NANOVEA

FRESNEL LENS

DIMENSIONS USING 3D PROFILOMETRY

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INTRODUCTION

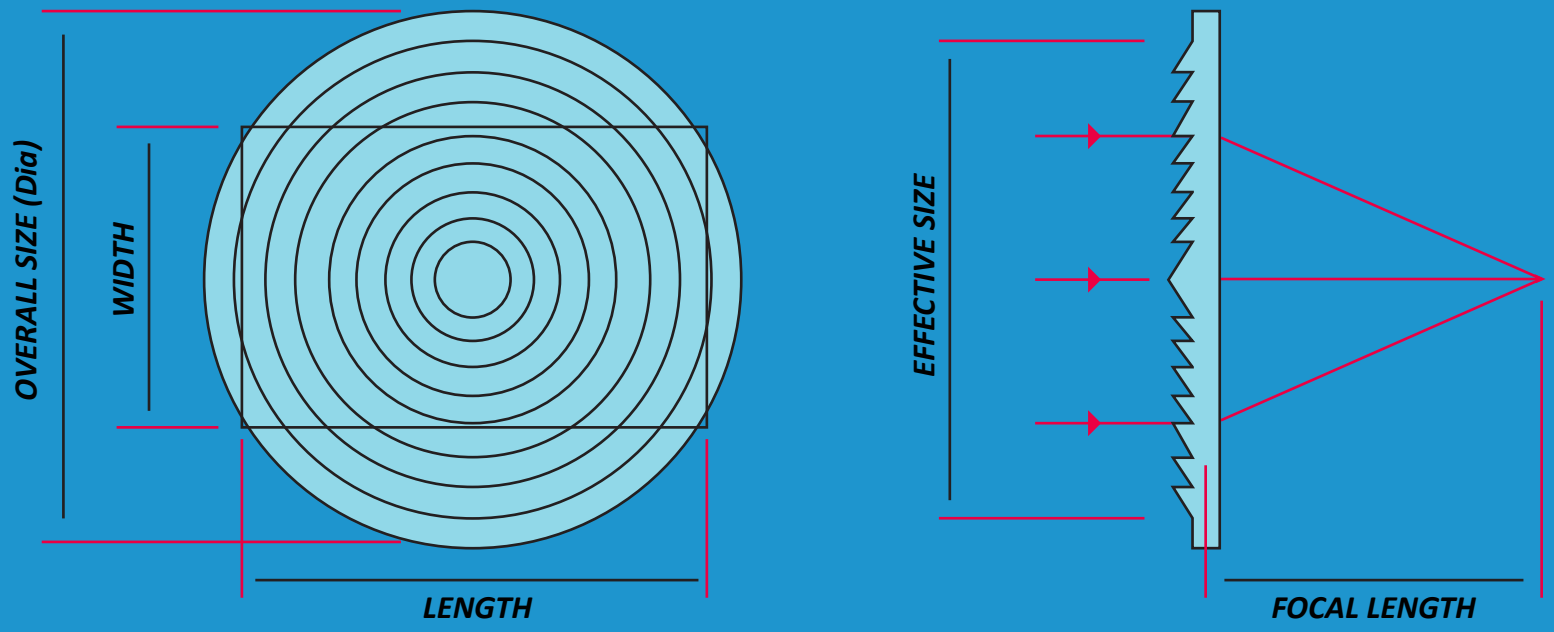
A lens is an optical device of axial symmetry that transmits and refracts light. A simple lens consists of a single optical component for converging or diverging the light. Even though spherical surfaces are not ideal shape for making a lens, they are often used as the simplest shape which glass can be ground and polished to.

A Fresnel lens consists of a series of concentric rings, which are thin parts of a simple lens with a width as small as a few thousandths of an inch. Fresnel lenses contain a large aperture and short focal length, with a compact design reducing the weight and volume of material required, compared to conventional lenses with the same optical properties. A very small amount of light is lost by absorption due to the thin geometry of the Fresnel lens.

IMPORTANCE OF 3D NON-CONTACT PROFILOMETRY FOR FRESNEL LENS INSPECTION

Fresnel lenses are extensively employed in the automotive industry, lighthouses, solar energy and optical landing systems for aircraft carriers. Molding or stamping the lenses out of transparent plastics can make their production cost-effective. Service quality of Fresnel lenses mostly depends on the precision and surface quality of their concentric ring. Unlike a touch probe technique, ***NANOVEA*** Optical Profilers perform 3D surface measurements without touching the surface, avoiding the risk of making new scratches. The Chromatic Light technique is ideal for precise scanning of complex shapes, such as lenses of different geometries.

