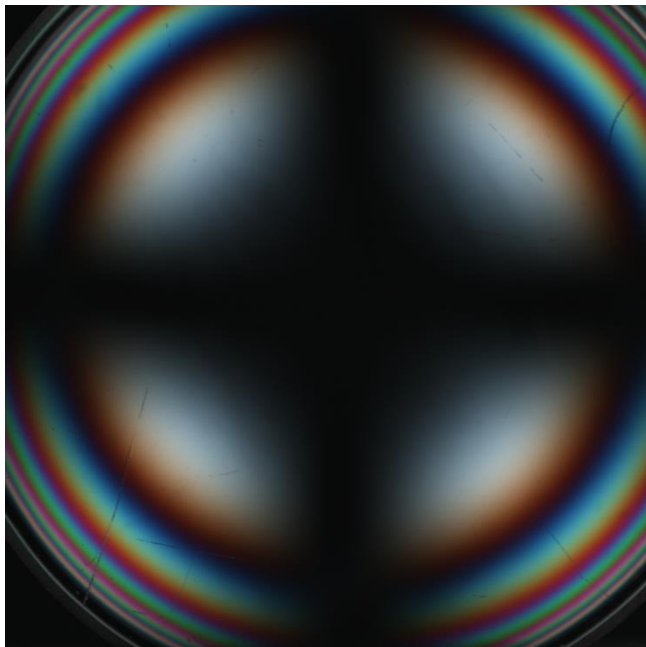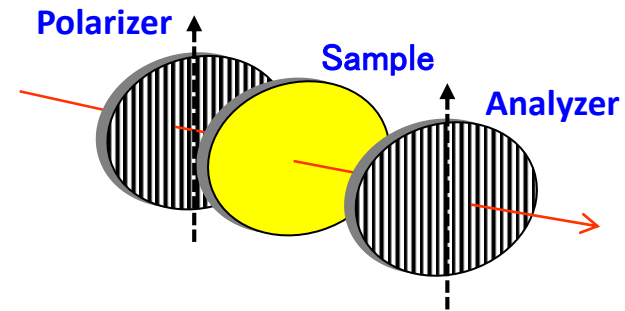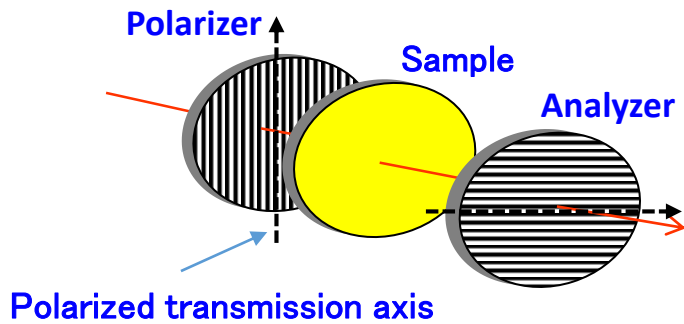polarizing plates
▪ wave plates
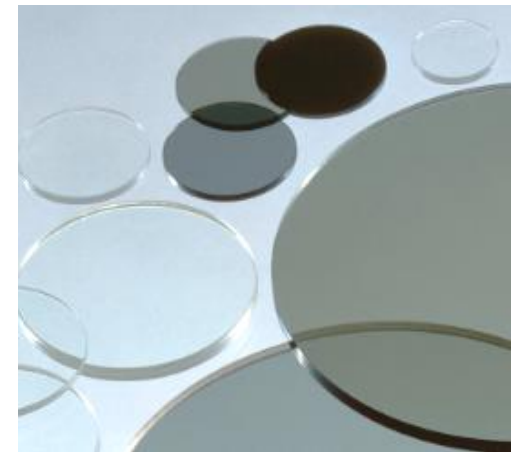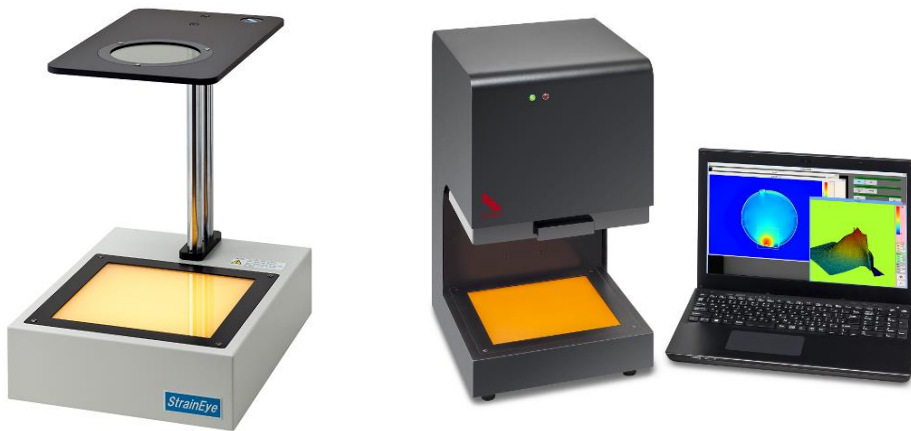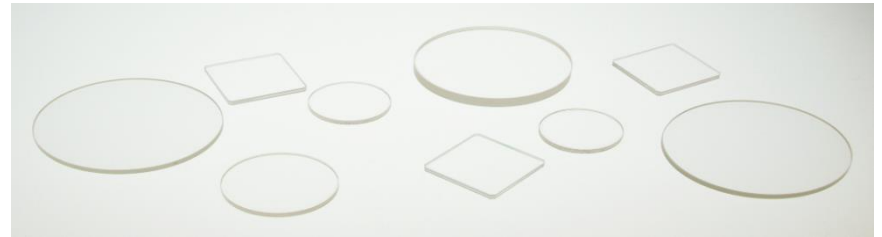
Polariscopes

Polarization

Light oscillates only in a specific direction

Polarizer

Natural light

Light oscillating in various directions
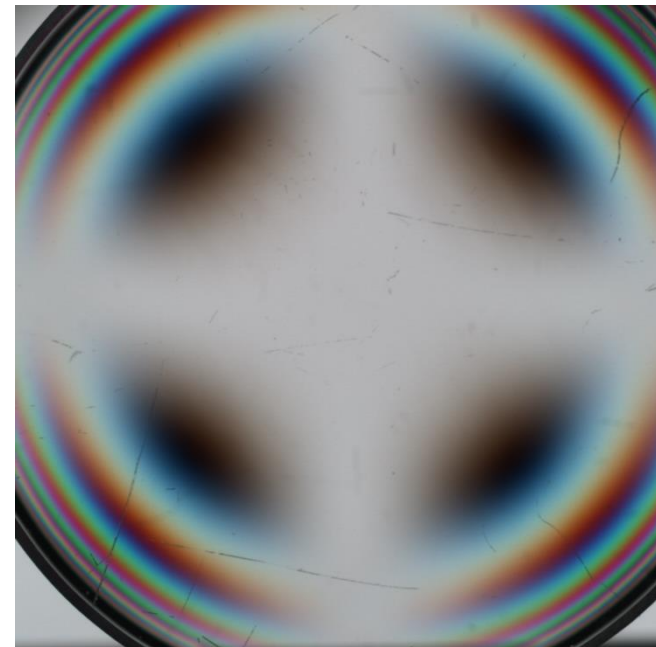
Light oscillates only in a specific direction

