10.00 CWD6 (Invited)

Recent Advances in Micro-Opto-Electro-Mechanical Systems (MOEMS)

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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. It allows us to manipulate optical beams more effectively than conventional methods, and is scalable to large optical systems. This new family of devices and systems is generally called Optical MEMS (Micro-Electro-Mechanical Systems) or Micro-Opto-Electro-Mechanical Systems (MOEMS)[1]. MOEMS have applications in display, sensing, and optical data storage. Recently, telecommunications have become the market driver for MOEMS. Many different kinds of devices and systems have been reported, including optical switches, optical crossconnect[2,3], wavelength division add/drop multiplexers[4], tunable filters/lasers/detectors[5], dispersion compensators, and polarization dispersion compensators.

MEMS technology has made it possible, for the first time, to integrate an entire free-space optical system onto a single chip. Optical elements such as lenses, mirrors, and gratings are batch fabricated along with the XYZ stages and the microactuators. The size of the system is dramatically reduced by one to two orders of magnitude. The main challenge for implementing MEMS-PIC is the ability to make different optical components using the same fabrication process. 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 mirror mount, and (3) movable structures and actuators such as XYZ micropositioners. In the past several years, our research group at UCLA has been developing a MEMS Optical Bench technology that can simultaneously fabricate these three different types of components using the same fabrication process. Our fabrication process is based on the standard polysilicon surface-micromachining processes. Single-chip optical disk pickup head and femtosecond optical autocorrelator have been successfully demonstrated. In this talk, we will describe the recent advances in Optical MEMS devices for telecommunications and WDM applications. We will also discuss the main roadblocks and challenges for practical applications of MOEMS.

[1] M.C. Wu, "Micromachining for Optical and Optoelectronic Systems," Proc. IEEE, Vol. 85, pp. 1833–1856, 1997.
[2] L.Y. Lin, *et al*, "Free-space micromachined optical switches for optical networking," IEEE J. Selected Topics in Quantum Electronics, vol.5, p.4-9, 1999.
[3] D.T. Neilson, *et al*, "Fully provisioned 112x112 micro-mechanical optical crossconnect with 35.8 Tb/s demonstrated capacity," OFC 2000, Postdeadline paper PD-12, 2000.
[4] J.E. Ford, *et al*, "Wavelength add-drop switching using tilting micromirrors," J. Lightwave Technology, vol.17, p.904-11, 1999.
[5] D. Vakhshoori, et al., "C-band tunable 6 mW vertical cavity surface-emitting lasers," Proc. OFC 2000, Postdeadline paper PD13.

08.30-10.30 CWE – Nonlinear Organic Materials and Devices

Presider: V. Degiorgio, *Universita di Pavia, ITALY* **ERATO**

08.30 CWE1 (Invited)

Optical and electrical processing of new oriented electrooptic polymer devices

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Electrooptic polymers are efficient materials for designing integrated optics devices for telecommunication applications. The electronic origin of their optical nonlinearities and the low dispersion of their refractive indices make them ideal materials for high frequency applications required in future telecommunication networks. We review some recent developments of polymer electrooptic modulators which make them suitable for applications in telecommunication systems.

Polymer devices are readily made with microelectronics technologies on silicon substrates and basically consist in polymer multilayers sandwiched between gold electrodes. These multilayers, made of low and high refractive index polymers, enable optical waveguiding in a wide optical range in the near-infrared.

The core polymer of the waveguide, which is highly functionalized with nonlinear optical molecules, has to be oriented with a so-called poling procedure in order to present a nonlinearity at the macroscopic level. This poling procedure is usually achieved by applying high electric fields at high temperatures on the device electrodes. Optical techniques such as all-optical, or electrical photoassisted procedures are shown to open up new possibilities in device conception, although still requiring some optimization [1].

A critical parameter in the polymer multilayer design concerns the effective electric field inside the active layer. Material selection for optimization of the effective fields has been achieved in electrical poling configurations with electrodes parallel or perpendicular to the substrate [2]. Applying the same considerations to device operation is shown to also result in lower bias voltages.

The polarization sensitivity and the stability of the operation point are critical parameters for optical communication devices. We present solutions to these problems with special designs of polymer modulators including electrodes parallel or perpendicular to the substrate or full control of the operation point with an electronic feed-back loop [3].

[1] A.Donval, E.Toussaere, S.Brasselet, J.Zyss, « From electrical poling to all optical poling of a coplanar electrodes configuration polymer phase modulator », Optical Materials, 12 (1999) pp215-219.

[2] Ochs,A.V. ; Rousseau,A., Boutevin,B. ; Toussaere,E. ; Donval,A. ; Hierle,R. ;Zyss, J. ; « Fabrication of low refractive index low loss fluorinated self-cross linking polymer waveguides for optical devices »
7th Internationnal Plastic Optical Fibres conference '98, Berlin

[3] Donval,A ; Toussaere,E ; Hierle,R ; Zyss,J ; « Polarization insensitive electrooptic polymer modulator », to J.Appl.Phys. (1999), to be published.