# Measurement and Analysis of Micro Lens Array using White Light Scanning Interferometer

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*Recently, micro lens array is applied to optics in small projector, image sensor and/or 3-deimension display. Micro lens array (MLA) is fabricated by microinjection molding to reduce cost and increase productivity. So it is important to measure topograph of mold core and patterned micro lens because their dimensional accuracy and surface roughness result in quality of product. To measure the surface of mold and MLA, white light scanning interferometer (WSI) is applied. The 3D surface is measured by analyzing the interferogram between reference and measured white light with short coherence. It is easy to measure 3D surface and without limitation of height of measured pattern. In this paper, in order to measure dimensional accuracy and surface roughness of MLA, we determine key parameters of measurement. Specially, it is important to investigate the large area of mold with high speed and accuracy; therefore, we discriminate key parameters from the measured data and analyze the quality of surface. The low-power objective lens is used to measure large area with high speed measurement. To verify the analysis, we use standard specimen. In order to make higher the Z-directional accuracy and measurement speed in the range of 100 μm, we use auto focusing module (AF) that consist of piezoelectric transducer (PZT) and controller. Closed loop control time delay. Therefore, makes lower the speed. For the reason, although open loop control cannot avoid hysteresis and creep, we apply open loop control. After the verification and enhancement, Mold core that is fabricated by milling machine is measured by WSI. It could measure not only the overall profile but also the detailed surface roughness, therefore, it responds to the demand of high speed and accuracy in industry.*

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## 1. Introduction

Recently, micro lens array (MLA) for optical data storage device, image sensor, medical diagnosis device and 3-D display is widely used according to the advance of devices, the high optical performance of MLA is needed. Therefore, it is required to produce the MLA with high productivity and good quality. The MLA is manufactured by micro injection molding process, which is getting more a titration recently, because the process can form goods with high throughput and low cost. Prior researchers have been interested in investigating the precision of mold core and molded product by measuring them. [1] This is helpful to make higher the quality of the produced goods. Conventionally, they have been used profiler to measure the mold core and molded components, however, this method may be harmful to the surface of mold core because the stylus makes scratch on the core. To avoid the damage of sample, several kinds of optical microscope are applied. Among them, white-light scanning interferometer (WSI) is our concern. It uses white-light with short coherence and CCD as an image sensor. For the measurement area, the CCD gets several hundreds of frames. The frames are captured when the interferogram between reference and reflected light is maximized. Especially, WSI does not have $2\pi$ ambiguity compared to optical phase shift interferometry, WSI has a wide measurement range from nanometers to millimeters. [2] In this paper, the shape and pattern of mold core were measured by WSI.

## 2. Reliability of equipment.

In order to check the reliability of WSI equipment shown in Fig.1, a standard specimen certificated by Korea Research Institute of Standard and Science (KRISS). It has a pattern with step. Nominal value of the step height is 10 ㎛. Actual height is 9.65 ㎛. The specifications of the equipment are listed in Table 1. To investigate the reliability, topography of the pattern is measured as shown in Fig 2. From the topography, the profile of the standard pattern is obtained and then the step height is calculated. The calculated measured step height is presented in Fig. 3 according to the number of measurement after applying median filter in In Fig. 3, the variation of value is lower than 200nm. The difference from the reference height is 400nm. This error should be compensated in the future work.55

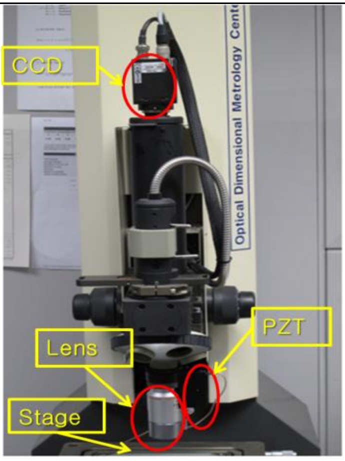


Fig. 1 Equipment

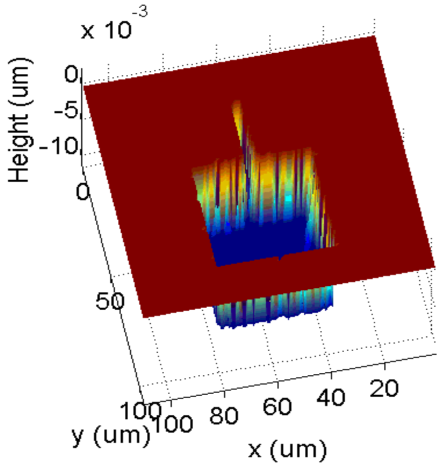


Fig. 2 Topography of standard specimen

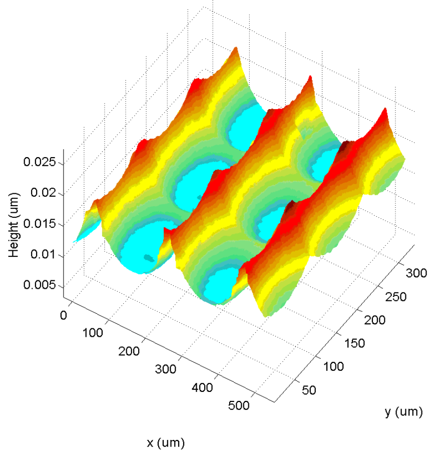


Fig. 4 topograph of mold core

Table. 1 Specification of equipment

| Equipment | Specification |
|---|---|
| AMP | INTEK PLUS Co.<br>Model: ACURA 2000 |
| CCD camera | PULNIX Co.<br>Model: TM200<br>Pixels: 768 (H) x 494 (V)<br>Cell size: 8.4 ㎛ x 9.8 ㎛ |
| Lens | NIKON Co.<br>2.5X |
| PZT | PI Co.<br>Range: 100 ㎛ |

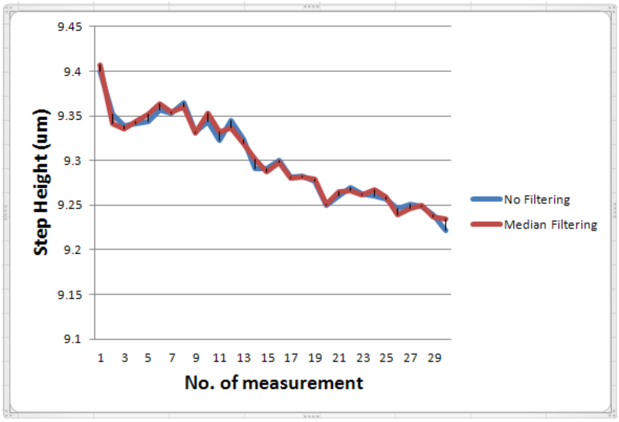


Fig. 3 Reliability of WSI equipment.

## 3. Measurement of mold core

Topography of test-machined mold core is presented in Fig.4. The mold core is machined on an aluminum surface to examine the precision of cutting path and method. The machine is by a milling machine. The result shows rough surface and poor dimensional accuracy. To enhance the precision, the cutting path and algorithm should be controlled sophisticatedly. After proper compensation of the equipment and suitable control of the milling machine, the precision of mold core will be described. Also, the patterned MLA is needed to be evaluated.

## 4. Conclusions

We obtained topography of mold core by using WSI measurement equipment. This equipment is verified by the measurement using a standard specimen. In the same way, we measured mold core that is processed by milling machine. After compensation of WSI and control of milling machine, we will provide the enhanced mold core and the improved measurement result. Using the measurement, the mold core will be evaluated using discriminated parameters.

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