💡 **Controlling light creates a new technology.**

LUCEO offers optical related products.
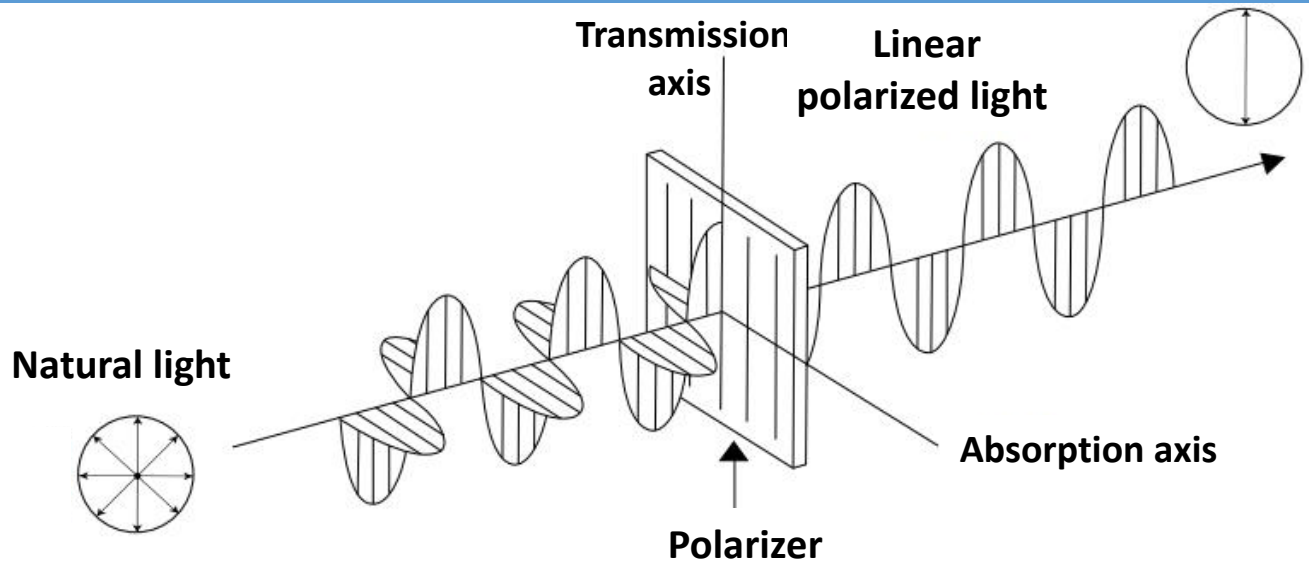
Cross nicol ・ Parallel nicol

Cross nicol
(Polarized transmission axis Cross)

Parallel nicol
(Polarized transmission axis Parallel)

Linear polarized light・Circularly polarized light

Linear polarized light	**Natural light** → **Transmission axis** / **Polarizer** / **Absorption axis** → **Linear polarized light**
Circularly polarized light	**Vibration direction of incident light** / **Linear polarized light** / **Quarter wave plate** / 45° / **Optical axis direction of quarter-wave plate** → **Circularly polarized light**
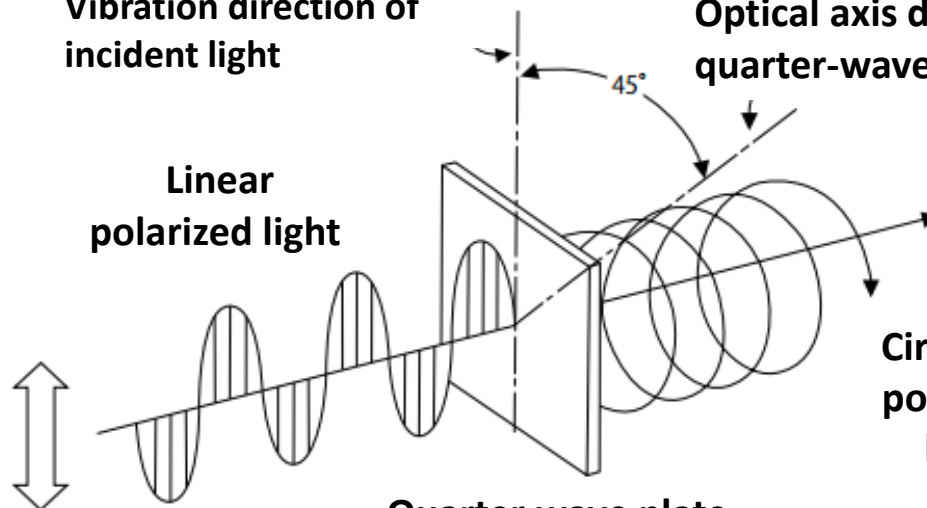
Retardation/principal axis direction
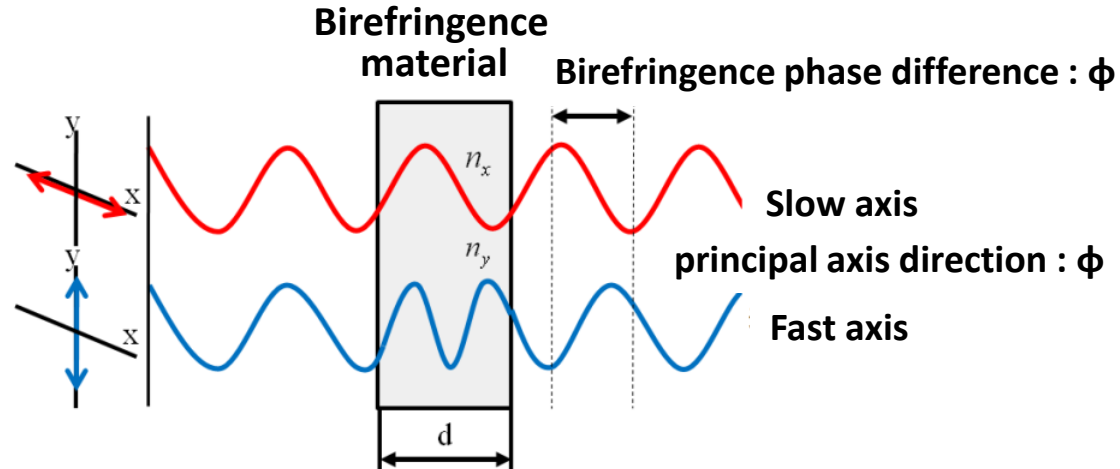
The polarization state of light propagating toward the z-axial direction is determined by the amplitude and the phase difference that are composed by x-component and y-component of a oscillation vector which are mutually orthogonal each other in the plane perpendicular to z-axial. When light passes through a birefringent object, a birefringent retardation $n_{x\text{-}y}$ is generated. Birefringence is expressed by the following equation, where n_x is the refractive index of the x-axis and n_y is the refractive index of the y-axis.
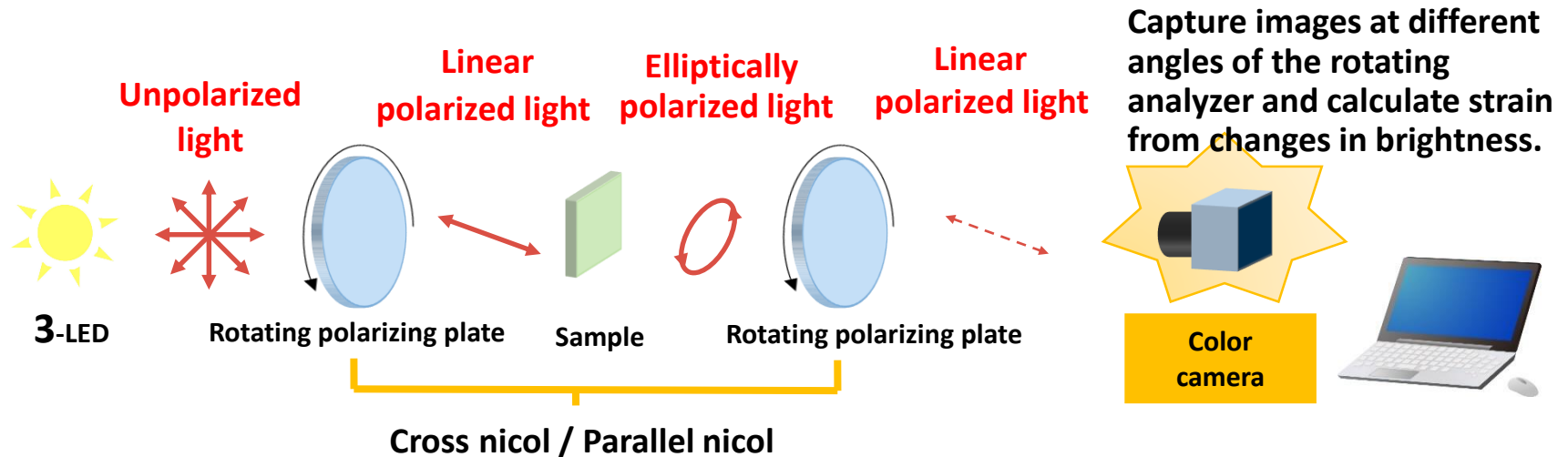
$$n_{x-y} = n_x - n_y$$

