LCD backlight with light guide reduces LEDs.

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Network analyzer covers 9kHz to 8.5GHz range.

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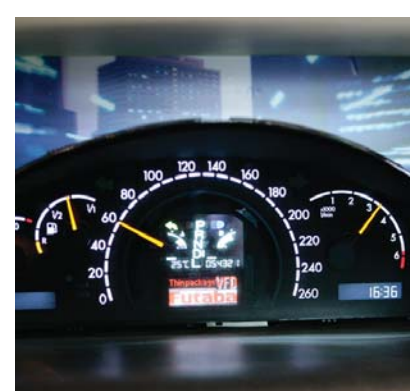

Infocrash or ease-of-use
The car cockpit of the future.

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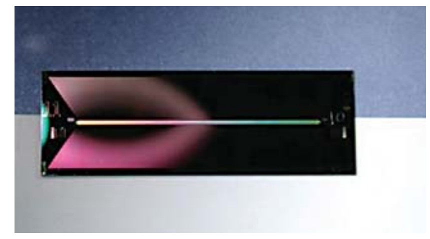
MOEMS field spawns development of varied devices for a diverse application set

By Glen Fitzpatrick, chief scientist, Micralyne Inc., Edmonton

A substantial portion of the MEMS space is now being given over to Micro-Opto-Electro-Mechanical-Systems (MOEMS), the miniaturization of optics, light modulation and control. Microlenses, waveguides and a number of ingenious approaches to micromirrors and Variable Optical Attenuators (VOAs) - devices which adjust optical signal strength in fiber optic systems) are all finding niches in the MEMS sphere.

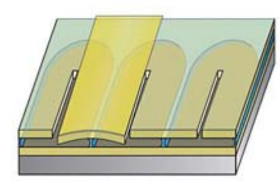
The desire to modulate light is motivated by a number of needs in diverse application areas. MEMS provides solutions thanks to its characteristic structural sizes on the order of the wavelength of light as well as its capability to manipulate large numbers of photons with relatively fragile structures. MEMS light modulators are also less expensive, more robust, faster, have a higher contrast, higher throughput and a lower actuating voltage than many competing technologies.


Shown here is a 38.4mm long array of 960 channels with bonding pads extended out to the perimeter to address each ribbon switch element.

Device examples vary from single mirrors, which undulate as a continuous membrane for adaptive optics, correcting for atmospheric seeing issues in astronomy or correcting for lens aberrations in ophthalmology, to arrays of flat and precise quasi-static mirrors for switching optical telecommunications signals from fiber to fiber.

The most familiar example from this wide range of specialty optical devices is the display specific designed Texas Instruments Digital Mirror Device (TI DMD), a two dimensional array of geometrically tilting mirrors (1280 x 764 elements for High Definition video). With this device, the MOEMS part steers white light signals geometrically to make a gray scale image, color is then added with filter wheels. The MOEMS device can also be used as a scanner, directing light in a temporal mode. A single detector picks up the signal, building an image from the time domain information. This method is used for bar code scanning and endoscopy using modulators of various types. The basic premise of all these devices is to be an optical transfer function, which can be changed electronically whether it is an output device or a controlled source.

The Micralyne SLV (Spatial Light Valve) is a one-dimensional linear array of elements (a zero dimensional array is a single mirror moving in two axis to raster scan an image). The Micralyne SLV uses diffraction rather than a geometric tilt to redirect light into different interference orders. This makes it ideal for applications where a high bit rate of information needs to be transmitted, whether onto a screen, a polymer, or a solid substrate. Rather than a square of pixels, the linear array can either be scanned on a surface, or be used for scanning moving objects such as a rotating cylinder.


Structure of pinned ends illustrating restoring force

The manufacture of the SLV device is done with a dedicated MEMS process, with just three masks and no polishing steps. The deposition of all of the films required to make the device are deposited before any lithography or etch steps are performed. The surface is almost as smooth and flat as the single crystal silicon substrate upon which the films are deposited. The different layers etch selectively to each other and allow the removal of sacrificial layers from between the stress compensated mechanical layers. This releases a three-dimensional moving structure while only patterning surface features. The result is a solid, well-anchored structure with a highly reflective surface. The contiguous film structure bonded to the conductive substrate allows greater heat conduction than would a free ribbon structure also.

