Chapter 6

Conclusion

6.1 Conclusion

The speed of servo mechanism in the conventional optical storage devices is limited by the mass of optical pickup which is normally comprised of several lenses, mirrors and prism. To reduce and size and weight of the optical pickup, a MEMS-type device with free space micro optical system has been proposed. Among the components in the proposed MEMS pickup, the objective lens plays a key role in the overall performance of the pickup and also significantly influences the design of the other components. The designs and analysis of the objective lens are therefore the focus of this thesis.

Two ways for making the micro objective lens have been surveyed, namely reflow process and gray scale mask photolithography. The analyses showed that reflow process, however, cannot make a high NA objective lens with well corrected spherical aberration, due to the constrain of the fabrication process. The gray-scale mask photolithography has the same constrain on the thickness of the lens as the reflow process, nevertheless, it has more degrees of freedom in making the lens surface profile. The constrain on the thickness can be overcome by slicing the refractive type lens into a diffractive harmonic lens with similar optical performance, at yet with reduced lens size.

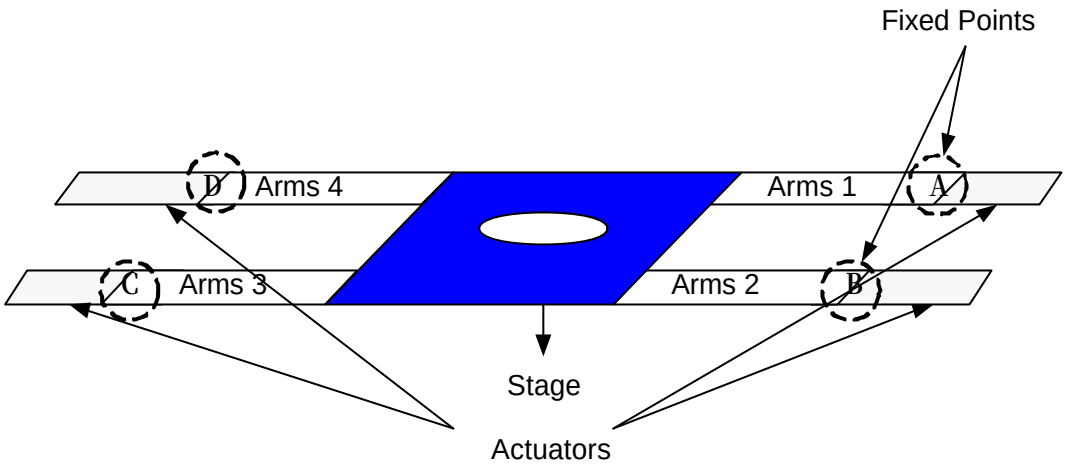
From the modeling and analysis by the optical design softwares, the conventional approach of slicing the lens profile into diffractive harmonic profile has been found to

result in serious aberration for a high NA objective lens. A new approach has been proposed to address this issue by redesigning the surface profile every time a slice is made to create an annular zone. The resulted harmonic lens has a thickness of 19.5 μm and shows a diffraction limit performance. The diameter of the lens met the other system specification and requirement of DVD, such as spot size of 1.08 μm and the separation for three beam tracking of 25 μm, and the overall volume of objective lens was estimated to be 1.91×10^{-6} mm^3.

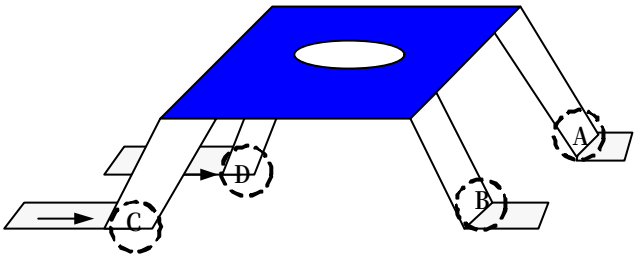
A harmonic diffractive objective lens has been designed to be fabricated with gray-scale mask photolithography and will be integrated onto a free space optical module for a MEMS-type DVD pickup. The modeling and analysis show that the performance of the objective lens meets all the specification of DVD-like player and the goal of a miniature and lightweight pickup.

6.2 Integration of the objective lens

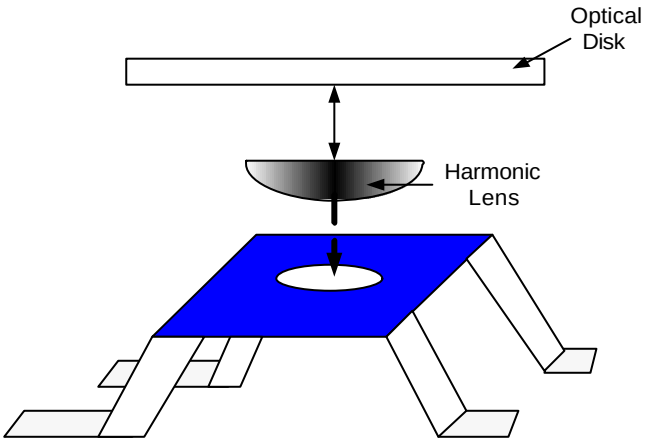
The redesigned harmonic lens can be integrated into the optical system of DVD-like pick up by installing the lens onto the stage drived by the micro actuators [1]. Besides, the micro actuators can fabricated on the substrate by surface machining. The fabrication steps are shown in Figs. 6-1. First, the stage, arms, and micro actuators can be fabricated by utilizing the surface machining as shown in Fig. 6-1 (a). Then, the stage is raise with points A and B fixed and arms 3 and 4 pushed at points C and D by micro actuators shown in Fig. 6-1 (b). The plate is made of poly-silicon, and the thickness of the plate is about 2 μm. Then, the redesigned harmonic lens can be mounted with the front surface facing downward as shown in Fig. 6-1 (c).The micro actuators can drive the stage within a distance of 20 μm. By using this method, the working distance can be about 50 μm.



(a)



(b)



(c)

Fig. 6- 1 Steps of integrating the redesigned harmonic lens: (a) using surface machining to fabricate actuators, (b) raising the plate, and (c) putting the harmonic lens on the plate