FRESNEL LENS SCHEMATIC



Transparent plastic Fresnel lenses can be manufactured by molding or stamping. Accurate and efficient quality control is critical to reveal defective production molds or stamps. By measuring the height and pitch of the concentric rings, production variations can be detected by comparing the measured values against the specification values given by the manufacturer of the lens.

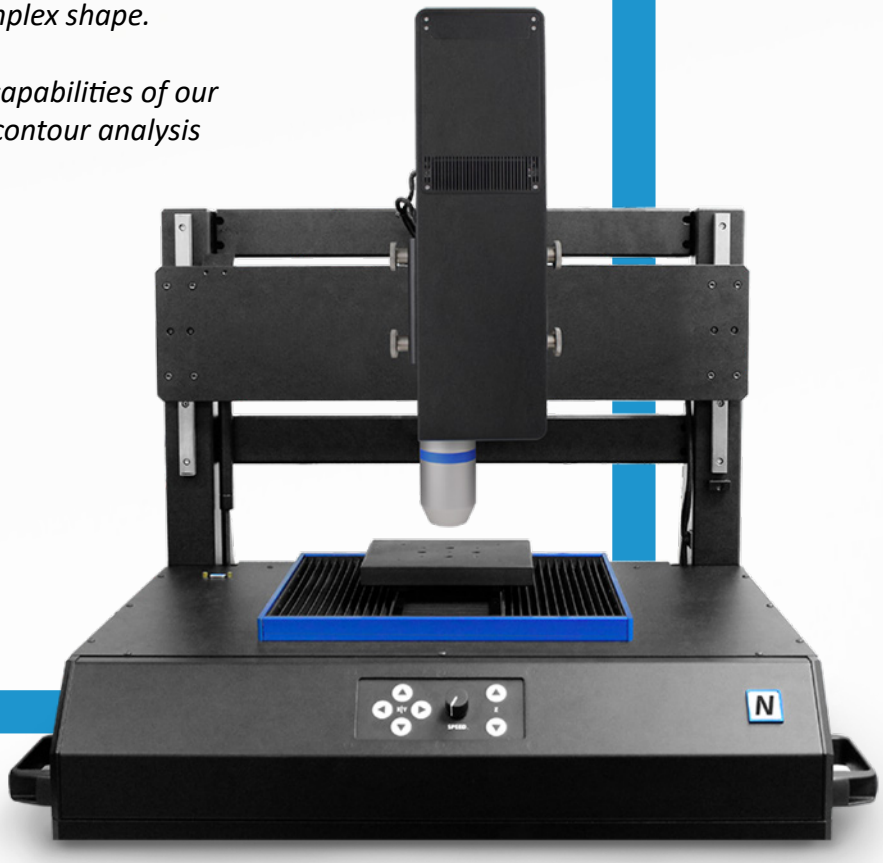
Precise measurement of the lens profile ensures that the molds or stamps are properly machined to fit manufacturer specifications. Moreover, the stamp could progressively wear out over time, causing it to lose its initial shape. Consistent deviation from the lens manufacturer specification is a positive indication that the mold needs to be replaced.

