Future Optical MEMS: Smarter and Smaller

Y.-A. Peter

Stanford University
Edward L. Ginzton Laboratory, 32 S
450 Via Palou street
Stanford, CA, 94305-4085

During the past decade, many Optical Micro Electro Mechanical Systems (Optical MEMS) have been developed [1]. Although very powerful, most of them have relatively simple functionality. Many of these systems are now in a commercialization stage [2,3]. Future Optical MEMS will need to be smarter and/or smaller. Smart Optical MEMS are being developed intensively for telecommunication applications [4,5]. Small Optical MEMS eventually will merge into Optical Nano Electro Mechanical Systems (Optical NEMS) [6] taking advantage of the near field properties of light. Recently, Photonic Crystal (PhC) devices have gain a large interest in the Optical MEMS community [8]. The availability of e-beam lithography, as well as optical lithography, makes the fabrication of PhC possible. As the typical size of a PhC structure is in the 100 nm range, these new devices will actually be Optical NEMS.

In the case of optical switching, relatively large number of interconnects can be efficiently addressed, using simple MOEMS [7]. Adaptive optics, however, enables a much more flexible operation of such a device, using, for example a membrane deformable mirror (see Fig. 1) [5]. Adaptive optical systems need smart optical

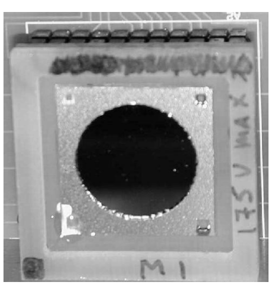

Figure 1

Photograph of the micromachined deformable membrane mirror. The membrane has a diameter of 15 mm.

MEMS for applications in free space optical telecommunication and astronomy. Basically, optical aberrations, generated by air turbulence, need to be corrected. Adaptive optics is here particularly well suited. A deformable mirror, made of many segmented micro-mirrors, is able to correct for these aberrations, and provides an almost perfect wavefront. Such a device need to fulfill challenging specifications, such as fast response time (typically 10 μs) and very high surface quality (better than $\lambda/50$). We will show an original fabrication process, enabling manufacturing large scale segmented micro-mirror arrays (see Fig. 2).

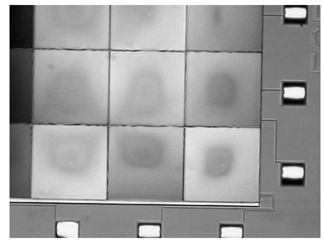

Figure 2

Optical microscope photograph of a segmented deformable mirror. Each pixel is 400 μm x 400 μm.

REFERENCES

1. H. Fujita and H. Toshiyoshi, IEICE Trans. Electron., **E83-C**, 9, pp. 1427-1434 (2000).
2. C. Marxer and N. F. de Rooij, IEEE Journal of Lightwave Technology, **17**, 1, pp. 2-6 (1999).
3. D. T. Neilson et al., in Optical Fiber Communication Conference, Baltimore, 2000.
4. B. Warneke, M. Last, B. Liebowitz and K.S.J. Pister, Computer Magazine, Jan. 2001, IEEE, pp. 44-51.
5. Y.-A. Peter, F. Gonté, H. P. Herzig and R. Dändliker, to be published in IEEE Photonics Technology Letters, **14**, 3 (2002).
6. M. L. Roukes, in Tech. Digest. Solid State Sensor and Actuator Workshop, Hilton Head, 2000.)
7. Y.-A. Peter, H. P. Herzig and R. Dändliker, to be published in IEEE Journal of Selected Topics in Quantum Electronics, **8**, 1 (2002).
8. Y. Xu, H.-B. Sun, J.-Y. Yeh, S. Matsuo and H. Misawa, J. Opt. Soc. Am. B, **18**, 8, pp. 1084-1091 (2001)