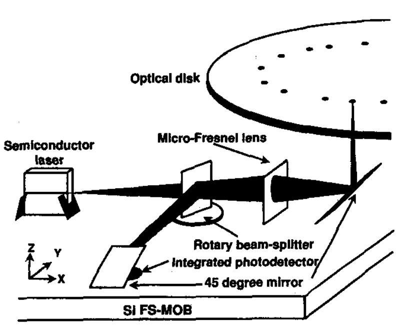
CTuG2 **11:00 am**

Novel monolithic free-space optical disk pickup head realized by surface micromachining

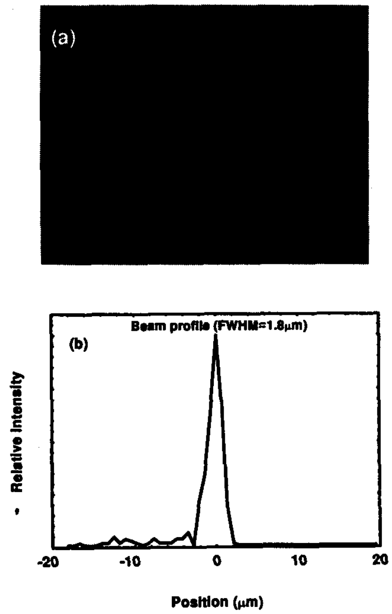
L. Y. Lin, J. L. Shen, S. S. Lee, M. C. Wu, *UCLA, Electrical Engineering Department, 66-147D Engineering IV, Box 951594, Los Angeles, California 90095-1594*

Compact, low-cost optical disk pickup heads are needed for advanced optical data storage applications, including multilayer optical disks, CD-ROM, and digital video disks (DVD). Monolithic integration of the optical pickup head on a single chip could significantly reduce its size, weight, and cost, and improve its performance.[1,2] Previously, using the surface-micromachined "free-space micro-optical bench" (FSMOB) technology, we have demonstrated a novel free-space optical disk pickup head on a single Si chip. The FSMOB is a batch-processing technique, which could be used to mass-produce "pre-aligned" optical systems at low cost. In this paper, we report on an improved free-space optical disk pickup head with four free-space micro-optical elements fabricated monolithically by the FSMOB technology.

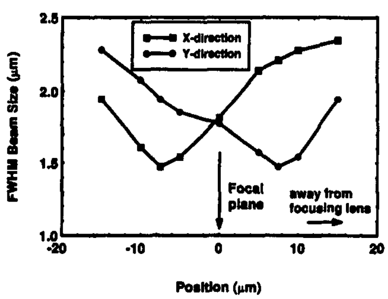
The schematic diagram of the pickup head is illustrated in Fig. 1. It consists of a semiconductor edge-emitting laser, an out-of-plane micro-Fresnel lens, a beam-splitter, and two 45° mirrors. All the micro-optical elements are built monolithically on a Si substrate with the optical axis parallel to the substrate. The light emitted from the semiconductor laser first passes through the beam-splitter, and is then focused by the micro-Fresnel lens. The focused light is bent upward by the 45° mirror, which transforms the in-plane optical path to surface-normal output. The reflected light is directed to the integrated Si quadrant photodetector. The surface-normal output has many advantages: it allows wafer scale processing and testing, which greatly reduce the cost; and packaging of the pickup head is simplified. Because all optical elements are fabricated simultaneously by photolithographic processes, it is possible to pre-align the optical systems during the layout of the photomasks. The hybrid-integrated semiconductor laser is precisely held by the tall, three-dimensional surface-micromachined alignment plates, which has been pre-aligned to the Fresnel lens.[3]



CTuG2 Fig. 1 The schematic drawing of the free-space integrated pickup head for optical data storage.



CTuG2 Fig. 2 (a) The CCD image and (b) beam profile of the focused spot.



CTuG2 Fig. 3 The FWHM beam widths of the focused beam versus the longitudinal displacement around the focal plane.

Figure 2 shows the CCD image and the beam profile at the focal plane. A nearly symmetric focused spot with FWHM width of 1.8 μm is obtained. The spot size is about three times smaller than the previous results. The improvement mainly results from better illumination of the focusing lens. The current spot size is limited by the wavelength of the laser (980 nm) and the numerical aperture of the Fresnel lens (N.A. ~ 0.17). The FWHM widths of the focused beam in X (parallel to the laser junction) and Y (perpendicular to the laser junction) are plotted in Fig. 3. The focal planes are offset by 15 μm, which is attributed to the astigmatism of the weakly index-guided ridge-waveguide laser. A similar pickup head operating at shorter wavelength (670 nm) has been designed and is being fabricated to improve the resolution.

In summary, a novel monolithic optical disk pickup head with four integrated free-space micro-optical elements has been realized by the surface-micromachined *free-space micro-optical bench* technology. A symmetric focused beam with FWHM width of 1.8 μm is successfully observed. Because the pickup head is very compact (2 mm × 3.5 mm), it is possible to integrate mutiple pickup heads on the same chip for parallel data access, or pickup head arrays with different focal length for multilayer optical data storage systems.

1. T. Shiono, H. Ogawa, Appl. Opt. **33**, 7350 (1994).
2. L. Y. Lin, J. L. Shen, S. S. Lee, M. C. Wu, Opt. Lett., in press.
3. L. Y. Lin, S. S. Lee, K. S. J. Pister, M. C. Wu, Appl. Phys. Lett. **66**, 2946 (1995).

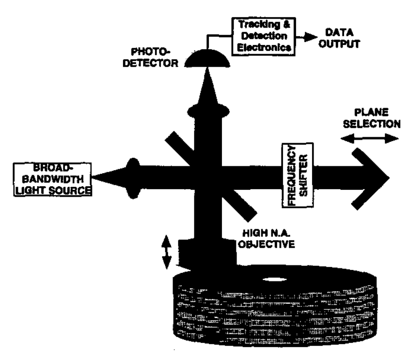
CTuG3 **11:15 am**

Multilayer optical storage using low-coherence reflectometry

S. R. Chinn, E. A. Swanson, *Lincoln Laboratory, Massachusetts Institute of Technology, 244 Wood St., Lexington, Massachusetts 02173-9108*

Optical coherence domain reflectometry (OCDR) is capable of high-resolution imaging inside partially transparent media. Its high sensitivity with good lateral and depth resolution make this technique an excellent candidate for reading optical data stored in closely packed layers. Because diffraction-limited imaging of local regions is used (as opposed to volumetric holography), much of the existing single-layer, direct-detection optical storage technology can be directly adapted.

A schematic drawing of the essentials of an OCDR readout system is shown in Fig. 1. A broad-band, incoherent light source, such as a super-luminescent LED, is divided in two arms, with the probe beam imaged onto and reflected from a target, and the other providing an interferometric reference. The two signals reflected from the interferometer are combined onto a detector. If the signal in the reference arm is phase-modulated or frequency shifted, demodulation at the detector provides heterodyne detection of



CTuG3 Fig. 1 Schematic drawing of OCDR optical readout apparatus from a multilayer optical disc.