The upper figure shows the process of generating the phase difference of birefringence. The axis with the highest or lowest refractive index is called the direction of the principal axis. Also, the axis with the lowest refractive index is called the fast axis because the light travels fast, and the axis with the highest refractive index is called the slow axis. Here, the relationship between the birefringence phase difference (retardation) that occurs when passing through the birefringent material, the thickness d of the material, and the birefringence of the material is expressed by the following equation.

$$\Delta = \frac{2\pi}{\lambda}(n_x - n_y)d$$

Measurement method

Unpolarized light

Linear polarized light

Elliptically polarized light

Linear polarized light

Capture images at different angles of the rotating analyzer and calculate strain from changes in brightness.

3-LED

Rotating polarizing plate

Sample

Rotating polarizing plate

Color camera

Cross nicol / Parallel nicol

"RGB linear polarization method"

・ Use RGB LED (460/525/630 nm) as light sources
・ 3 wavelengths images are taken at the same time.
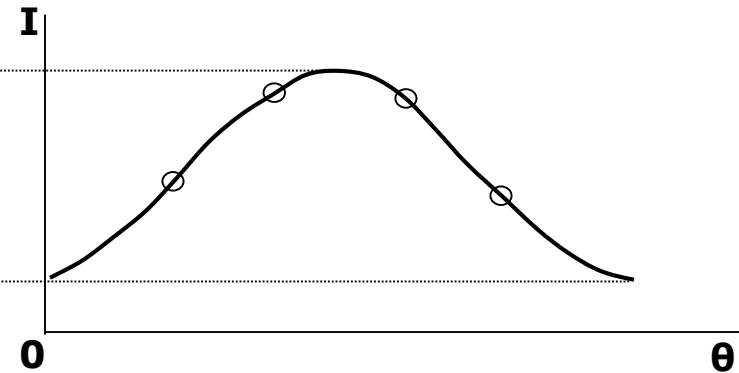
Light intensity

Wavelength

Color camera
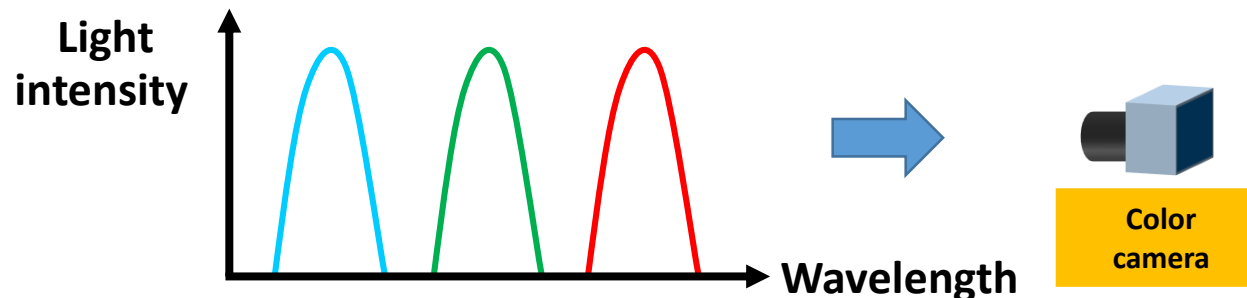
Measurement method

■ Light intensity data at any point ～ Fourier analysis
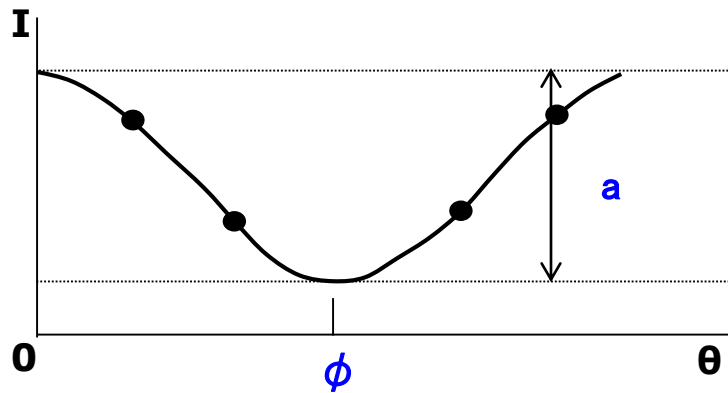
直行ニコル光強度データ

平行ニコル光強度データ

Calculate the retardation "Re" from the amplitude "a"