MEASUREMENT OBJECTIVE

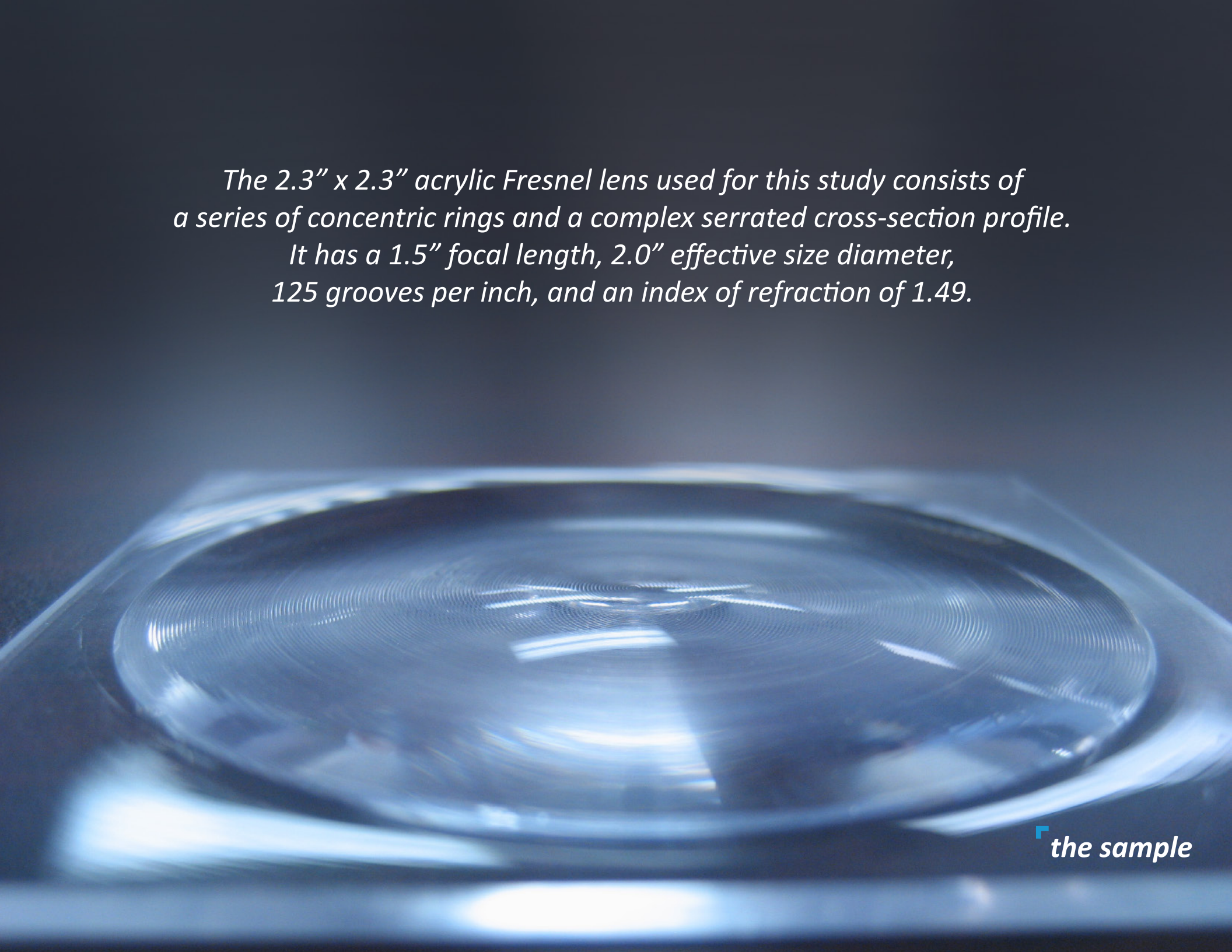
*In this application, we showcase **NANOVEA** ST400, a 3D Non-Contact Profiler with a high-speed sensor, providing comprehensive 3D profile analysis of an optical component of a complex shape.*

To demonstrate the remarkable capabilities of our Chromatic Light technology, the contour analysis is performed on a Fresnel lens.

