LUMETRICS®
Precision Measurement Solutions

Application Note AP-105-01

MEASUREMENT OF MULTIPLE LENS THICKNESSES AND AIR GAPS WITHIN A LENS STACK

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***Abstract*—The camera lens stack manufacturing process relies heavily on polished lenses that have precise thicknesses and distances between individual lenses.**

Lumetrics' low coherence interferometer, commercially marketed as OptiGauge® II, is a device capable of measuring both lens thickness and distance between lenses with sub-micron precision. Combined with custom software and a precision height adjustment stage, a lens stack can be characterized in terms of lens thickness and distance between lenses aiding in both incoming material inspection and outgoing product quality control.

***Index Terms*—lens, stack, interferometry, metrology, optical thickness measurement, center thickness, glass, center, sagittal**

I. Introduction

LUMETRICS is the market leader in providing high-precision, non-contact optical thickness measurement solutions to medical, scientific, and ophthalmic industries.

A unique capability of our flagship thickness measurement device, OptiGauge II, is its ability to measure the individual layer thickness of a multiple-layer sample.

Figure 1: OptiGauge II

The OptiGauge II measures using a 1310nm wavelength which is an ideal wavelength for measuring through nearly all visually transparent and semi-transparent objects.

An example of a transparent object with multiple layers is a lens stack. A lens stack consists of multiple lenses usually with air gaps in between each lens.

Figure 2: Examples of camera lens stacks

When combined with a precision height adjustment stage, the entire lens stack can be profiled to provide the user with lens thickness and air gap measurements. Based on these measurements, the user may implement process changes to correct for out of spec air gaps.

This capability makes the OptiGauge II an ideal measurement tool for lens stack measurement.

II. Single Lens Measurement

When measuring a single lens with the OptiGauge II, it is possible to measure not only the center thickness (CT) but also the sagittal height (SAG).

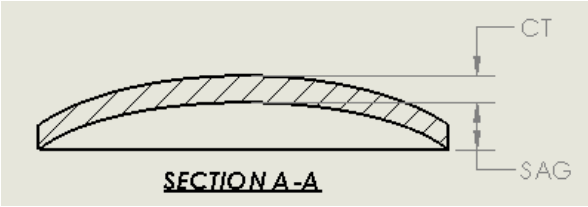

Figure 3: CT and SAG diagram

If the lens is resting on an optical flat the CT and SAG measurements can be used to help evaluate incoming lenses.

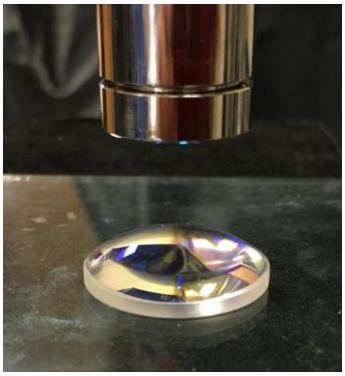

Figure 4: Single lens inspection

CT (µm)	SAG (µm)
6516.98	3497.21

Table 1: CT and SAG measurements for a glass lens

III. MULTIPLE LAYER THIN LENS STACK

The OptiGauge II can also be used to simultaneously measure thicknesses of multiple lenses in a lens stack without needing to adjust the probe's height. The table below shows what the thickness of each lens is as well as the air gaps between them.

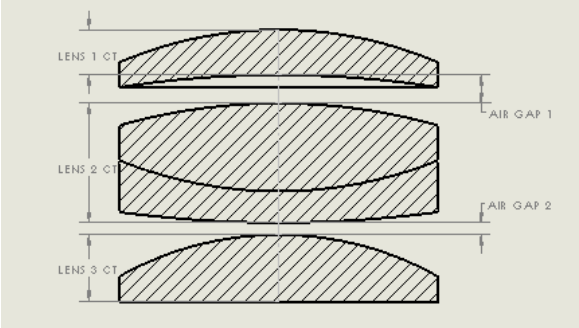

Figure 5: CT and air gap measurements of a lens stack

Layer	Thickness (µm)
1 (Lens 1)	3690.99
2 (Air Gap 1)	165.70
3 (Lens 2)	4235.97
4 (Air Gap 2)	263.14
5 (Lens 3)	2891.75
Total Thickness	11247.54

Table 2: CT and Air Gap values for thin lens stack

IV. MULTIPLE LAYER THICK LENS STACK (> 16MM OVERALL THICKNESS)

The OptiGauge II has the ability to measure lens stacks that are thicker than the measurement range of the system. By moving the measurement probe up and down with a precision height adjustment stage and utilizing custom software, the OptiGauge II can scan through the height of the lens stack.

V. REAL-WORLD APPLICATIONS

The data gathered by the OptiGauge II has several practical applications.

- Inspection of lenses or lens stacks may be checked during an incoming inspection process upon receipt from a supplier.
- Technicians are able to manually inspect before and after an assembly process to verify they are gaping the lenses properly.
- Valuable data can be provided to engineers when diagnosing a performance issue with a lens assembly or telescope
- With proper mounting and software, the OptiGauge II can be integrated directly into an inspection system.

VI. CONCLUSION

The OptiGauge II is a powerful non-contact optical measurement instrument. It can precisely measure CT, SAG, Air Gap thickness and total lens stack thickness. This instrument can be integrated onto robotic arms or other automated stations for fast inspection of lenses during the inspection and manufacturing processes.

Lumetrics' engineers can quickly answer any questions pertaining to software communication with the OptiGauge II, mechanical mounting options of the optical head, or any other technical question to evaluate metrology options.

Contact Lumetrics for additional information

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