The Micralyne SLV is designed to be used in the zeroth diffraction order to achieve over 96% throughput of the laser wavelength being used. The SLV structure affords exceptional switching speeds, in the tens of MHz. This enables data throughput in the tens of Gbit/second rates over hundreds of devices with adequate contrast for infrared (thermal)

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MOEMS field spawns development

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media exposure.

The following table summarizes some of the present devices available, all of which have been designed for their own specific applications. The values in the table were extracted from publications and are intended to show differences in the devices. Due to the diverse application areas, there are no easy metrics to compare different designs, so these numbers are only guidelines.

For instance, the TI DMD has relatively slow elements when compared to many other devices, but the ability to make one million mirrors move for HD video makes it a premier device for this application.

Another interesting device is the Polychromix Polychromator. This device forms a grating that can be programmed to interfere throughout a range of wavelengths, thus allowing a variable transfer function of reflectance wavelengths. This forms the basis of a novel and simpler method of spectroscopy in a handheld unit.

The management of CO2 laser power could prove to be a future application for MEMS technology; the Micralyne SLV has shown some initial promise in this area. Micralyne has fabricated devices which could split a 50W beam into 50 or 100 smaller beams, all switching at an order of magnitude faster than the single beam (switching speeds of 250kHz with a 50V drive). The application area, which could most benefit from this medium power modulation of 10.6 micron wavelength radiation is marking.

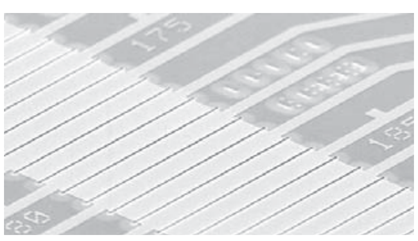

Photo of 40 micron by 300 micron elements, separated by 1 micron spaces.

Most items which require unique marking of identification numbers presently use laser marking techniques; CO2 is simple but slow due to the use of galvanometers, YAG variants are fast due to their solid state switching but are expensive. Micralyne has modeled, manufactured and tested variants of this switch, and is presently rounding out the tests in order to present validated prototypes to potentially interested marking system manufacturers.

The Micralyne SLV is protected under US Patents 6,661,561, 6,836,352, 6,856,448 and German Patent DE10213579.

MOEMS is a relatively new field that has seen the development of a wide variety of device types for a diverse application set. Fabrication methods vary in design and complexity. All methods have specialization beyond standard electronic fabrication processes to provide the optical performance desired.

For more information on MEMS-based products from Micralyne Inc.
Circle 238 or http://ept.ims.ca/9943-238

Device	Operation	Application	Design Philosophy	Element speed	Reflectivity	Process
Micralyne SLV	Electrostatic membrane/diffractive	Potential: IR switch, display, analogue, scanning	Fast, efficient, simple	10 MHz	~96%	Surface micromachining; 3 masks
TI DLP	Electrostatic geometric tilt 2D array	Area display	Integrated electronics, white light display	50 kHz	~85%	Double metal CMOS SRAM plus 4 masks
Silicon Light Machines GLV	Electrostatic ribbon 1D array/diffractive	Laser display, Near IR switch	CMOS base process, drive electronics to on board	180 kHz 1 MHz	~50-70%	Modified CMOS plus MEMS processing
Kodak GEMS	Electrostatic membrane 1D array/diffractive	Laser display	Novel diffraction for simple optical design	10 MHz	80.00%	Etch and sacrificial CMP
Qualcomm (Iridigm) iMoD	Electrostatic membrane 2 D array/diffractive	Small/medium direct display	Flat phone/PDA display – OLED and LCD competitor	>10 kHz	50.00%	Straightforward thin film MEMS process; simpler than LCD or OLED
Polychromix Polychromator	Electrostatic ribbon 1 D array/diffractive	IR spectroscopy	Long wavelength and analogue control	~50-100 kHz	~90%	Two polysilicon CMOS process
Fraunhoffer	Electrostatic 2D array/diffractive	UV lithography	Diffractive form of TI device with some grey scale	1 MHz	Should be fairly high; not published	Straightforward thin film MEMS

new literature

LIGHTING SOLUTIONS

Brochure covers CML Innovative Technologies' comprehensive range of optoelectronic components.

SIMCONA

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MASTER SOLUTIONS GUIDE

350 page LED and LCD Solutions Guide is a single reference work which presents design and technical information from firm's major product families.

LUMEX

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