NANOVEA
ST400

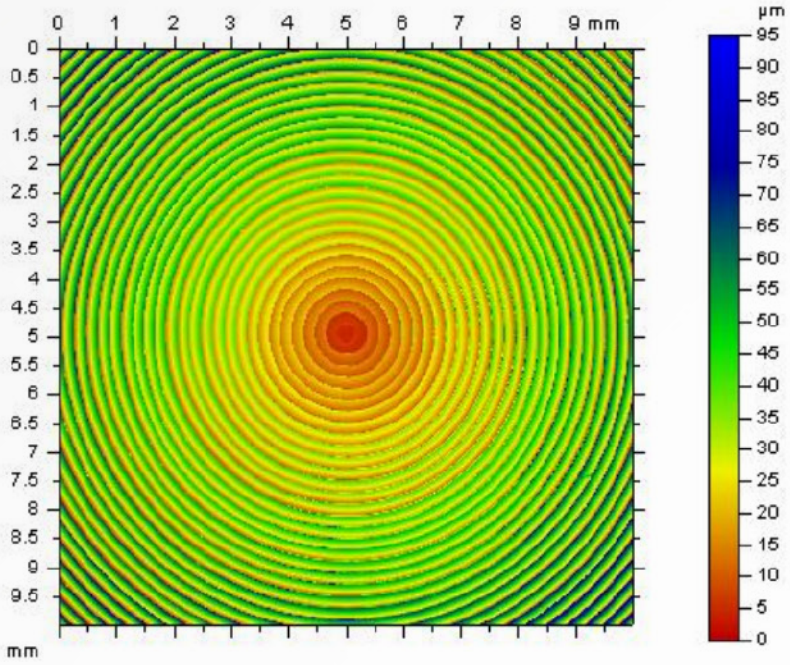


The 2.3” x 2.3” acrylic Fresnel lens used for this study consists of a series of concentric rings and a complex serrated cross-section profile. It has a 1.5” focal length, 2.0” effective size diameter, 125 grooves per inch, and an index of refraction of 1.49.

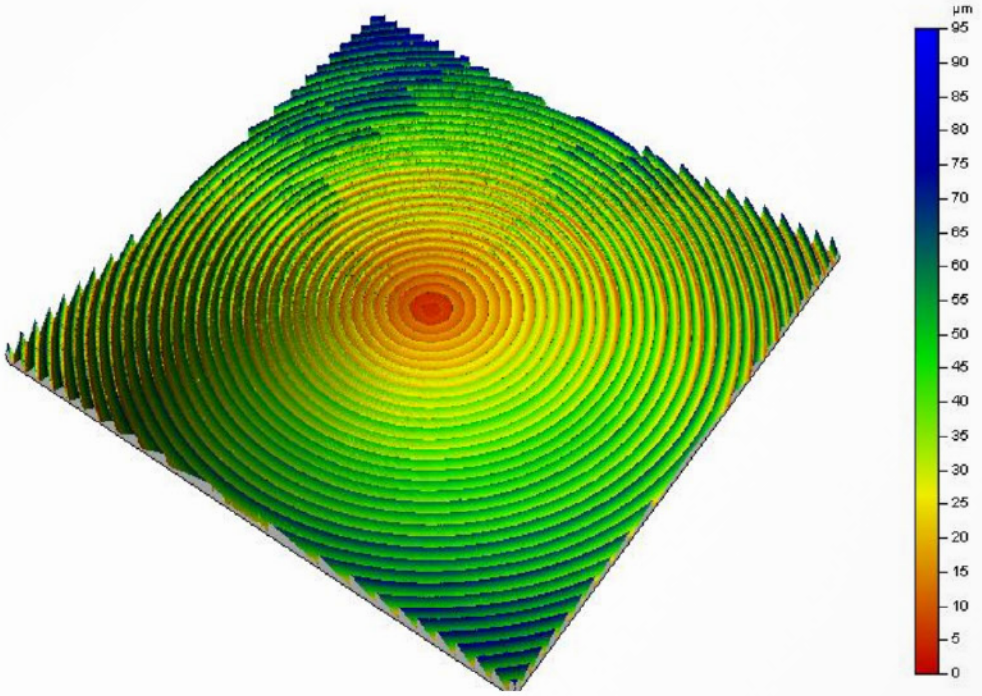


the sample

*The **NANOVEA** ST400 scan of the Fresnel lens shows a noticeable increase in height of the concentric rings, moving outward from the center.*

