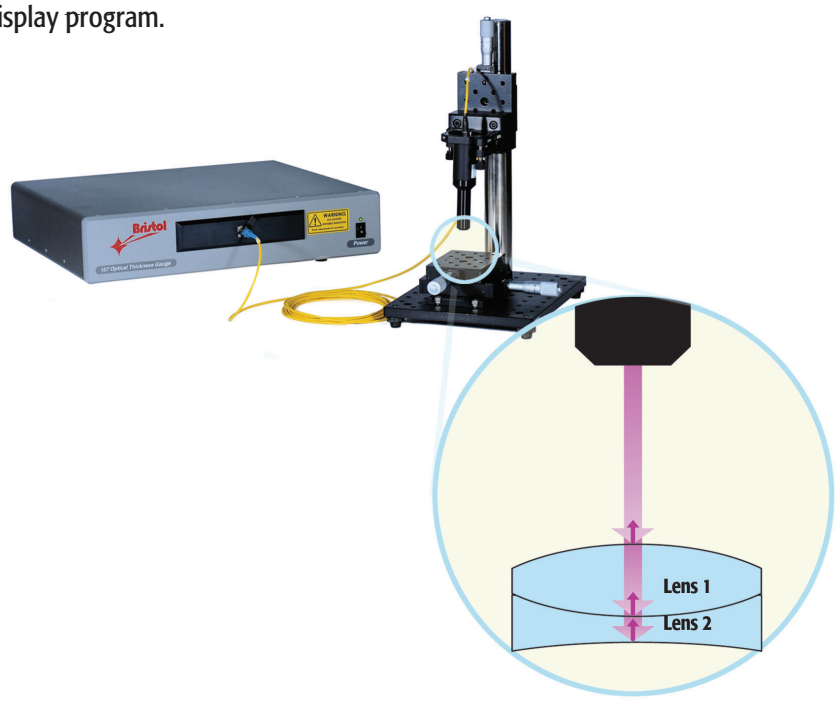
TECHNICAL NOTE 003-M

Thickness of Lens Assemblies Measured by the 157 Series Optical Thickness Gauge

Precise thickness information is critical in the development and production of optics such as cemented or air-spaced achromatic doublets, triplets, and more complex lens stacks. To address this need, Bristol Instruments offers the 157 Optical Thickness Gauge. This instrument uses Bristol's proven optical interferometer-based technology to measure absolute thickness of single-layer or multi-layer materials to an accuracy of ± 0.1 µm and a repeatability of ± 0.02 µm.

To demonstrate this capability, the 157 Optical Thickness Gauge was used to analyze an achromatic doublet that consists of two singlet lenses that are cemented together. The 157 system is ideal for themetrology of an achromatic doublet because it can accurately measure the central thickness of both elements simultaneously.

The setup for making the thickness measurements of the lens is quite simple. The optical probe of the model 157 was aligned to the optical axis of the achromatic doublet on a test fixture as shown below. Light from an LED is sent to the achromatic doublet through an optical probe and reflections from every surface (top, bottom, and internal) are collected and returned to the 157 system for analysis. Thickness is calculated on the model 157 using an internal DSP and then reported on a PC using a Windows-based display program.



The temperature of the environmental chamber was cycled from 10°C to 35°C, a range that exceeds the specified operational temperature range of the 157 Optical Thickness Gauge. Measurement data was transferred to a PC and logged for further analysis.