From the angle of the polarizing plate at the darkest position,the direction of the principal axis φ is caught according to sine wave approximation.
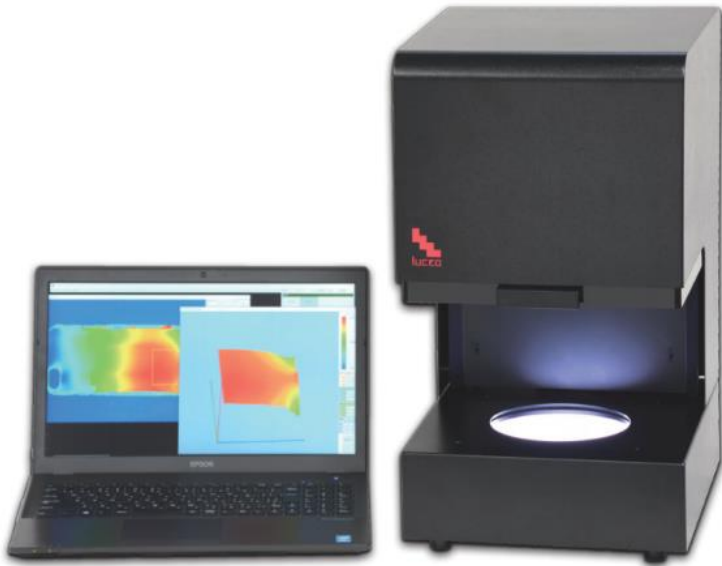
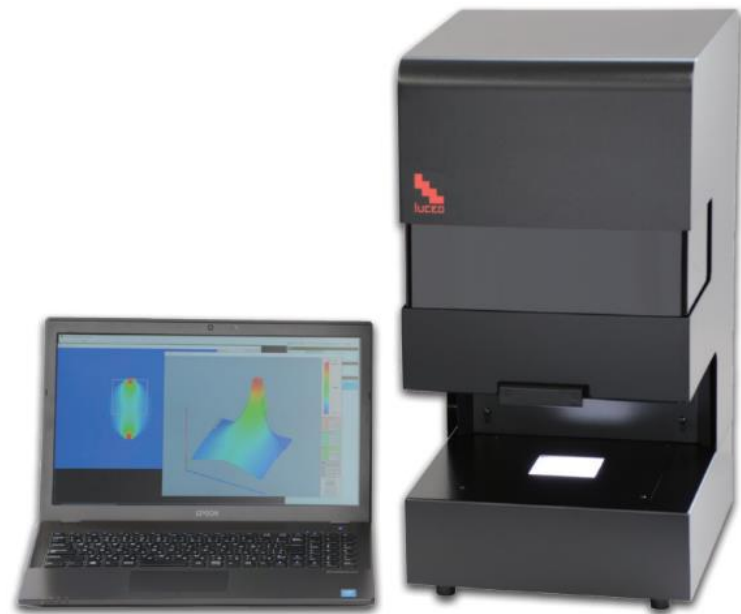Base on image processing by every pixel,result of every point in the field of view will be obtained.
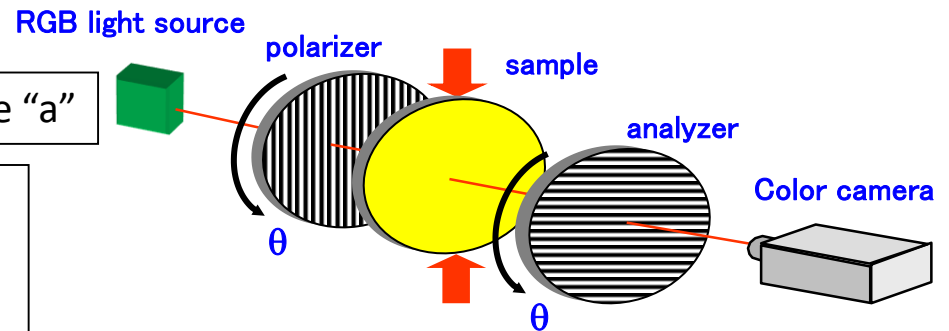
Variation in measurement results can be reduced by using both cross nicols and parallel nicols.

RGB light source

polarizer

sample

analyzer

Color camera

θ

θ

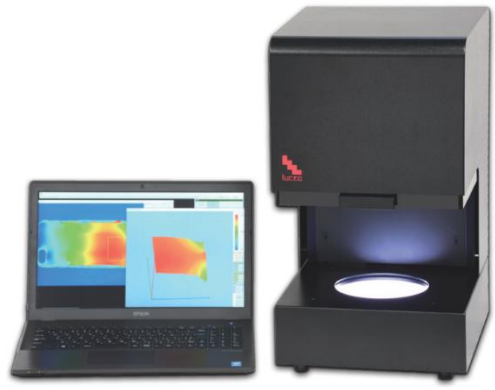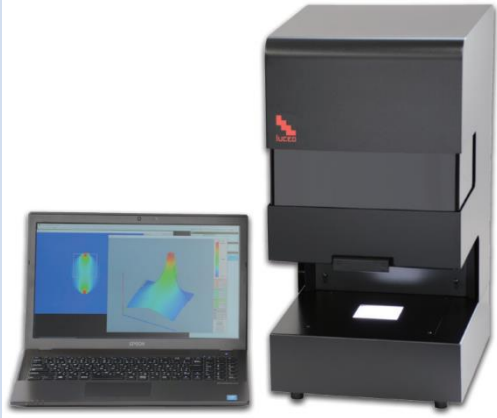# Fullauto StrainEye LSM-9100W/WS

LSM-9100W

LSM-9100WS

Fullauto StrainEye LSM-9100W/WS

- LSM-9100W / WS is a device that non-destructively measures the internal stress of plastic products with large strain (internal stress) nondestructively in the retardation range of 0 to 3,000 nm.

- LSM-9100 Product family

    LSM-9000W   Suitable of bigger samples（φ150mm）

   **LSM-9100WS**   6x zoom lens for measurements on smaller samples

Fullauto StrainEye LSM-9100W/WS

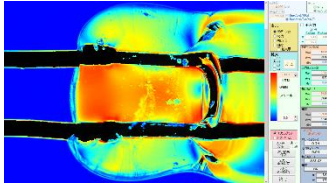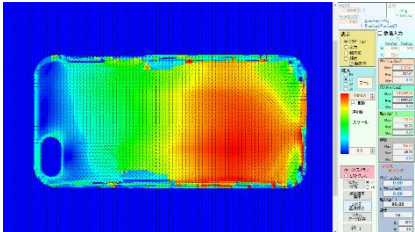| Contents	LSM-9100W	LSM-9100WS
Outer		
Outer dimension（Body）	W300×D353×H540mm	W300×D353×H580mm
Weight（Body）	22kg	24kg
Sample Available Height	0〜160mm	0〜115mm
Inspection method	RGB linear polarization method	←
Set wavelength	420〜680nm	←
Retardation Range	0〜3000nm	←
Repeat Accuracy	Single wavelength σ<1nm Three wavelength σ<3nm	←
Measurement area	Φ150mm	60×60mm 〜 10×10mm

Polarimeter
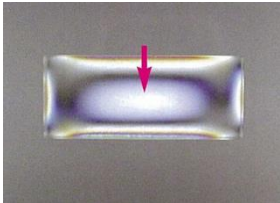
- In glass and plastic products, internal residual stress remains in the form of strain when they are heated and formed in the manufacturing process.

- Products with strain have poor optical properties and are fragile.

- A polarimeter is an instrument that observes/measures the strain quantitatively.

Strain is observed by the differences in color
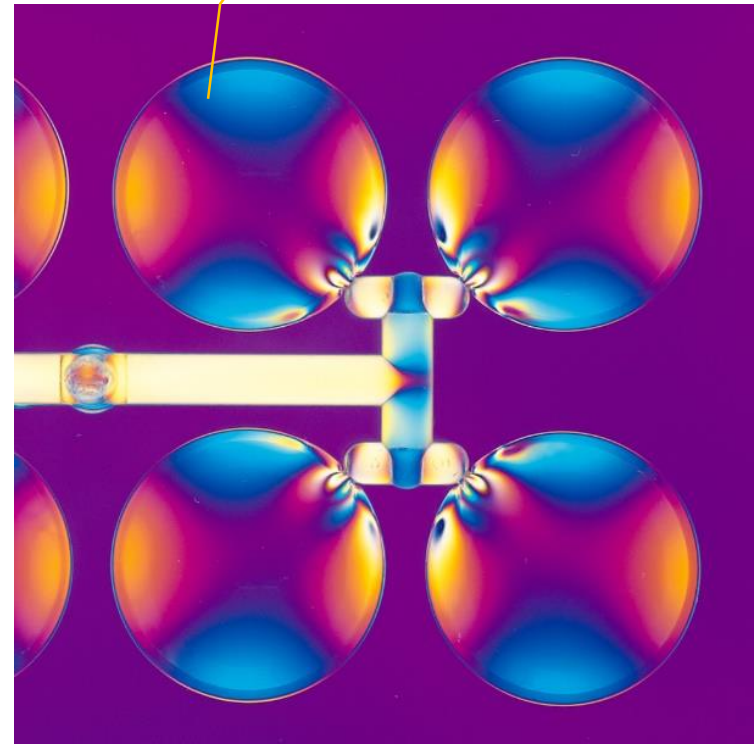
（Sensitive Color method）

