광스캐닝을 위한 직교형 헤미실린더렌즈
An orthogonal system of two hemicylindrical lens as a light scanner

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1. Introduction

In this report we present our research about using a single casting method of poly(dimethyl siloxane) (PDMS) to prepare fluidic adaptive hemicylindrical lenses, characterization of these lenses and application these lenses in an optical system as a light scanner.

Adaptive lenses are interested in because of many new application in optical communications and biotechnology. To reduce the complication and limitation from the bulky optical systems and other fabrication methods as electrowetting, liquid crystal, using microfluidic adaptive lenses is a possible way [1].

Cylindrical lens and hemicylindrical lens have some specific characteristics and a lot of particular applications. A hemicylindrical lens can be used for stretching images, focusing light into a slit, converging light to a line-scanning detector, or correcting low order aberration because through it, light will be focused in one dimension [2, 3]

2. Experiment

In this study, SU-8 patterns on Si wafer were used as a mold for PDMS single casting to prepare a fluidic hemicylindrical lens. SU-8 50 photoresist was spin coated at 1000 rpm, baking, UV exposured, developed to form 100 μm patterns. The PDMS (Sylgard 184, Dow Corning) elastomer solution was prepared by mixing prepolymer with cross-linking agent in the weight ratio of 10:1. Then PDMS mixture was poured onto the master and cured in an oven at 65^0C for 2 hour under pressurizing by Heating press machine D3P-20J (Daehung Science Co). After curing, the PDMS replica was peeled from the master followed by drilling to place the posts that allocate the inlets and outlets. Then, the PDMS mold was bonded on glass plate after plasma treatment for 2 minutes. Finally, PDMS blocks were bonded with this structure, polyethylene tubes were placed into the holes and sealed with epoxy glue.

3. Results and discussion

Figure 1 shows a test setup of the optical experiment on the hemicylindrical lenses. A laser spot beam was illuminated through the lens after pass through a pin hole. Then the applied pressure on the hemicylindrical lens was changed to cause a change of lens curvature and hence a change of lens focal length. The laser spot beam was focused in one dimension became a slit. The size of the laser slit beam depend on the fluidic pressure which was applied on the lens.

An orthogonal optical system of two hemicylindrical lens was built include a fixed lens and an adaptive lens. Figure 2 shows this system structure and the mechanism of the light scanning. The laser spot beam was changed to the slit beam with a fixed size after pass through the fixed hemicylindrical lens and then go to the adaptive lens. The positions where the slit beam come to the adaptive lens are not the center point of the lens. The distance between the center point and the illuminated point is offset distance and the scanning range of the laser slit beam depend on the offset distance and the applied pressure on the adaptive lens.

Figure 3 shows the result of the laser scanning test. When applied pressure on the adaptive lens changed, the laser slit beam was scanned and the scanning range depend on the pressure which was applied on the lens.

4. Conclusion

The fluidic variable hemicylindrical lenses were fabricated by PDMS single casting method. The lens optical properties were characterized and light scanning ability of the orthogonal system of two lenses was investigated. These results promise many application of this lens and lens system in optical and bio-photonic fields.

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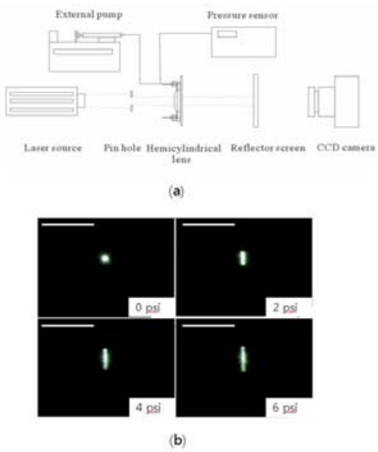

Figure 1. Focal length measurement instrumental setup to evaluate lens characteristics (a) and variation of laser beam spot shape through a microfluidic hemicylindrical lens with various applied pressure (b). Width of the lens: 1 mm, length of the lens: 5 mm, thin membrane thickness of the lens: 80μm, Scale bar= 5 mm.

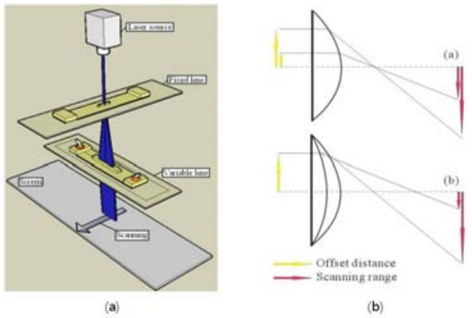

Figure 2. Schematic diagram of scanning process using a variable microfluidic hemicylindrical lens with a upper fixed lens (a) and scanning range variation of a lens by changing offset distance and applied pressure (or focal length) of a lens.

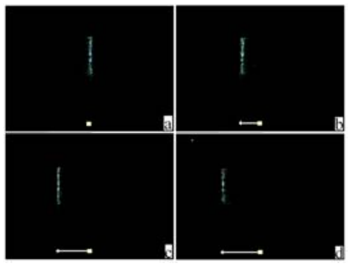

Figure 3. Scanning procedure of a laser beam by a variable microfluidic hemicylindrical lens with a fixed lens under various applied pressure. (a) applied pressure: 0 psi and scanning distance (white bar length): 0 mm, (b) 0.2 psi and 2.2 mm (c) 0.4 psi and 3.9 mm, and (d) 0.6 psi and 4.6 mm.

Width of the variable lens: 3 mm, length of the variable lens: 15 mm, thin membrane thickness of the variable lens: 80μm, width of the fixed lens: 1 mm, length of the fixed lens: 5 mm.

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