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MEMS inside the ROADM

With the explosion in demand for large data centers, cloud computing, and video-streaming, there has been a rapid development in telecommunication infrastructure across the world.[1] MEMS mirrors offer smaller form factors, increased scalability, extended product lifetime, and improved power consumption over conventional technologies, namely electrical motor-driven products. These advantages have triggered adoption in many telecom applications such as the Variable Optical Attenuator (VOA), Tunable Optical Filter (TOF), Optical Channel Monitor (OCM) and 1xN switch. The expected growth in market size and demand for new applications in telecom and datacom, such as 100Gb+ transceivers using coherent lasers, makes it clear that MEMS mirrors will be critical to product development in the coming years and Preciseley Microtechnology Corporation (PMC) will provide these necessary devices.

To support larger, more reliable, and flexible networks, a colorless, directionless, contention-less, and flexible grid (CDC-F) Reconfigurable Optical Add-Drop Multiplexer (ROADM) is introduced.[2] Two of the key functionalities of the ROADM are wavelength switching and port switching, both of which can be realized through MEMS devices. Within wavelength switching modules, MEMS-based high-fill-factor mirror arrays offer low insertion loss, low crosstalk, and low wavelength dependent loss. In port switching modules, single MEMS mirrors can be used to construct an array of switches, known as a multicast switch (MCS). The MCS module consists of integer M splitters, couplers, and integer N selector switches to route (add/drop) optical signals. Due to the large number of splitters and couplers connected in the MCS module, significant attenuation of signal optical power is observed. Although optical power loss can be mitigated through the use of an amplifier array, such as an Erbium-Doped Fiber Amplifier (EDFA) array, the total power of a channel increases proportionally to the overall channel bandwidth. As the port count increases, the requirement for EDFA array output power with a 150-GHz channel bandwidth becomes impractically high.

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Alternatively, the MCS's splitters and switches can be replaced with a single monolithic MEMS mirror array chip (Figure 1), offering advantages of high reliability, low insertion loss, low power, and a small form factor. Each mirror can be independently addressed, with tilting in one (1D) or two (2D) axes. This allows high-fill-factor MEMS mirrors to be configured as a linear array or a matrix of mirrors (Figure 2) on a single chip.

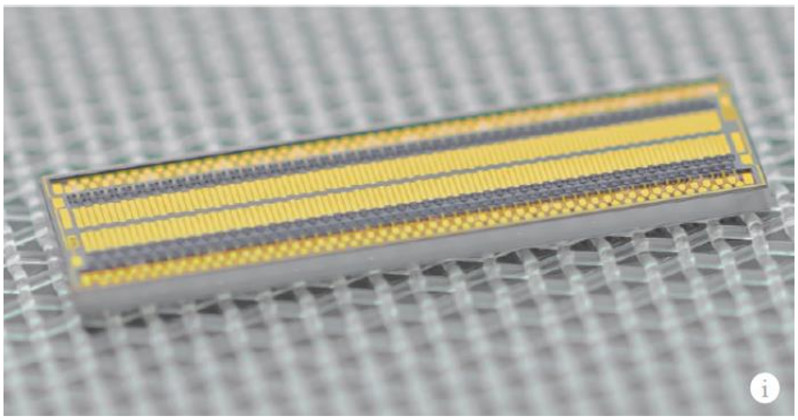

Figure 1: MEMS 2D tilting mirror chip

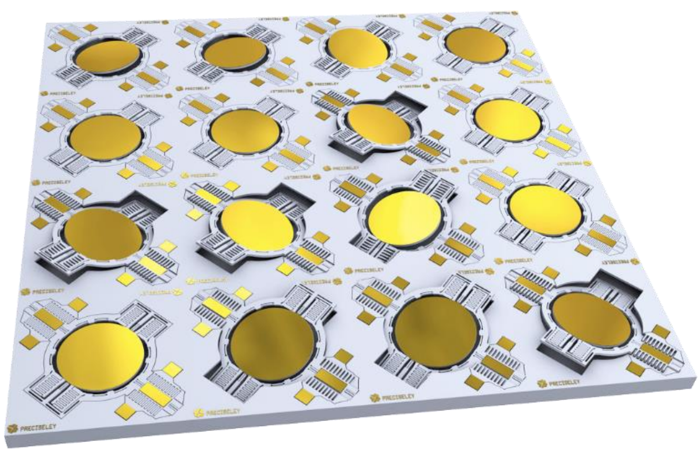

Figure 2: MEMS matrix mirror array

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The Benefits of MEMS Mirror Arrays

When a MEMS mirror array is integrated with a liquid crystal on silicon (LCoS) based WSS and no EDFA arrays are used in the add/drop path, there are no limitations on channel bandwidth or power - unlike an MCS configuration. The result is a contention-less MxN WSS with the capability of seamlessly supporting wider bandwidth channels of any total optical power.

With more traffic created by cloud applications and video streaming, service providers and data centers must adapt and work with suppliers to find a solution with greater capacity, smaller footprint, higher power efficiency and longer lifetime. PMC's Linear Mirror Arrays and Matrix Mirror Arrays are the solution to achieve low power consumption and high-density requirements in communications network systems.

Our mirrors are optimized for stability and repeatability with negligible crosstalk between adjacent mirror structures. They also feature an extremely high fill factor in excess of 95%, with fixed or variable mirror pitch, a mirror length up to 1 mm or more, and 1-axis or 2-axis tilting. PMC's mirror arrays are used for many applications including but not limited to telecommunications, data networks, automotive, 3D sensing, and will continue to expand to other markets in the future.

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