Non-contact measurement of aspherical and free-form optics with a new confocal tracking profiler

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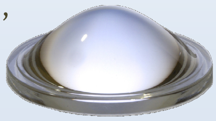
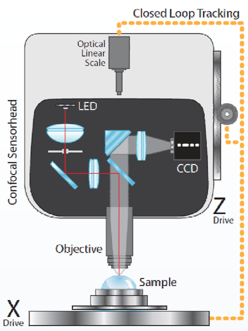
OVERVIEW

Manufacturing technologies for optics have evolved rapidly in the latest years due to a demand for ever-complex optical surfaces to be machined. In parallel, requirements for the metrology for such parts has also tightened.

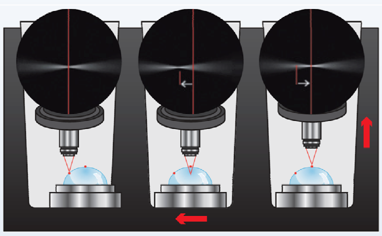
We present a new non-contact measurement technique for aspherical and free-form optics. This technique, called confocal tracking, is based on confocal imaging and can be considered the optical equivalent of contact profiling.



CONFOCAL TRACKING



Confocal tracking consists on tracking the focus on the sample to be measured while it is moved along the horizontal, x-axis. Slit confocal technology together with high numerical aperture objectives are used to determine focus to a high degree of accuracy [1]. Once the sample is in focus, a closed-loop PID based control algorithm that drives the z-stage keeps the focus at the center of the field of view while the sample is moved along the x-axis.

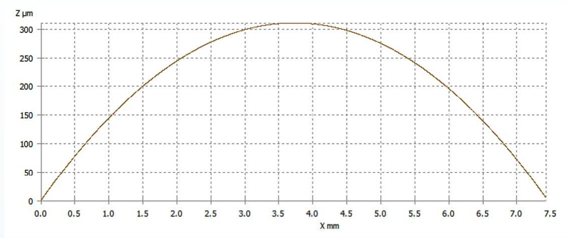


Initially the sample is focussed at the desired initial position. Then the sample is moved along the x-axis using a high accuracy air-bearing stage and the closed-loop system moves the sensorhead in a coordinated move in such a way that focus is kept all the way at the center of the field of view until the desired measurement length is reached. High quality position encoders are used to determine both the x and z position. The sample profile is reconstructed from the moves executed by the x and z stages [2].

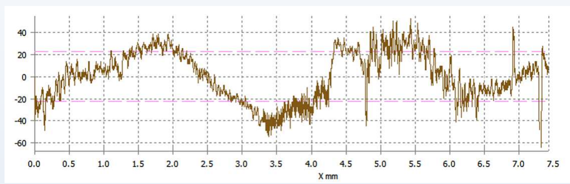
A unique feature that this technology provides is the fact that the system can determine the center of the lens automatically without the need to carry out a measurement [2]. It takes advantage of the fact that it is an image-based technology.

RESULTS

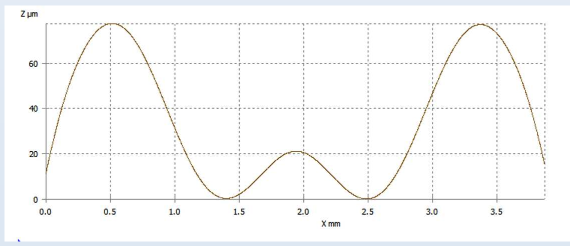
Calibrated ball standard (22498.2 ± 0.4 µm):



Best-fit residuals (22498.0 µm):



Free-form lens:



CONCLUSIONS AND REFERENCES

We have presented a new non-contact technique for the measurement of aspherical and free-form optics that can reach sub-100 nm accuracy and measurement speeds up to 1 mm/s typical. Depending on sample geometry a measurement objective that can reach slopes up to 65° can be used.

[1] R. Artigas, A. Pintó, and F. Laguarta, SPIE Proceedings, 3824, 92, 1999
R. Artigas, F. Laguarta, and C. Cadevall, SPIE Proceedings, 5447, 166, 2004
[2] Sensofar proprietary technology, patent pending