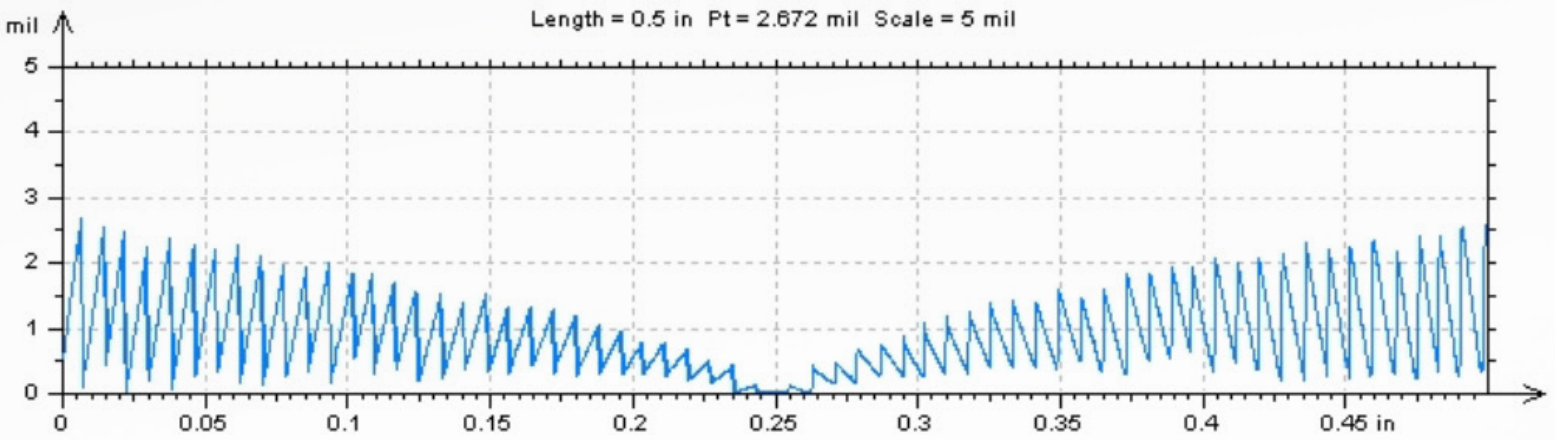


2D FALSE COLOR
Height Representation



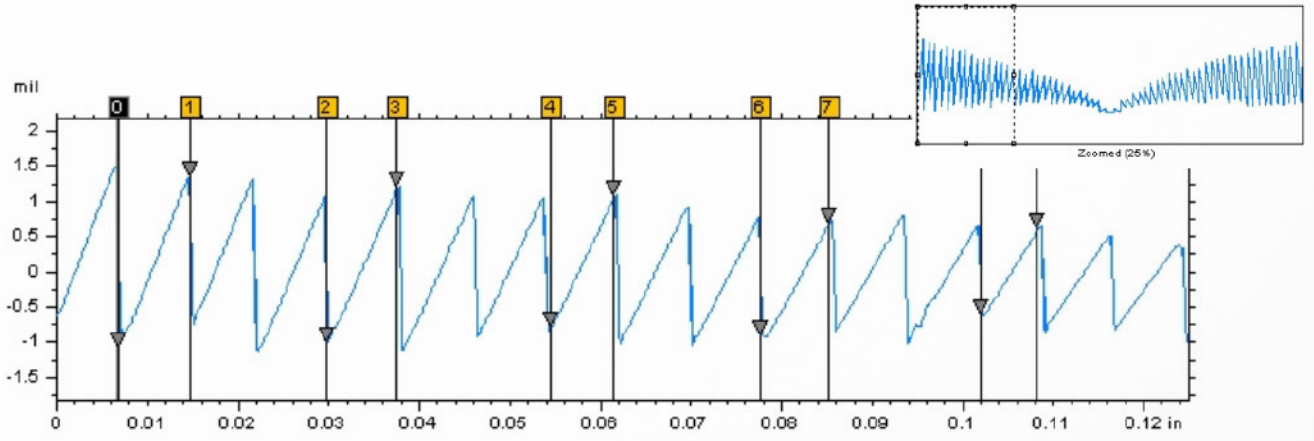
3D VIEW

EXTRACTED PROFILE



PEAK & VALLEY

Dimensional Analysis of the Profile



	0-1	2-3	4-5	6-7	8-9
Horizontal distance :	0.007795 in	0.00766 in	0.007023 in	0.007409 in	0.00625 in
Height difference :	2.445 mil	2.193 mil	1.853 mil	1.589 mil	1.248 mil
Slope :	313.6 mil/in	286.3 mil/in	263.8 mil/in	214.5 mil/in	199.8 mil/in
Angle :	17.41°	15.98°	14.78°	12.11°	11.3°

CONCLUSION

In this application, we have showcased that the ***NANOVEA*** ST400 non-contact Optical Profiler accurately measures the surface topography of Fresnel lenses.

The dimension of the height and pitch can be accurately determined from the complex serrated profile using ***NANOVEA*** analysis software. Users can effectively inspect the quality of the production molds or stamps by comparing the ring height and pitch dimensions of manufactured lenses against the ideal ring specification.

The data shown here represents only a portion of the calculations available in the analysis software.

NANOVEA Optical Profilers measure virtually any surface in fields including Semiconductors, Microelectronics, Solar, Fiber Optics, Automotive, Aerospace, Metallurgy, Machining, Coatings, Pharmaceutical, Biomedical, Environmental and many others.

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