2:15pm-2:45pm(Invited)
MF3

Micromechanical Photonic Integrated Circuits

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The ability to integrate micro-optical elements with movable structures and microactuators has opened up many new opportunities for optical and optoelectronic systems[1,2]. It allows us to manipulate optical beams more effectively than conventional methods, and is scalable to large optical systems. Optical MEMS (MicroElectroMechanical Systems) have applications in display, sensing, and optical data storage. Recently, telecommunications have become the market driver for Optical MEMS. Many different kinds of devices and systems have been reported, including optical switches[3,4], optical crossconnect[5,6], wavelength division add/drop multiplexers[7], tunable filters/lasers/detectors[8], dispersion compensators[9], and polarization dispersion compensators[10].

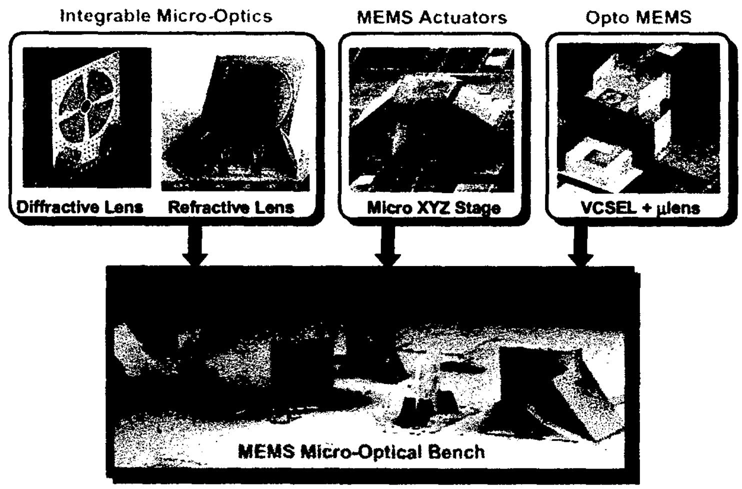

Figure 1. Free-space micro-optical systems realized by MEMS photonic integrated circuits. The insert shows various Optical MEMS components: (from left to right) diffactive microlenses, refractive microlenses, micro-XYZ stages with integrated microlenses, and hybrid integration with vertical cavity surface-emitting lasers.

Typical optical components for free-space optical systems include (1) optical elements, such as lenses, mirrors, refractive and diffractive optical elements, (2) three-dimensional optomechanical support, such lens mount, and (3) adjustable structures and actuators such as XYZ micropositioners. The main challenge for implementing MEMS-PIC is the ability to make different optical components using the same fabrication process. In the past several years, our research group at UCLA has been developing a MEMS Micro-Optical Bench technology that can simultaneously fabricate these three different types of components using the same fabrication process. An example of single-chip MEMS optical system is shown in Figure 1. It is based on the standard polysilicon surface-micromachining processes. Single-chip optical disk pickup head and femtosecond optical autocorrelator have been successfully demonstrated. This technology can also be applied to optical switches and tunable WDM components.

For most applications, the quality (flatness, surface roughness) of micromirrors is very important. Surface-micromachining technology offers great flexibility for microactuator design and integration; however, the micromirrors often exhibit curvatures due to the residue stress or stress gradient of the deposited thin films. Bulk micromachining has been shown to produce optically flat single crystalline micromirrors.[11,12] However, it does not have the flexibility and versatility of surface-micromachined structures. Recently, we have developed a wafer-scale mirror bonding process to fabricate high performance single-crystalline Si micromirrors on surface-micromachined actuators. This technique combines the advantages of high quality single-crystalline optical elements and the versatility of surface-micromachined structures. 2D optical scanners with optically flat micromirrors have been demonstrated.[13] Honeycomb micromirrors have also been developed to reduce the mass of micromirrors.[14] Detailed performance will be presented at the conference.

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