# Difference with other measurement principles

	Sensitive color	Senarmont	Rotating analyzer	RGB linear polarization
Classification	Visually	Semi-automatic one-point measurement	Automatic two-dimensional measurement	Automatic two-dimensional measurement
Items	LSM-4300LE	LSM-7000LE	LSM-9000LE/S	LSM-9100W/WS
Measurement item	Retardation Determination of compression and tension	Retardation principal axis direction	Retardation principal axis direction	Retardation principal axis direction
Retardation measurement resolution	10nm	1.5nm	1nm	3nm
merit	Determined visually from color	Quantitative measurement	High precision measurement of small strain	Measures large strain up to 3000 nm
Demerit	Requires comparison with standard	It takes time to measure. Not 2D measurement.	Unable to measure strain of 130 nm or more	Lower measurement accuracy in low strain (about 0 to 5 nm)
Measurement example				

Application1 LSM-9100W smartphone cover

Max1250nm

Live image
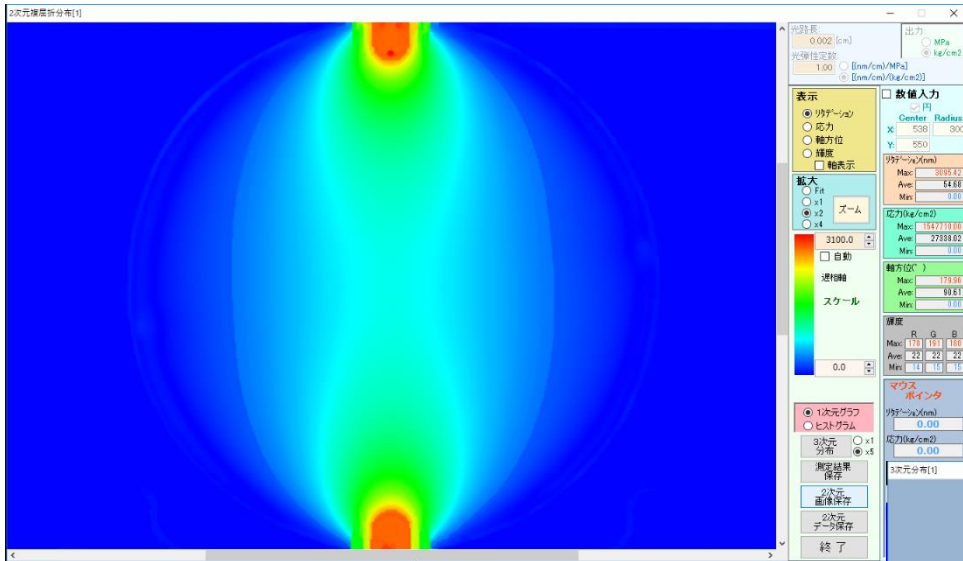
histogram

1D graph
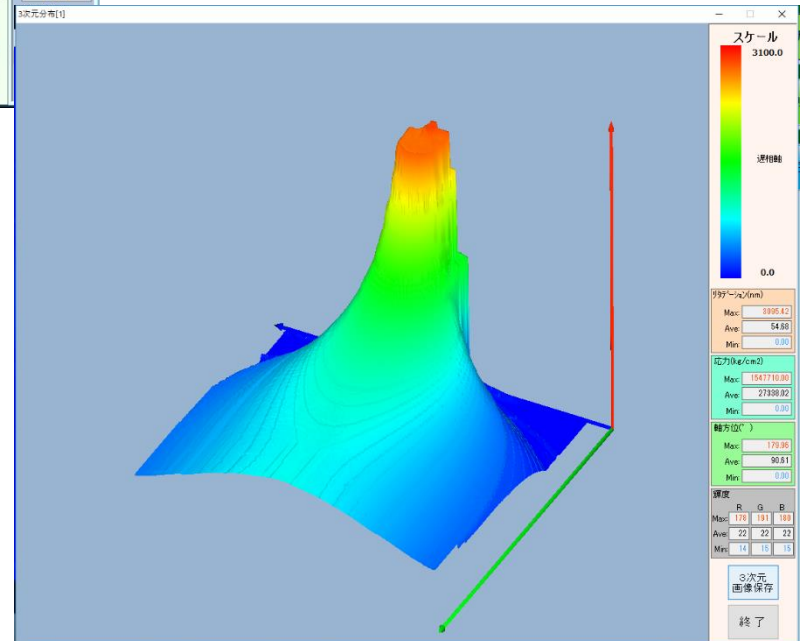
Retardation map
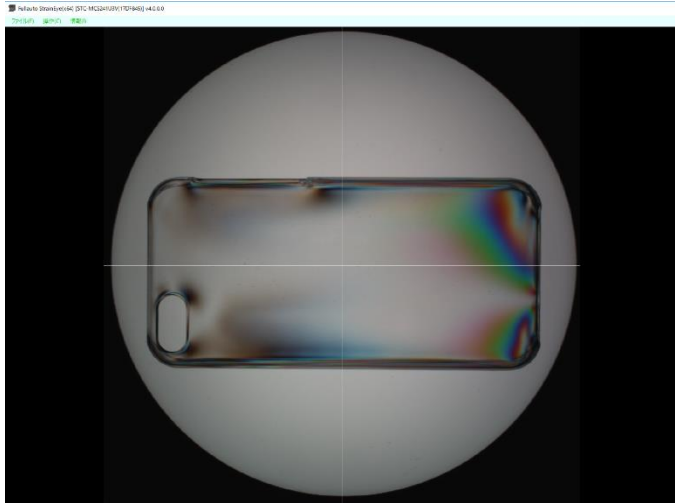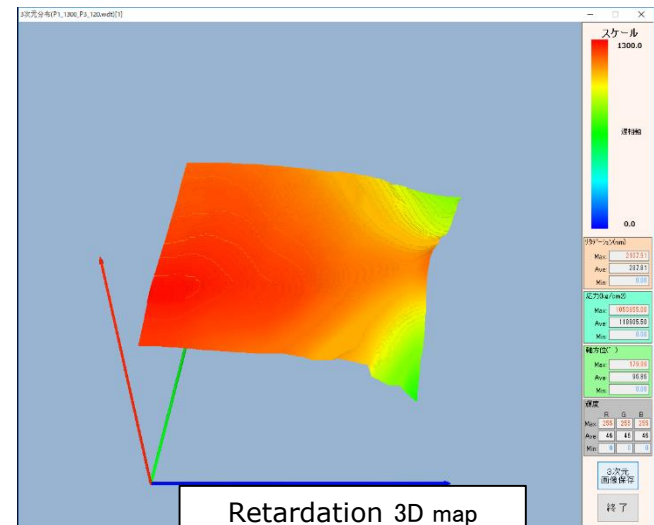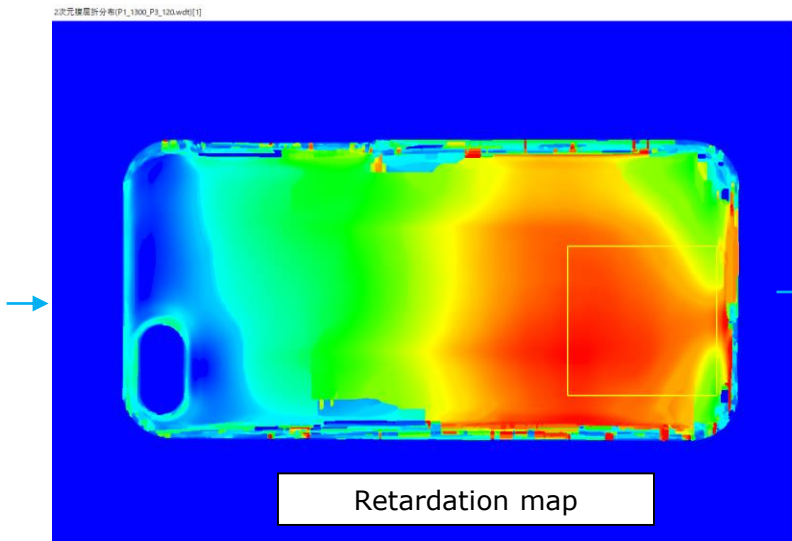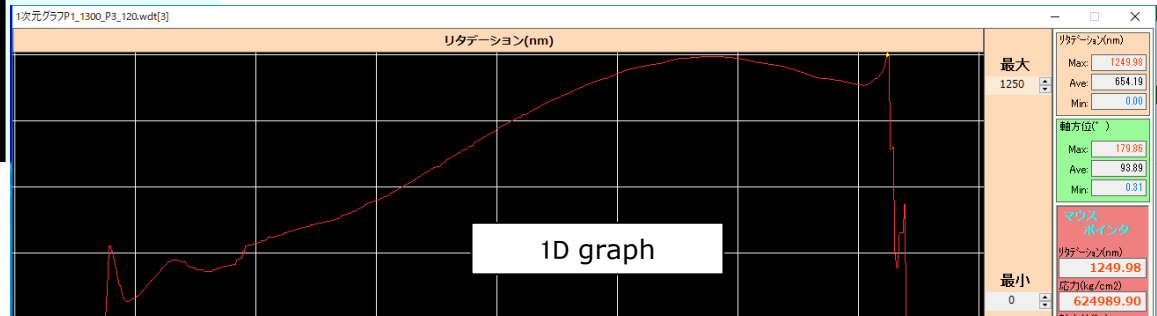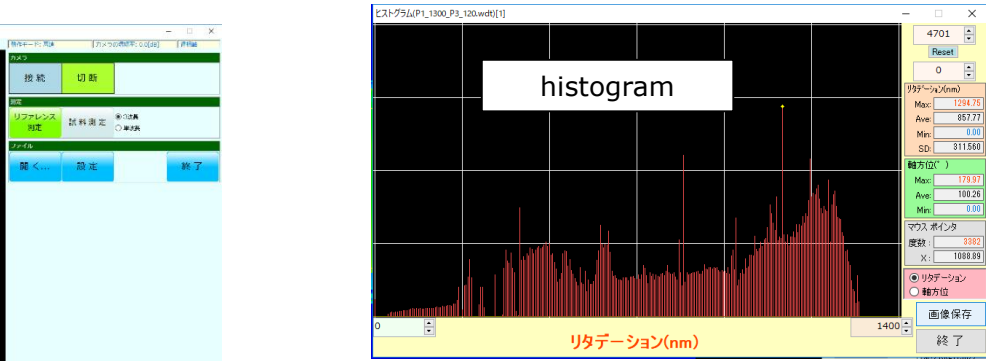
Retardation 3D map

