3:30pm-4:00pm (Invited)
WY1

Micromachining for Optoelectronic Systems

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There has been a growing interest in applying the micromachining technology to optoelectronic systems. Bulk micromachined structures such as Si V-grooves have long been used to facilitate the packaging of optoelectronic components. Recently, the surface-micromachining technology has further enabled moveable structures and microactuators to be integrated with optoelectronic devices and systems. The marriage of optoelectronic and micromachining technologies has resulted in a new family of highly functional optoelectronic devices and systems that cannot be achieved with conventional technology. In this talk, we will review the current state of the art of micromachining in optoelectronic systems, and discuss in detail the progress of the *free-space micro-optical bench* (FSMOB) project at UCLA.

Micromachining has been used to create new opto-mechanical devices. For example, digital micromirrors and deformable grating light valves have been used for projection display applications; diffraction grating has been integrated with micromotors for scanning applications; broadly tunable lasers, detectors, and filters have been demonstrated. Most of these devices are free-space optical components and have surface-normal optical access, which lends themselves to massive two-dimensional arrays.

At UCLA, we have been focused on the integration of free-space micro-optical systems on a single chip of semiconductor. Free-space optical systems, which have applications in display, optical sensing, printing, optical data storage, optical interconnect, and signal processing, consist of lenses and bulk optical elements and cannot be integrated by conventional techniques. Micromachining offers an inexpensive and reproducible batch processing technique to fabricate micro-optical components, micropositioners, and microactuators on the same substrate. It also enables wafer-scale integration of the micro-optical systems. Previously, using the surface-micromachined microhinge technique, we have fabricated an out-of-plane micro-Fresnel lens which stands perpendicular to the substrate. Out-of-plane refractive microlenses have also been demonstrated by combining the microhinge and micro-optics fabrication techniques. These vertical optical elements allow photons to travel parallel to the substrate and, therefore, enable the optical elements to be cascaded and integrated on the same substrate. This forms the basis of the *free-space micro-optical bench* (FSMOB) technology.

As illustrated in Fig. 1, the FSMOB comprises passive optical elements (diffractive and refractive lenses, gratings, beamsplitters, filters, etc.), micropositioners (translation and rotation stages), and microactuators. Because the micro-optical elements on the FSMOB are precisely positioned by photolithography, they can be "pre-aligned" during the photomask layout. The fabrication of the out-of-plane optical elements are compatible with the micromotors and other microactuators. Therefore, the optical elements can be monolithically integrated with micropositioners and microactuators for optical switching or scanning, or to achieve fine optical alignment. Examples of the FSMOB will be described in the conference.

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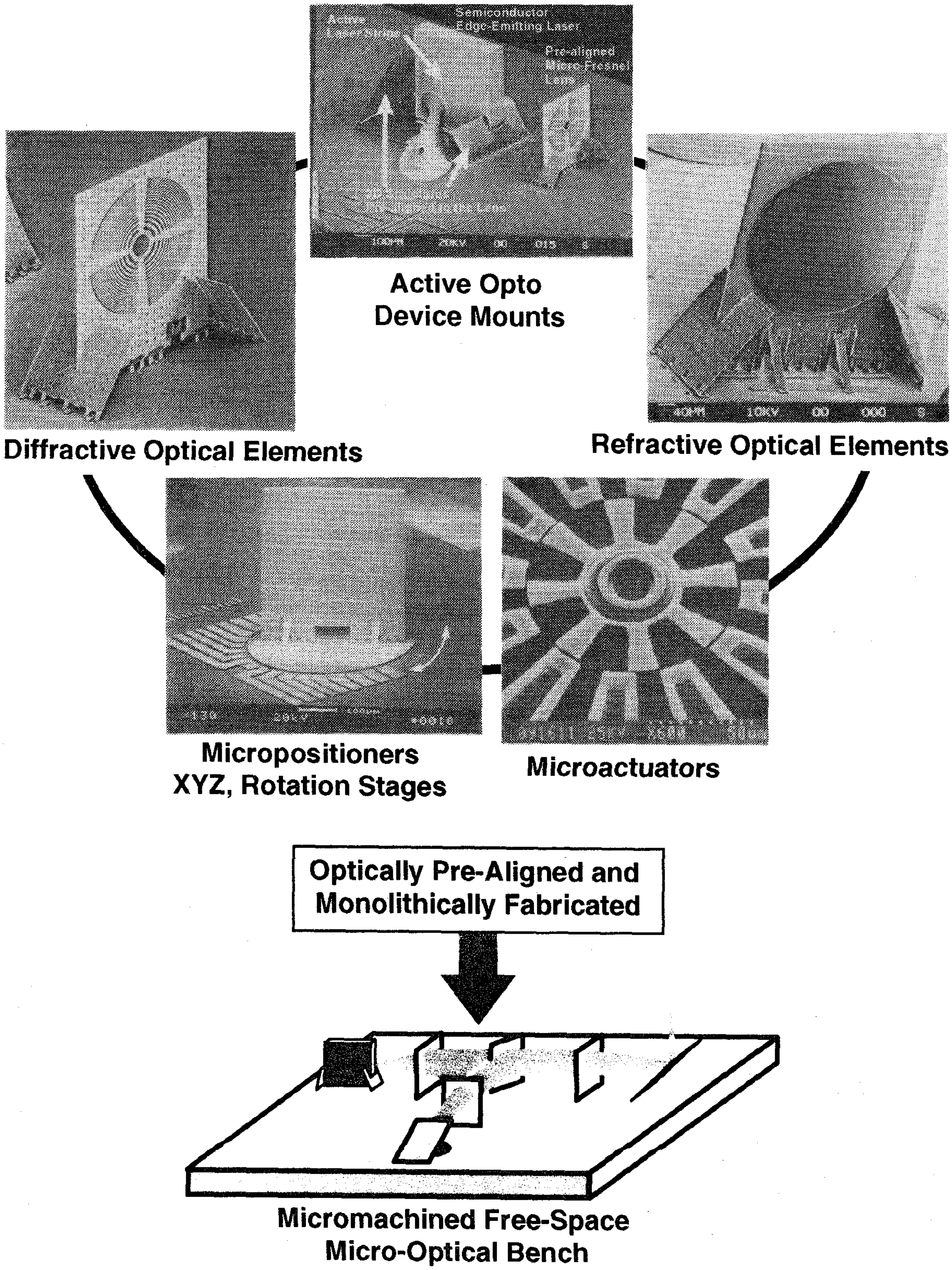

Fig. 1. Schematic diagram illustrating the concept of free-space micro-optical bench.