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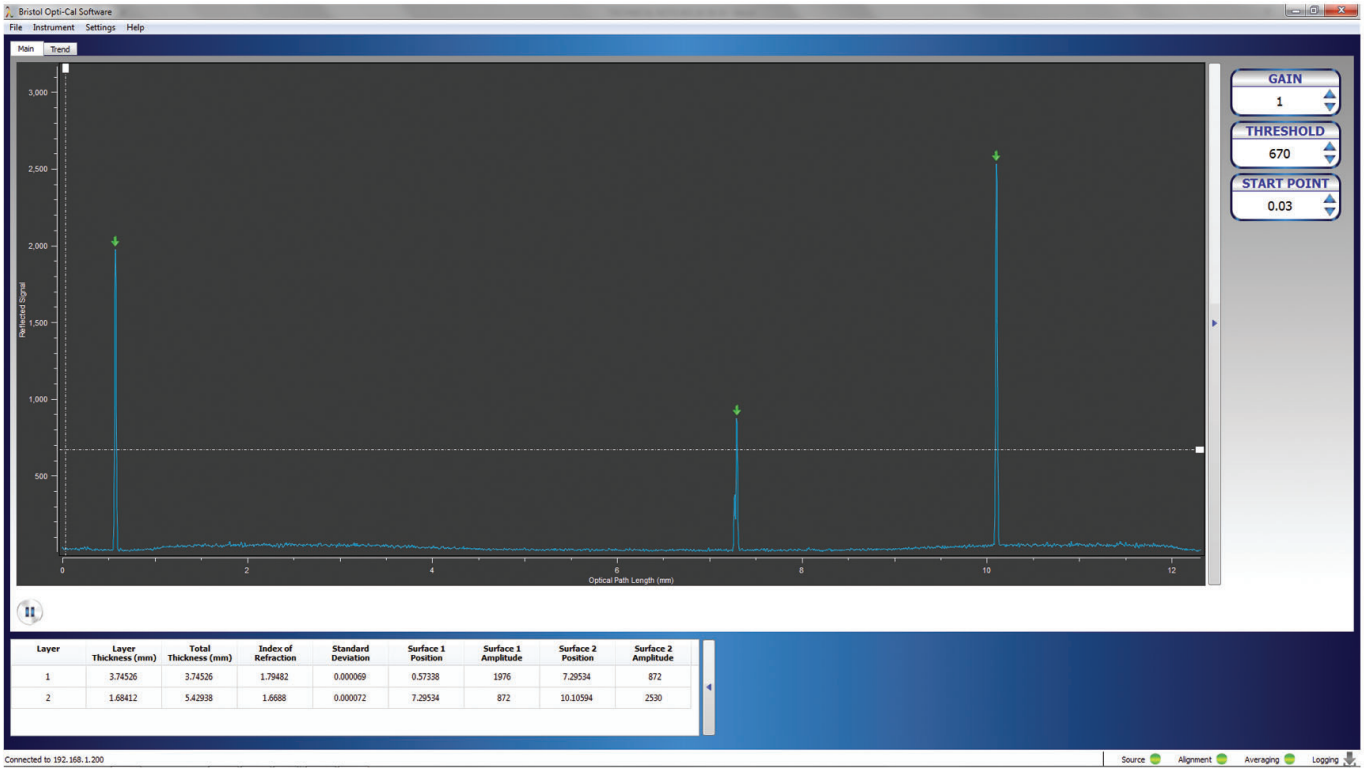
A commercially available standard achromatic doublet was tested. The first element is identified as an N-BAF10 lens with a thickness of 4.0 mm. The second element is an N-SF6HT lens with a thickness of 1.5 mm. In order to measure absolute physical thickness, the group index for the different lens materials must be known and entered into the 157 system's software. The group index values used were 1.79482 for N-SF6HT and 1.66880 for N-BAF10. A screenshot of the measurement is shown below.



In the graphical display, the three peaks represent the different surfaces of the lenses that are used to make the doublet. The first peak is the top side of the first lens, the second is the interface between the two lenses and the third is the bottom surface of the bottom lens. The display software of the 157 Optical Thickness Gauge shows the thickness of the first element (N-SF6HT) to be 3.74526 mm and the thickness of the second element (N-BAF10) to be 1.68412 mm with the total thickness measured at 5.42938 mm. The measurements show that the total central thickness of the lens is within the published manufacturing tolerance of ± 0.15.