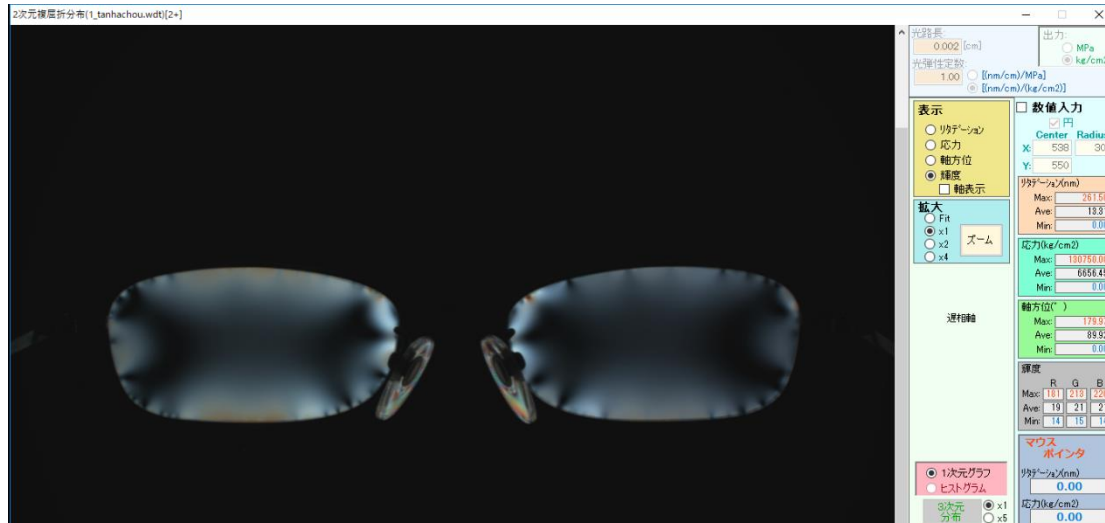# Application2 LSM-9100W Plastic disc compression
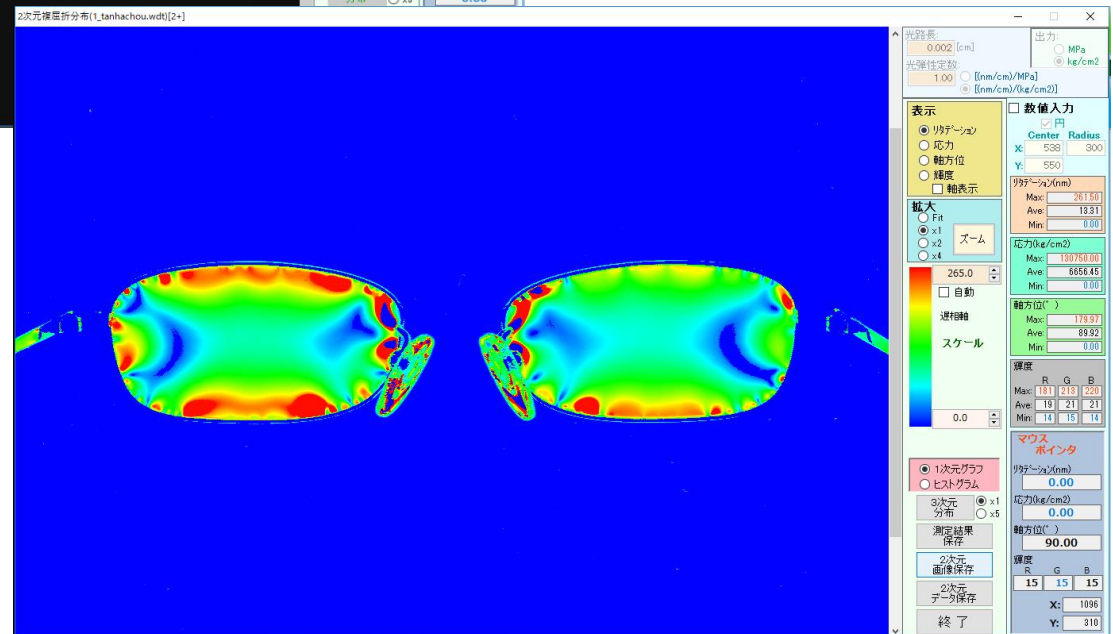
Max3068nm

