Development of an automatic adjustment process for a commercially available Interferometer

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In precision optics more and more aspheres are built into optical designs. The metrology used to measure high precision aspheres in production consists of interferometers. In the presented contribution modifications on an existing commercially available interferometer are reported, where an automatic adjustment process instead of a manual one is implemented.

1 Introduction

The advantages of aspheres in optical designs and the difficulties to fabricate them are known since several years [1]. New design approaches, based on aspherical shapes, and decreasing production quantities per system require a rapid, deterministic and cost effective fabrication process [2]. Fast and reproducible metrology for process control and final quality assurance is one of the major steps for an economic process chain. Despite this requirement, workshop interferometers like the ALI 201 [3] require skilled workers, sometimes even engineers or scientists and long adjustment times to get an intermediate or final measurement result. In our lab we upgraded the ALI 201 in way that after course alignment of the fringes by the operator an automatic alignment and measurement cycle could do the job.

2 Existing setup

Our test element is a rotational symmetric convex asphere with diameter of 40mm and about 0.8 mm deviation from the best fitting sphere. The metrology equipment is a Schneider ALI 201 setup, equipped with Zygo GPI phase shifting laser interferometer and a Computer Generated Hologram (CGH) from Jenoptik (Fig. 1).

The interferometer is equipped with manual screw drives for adjusting lens shift. To avoid tilt introduced coma, tilt should be lower than 0.1 waves.

For the economical production of aspheres the metrology cyle should be less than 10 minutes and should be performed in parallel to the work on the polishing machine. With original manual adjustment this requirement could not be fulfilled.

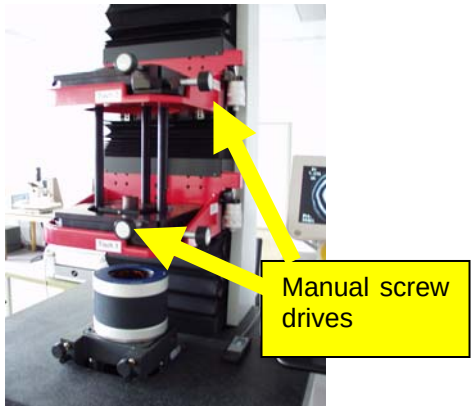

Fig. 1 *Interferometer setup before modifications.*

3 Modifications on the interferometer setup

To improve the accuracy of tilt adjustment and to install an automatic alignment and measurement cycle the following hard- and software is modified:

- Skip the manual adjustment
- Mount electronic drives and controllers (Fig. 2)
- Calculate the Zernike coefficients from the measurement
- Use the measured tilt Zernike term (Z2 and Z3) from the interferometer as input parameter
- Build up a software controlled loop for adjustment in a way, that out of Z2/Z3 a x-y shift is calculated and realized by the electronic drives
- Integrate the final measurement
- Integrate all in the Metro Pro Software of the Zygo Interferometer(Fig. 3)

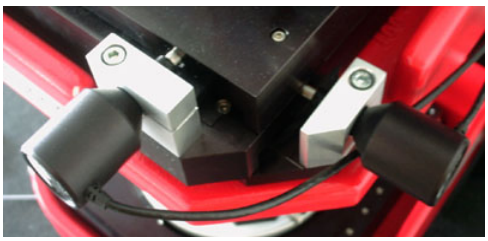

Fig. 2 *Integrated linear computer controlled gauges which replaced the mechanical screw drives.*

Fig. 3 *Integrated software button in ZYGO MetroPro® metrology software and control unit for automatic adjustment. .*

4 Results of improvements

After implementation of the hardware and software modifications, the lens (sphere or asphere) had to be only rough adjusted, so that fringes on the interferometer are visible. The operator pushes the software button and can leave the interferometer. The fine adjustment of x-y position related to tilt is performed automatically until the optimum position is reached. Afterwards the final measurement is made. The reproducibility of Z2/Z3 is a factor of 3.5 better compared to the manual alignment and well within the required 0.1 waves.

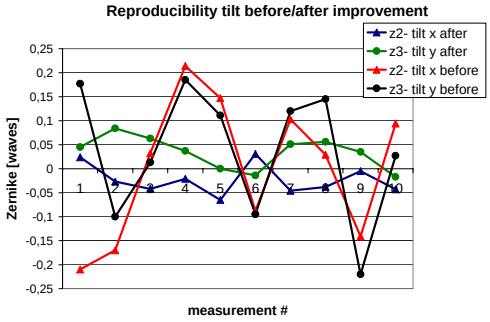

Fig. 4 *Reproducibility Zerniketerms Z2 and Z3 with manual (before) and automatic (after) adjustment.*

The result of 10 subsequent measurements with a) manual (original setup) and b) automatic (modified setup) is shown in Fig. 4.

5 Summary

The upgrade of the ALI 201 Interferometer demonstrates 2 advantages compared to the original setup:

- The accuracy of tilt adjustment is improved by a factor of 3.5
- The adjustment and measurement cycle can be done without an operator. The operator is therefore able to work in parallel on the polishing machine, which reduces cycle time for optical fabrication about 30% and production cost about the same amount.

With the automatic metrology setup one major step towards a cost effective process chain for aspheres is reached.

References

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[2] R. Boerret, J.Burger, A.Bich, C.Gall, T.Hellmuth „Research on fabrication of aspheres at the Center of Optics Technology” in *SPIE Optifab 2005, Technical Digest Vol. TD03,* 30-23 (2005)

[3] Schneider ALI 201, Schneider GmbH + Co. KG, D-35239 Steffenberg, Germany