Retardation map

Retardation 3D map
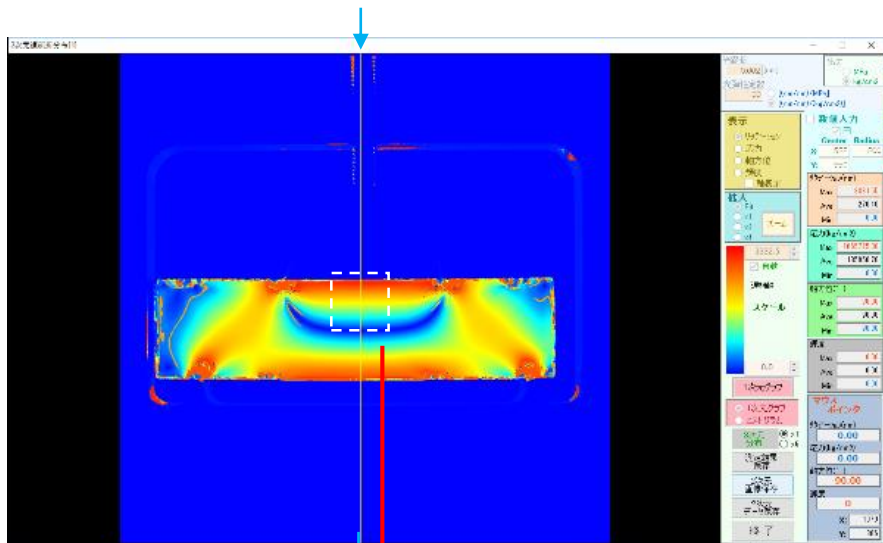
Application3   LSM-9100W   Glasses
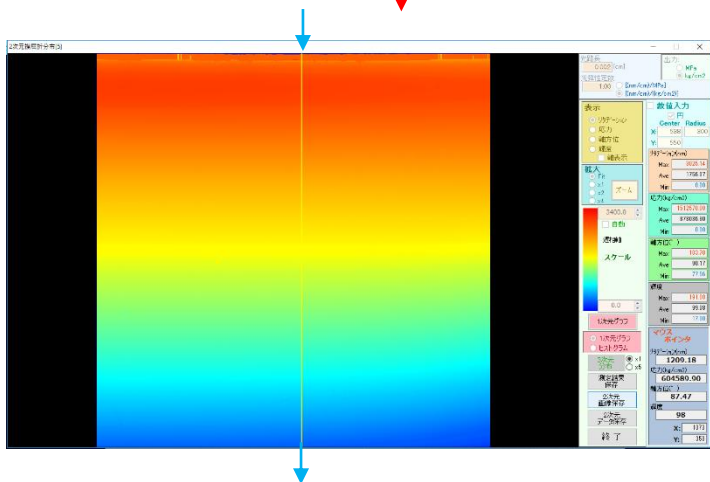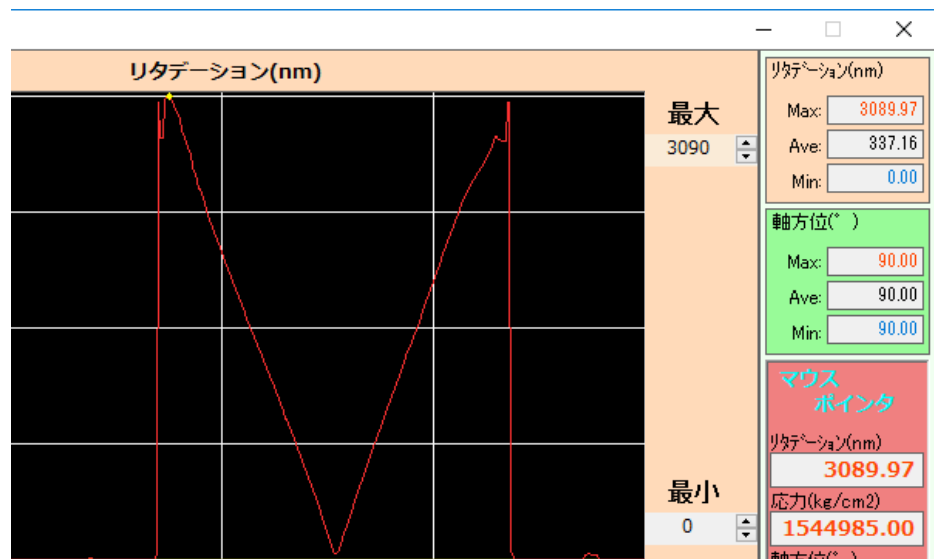
Max250nm

Light intensity image

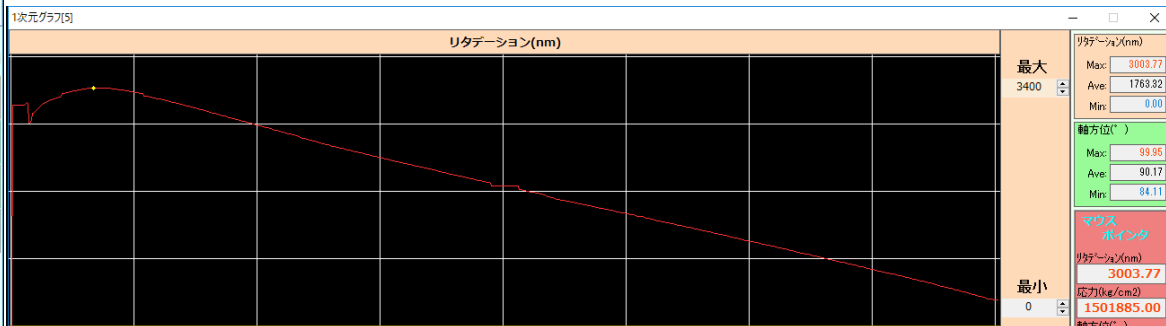Retardation map

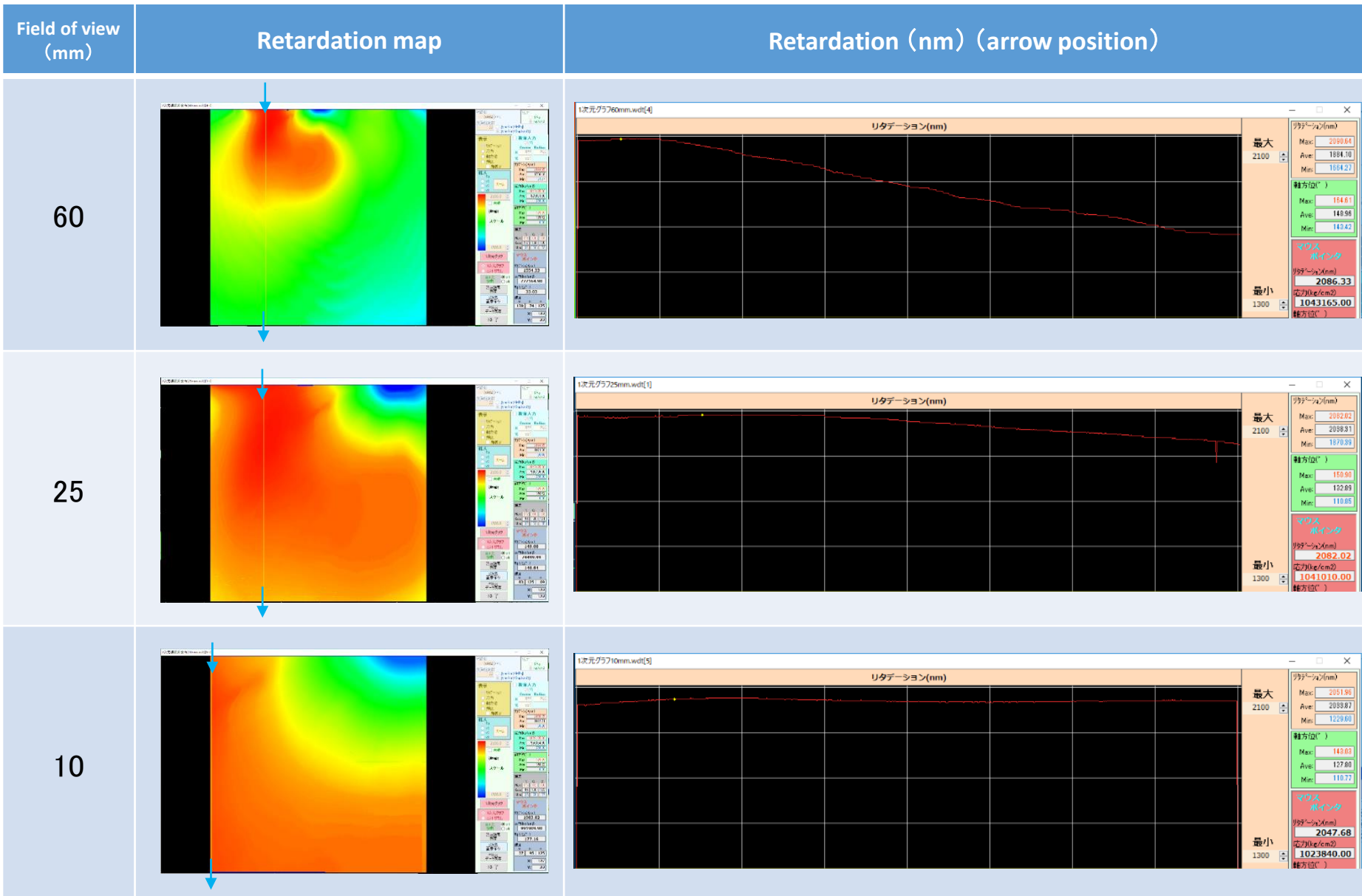# Application4 LSM-9100W/WS Beam bending

Max3090nm

LSM-9100W

LSM-9100WS

Application5　LSM-9100WS　CD case

Field of view（mm）	Retardation map	Retardation（nm）（arrow position）
60		
25		
10		

Application6 LSM-9100WS Plastic bracket compression

Max3378nm

Field of view（mm）	Retardation map	Retardation（nm）（arrow position）
60		
25		
10		
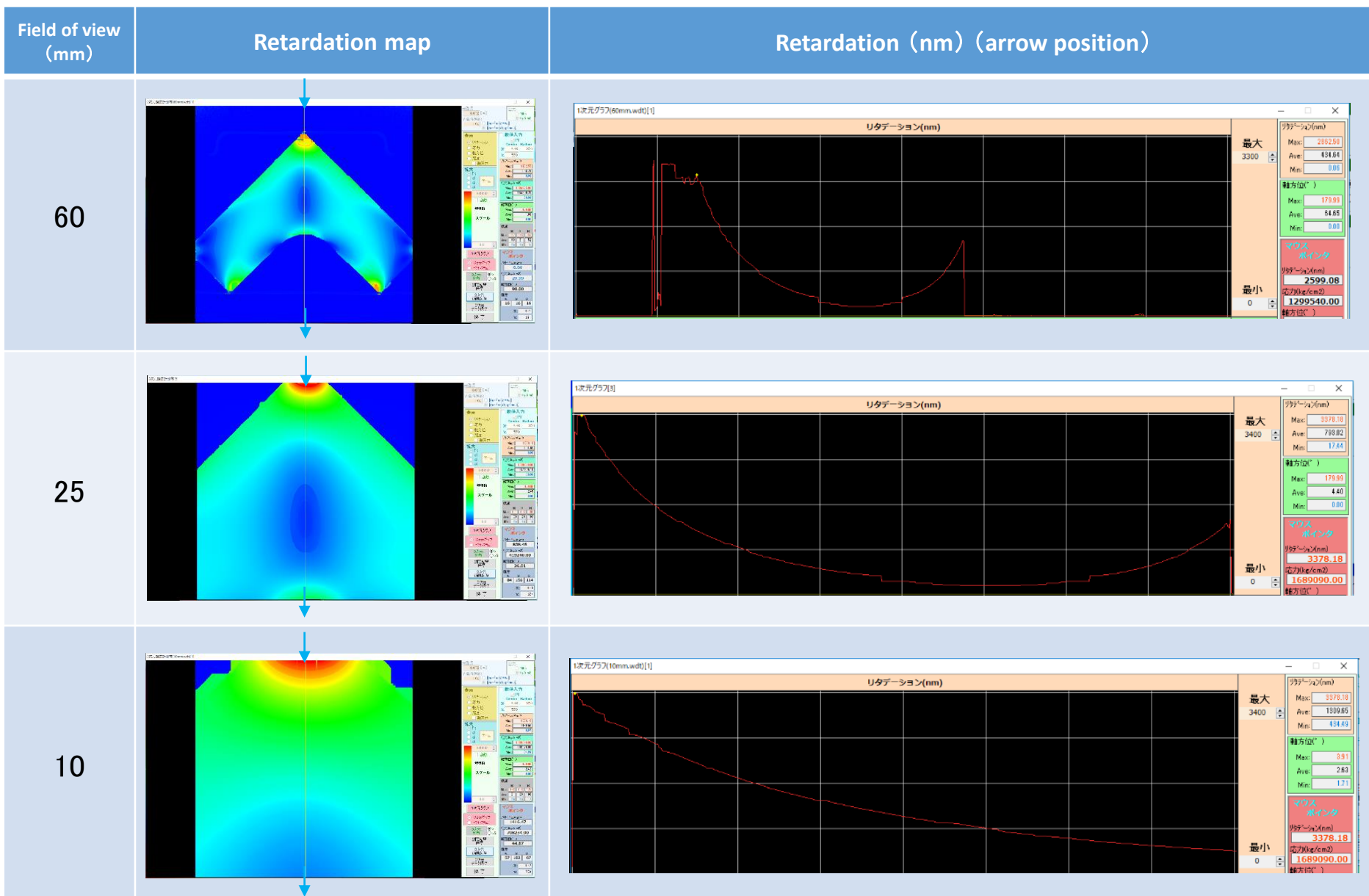
Application7 LSM-9001LE/S Glass

Max10nm

LSM-9001LE lens

Max100nm

LSM-9001S Lamp bulb