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Optical MEMS

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1. Introduction

Information Technology (IT) is recognized as one of essential technology in recent economic development. Broadband information sharing systems are essential to meet the needs of remarkable increase in data traffic such as the Internet. Especially an optical network is the most competent for broadband information systems from the point of view of high-speed access. Optical MEMS will play an important roll in optical networks.

There are two categories of optical MEMS applications in telecommunication fields. The first includes telecommunication infrastructure equipments such as optical switches. The second includes input/output devices, namely sensors, actuators, displays, printers, and storages. Strategies and efforts for developing optical MEMS technologies/devices within the framework of broadband information sharing systems and services are described.

2. Optical MEMS for Telecommunication Infrastructure

Faced with the explosive growth of the Internet traffic, research and development efforts are focusing on photonic networks based on wavelength division multiplexing (WDM) as the most promising solution for delivering massive traffic volumes at relatively low cost[1]. Optical switches play a number of key roles in photonic networks including optical add/drop multiplexing (OADM) to enable wavelength-specific optical signals to be split off or merged at intermediate points along a transmission route, optical cross connecting (OXC) that permits wavelength-specific circuits to be switched from one route to another as shown in Fig.1.

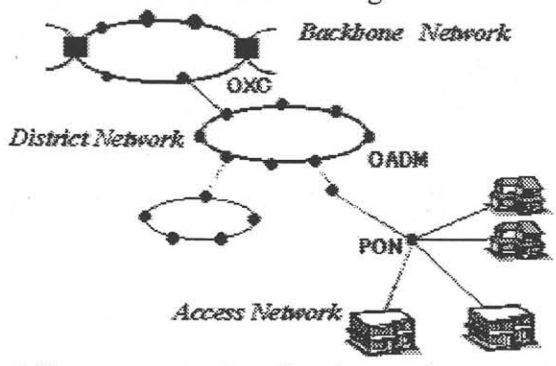

Fig.1 Next generation broadband network using WDM..

A Thermo-capillary optical switch array for OXC and stand-by use was developed by NTT[2]. Figure 2 shows a Thermo-capillary optical switch element that is implemented on a silica-based planar light wave circuit substrate. Switching is done by heating micro-heaters along the split that is partially filled with refractive-index-matching oil at the crossing point. This switch is highly reliable, because the thermally and chemically stable oil is sealed between glass and PLC substrate. A 16-arrayed thermo-capillary switch was developed[3]. The switch is also insensitive to wavelength and polarization, having low insertion loss (below 3dB in a 1x8 selector switch), a high extinction ratio (>50 dB) and low crosstalk (<50dB).

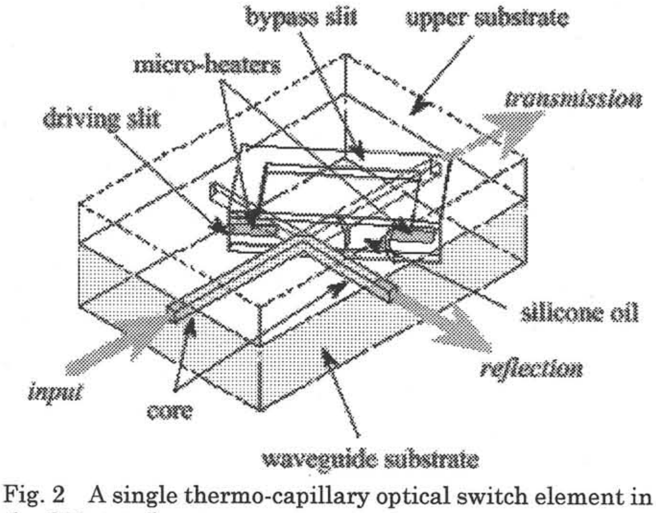

Fig. 2 A single thermo-capillary optical switch element in the ON state[2].

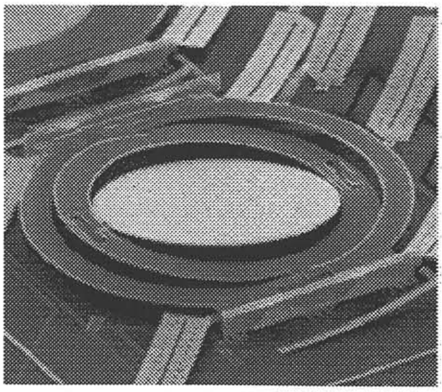

Fig.3 A micro mirror array actuated by electro static force[4].

Figure 3 shows an array of microscopic

mirrors[4] developed by Lucent Technologies, each able to tilt in various directions, to steer light by using electrostatic micro actuators. The micro mirrors route information in the form of photons, or light pulse, to and from any of 256 input/output optical fibers.

A mirror with a high-aspect-ratio torsion spring, electro statically driven by a terraced electrode is proposed by NTT[5] to increase resonant frequency and to decrease the hysteresis in the tilting of a mirror as shown in Fig.4. The mirror chip size is 1.8 or 2 mm square. When the potential difference was about 100 V, approximately 5 degrees of tilt angle was obtained. The mirror roughness is a few ten nanometers, which is far better than poly-silicon mirrors fabricated by surface micro machining.

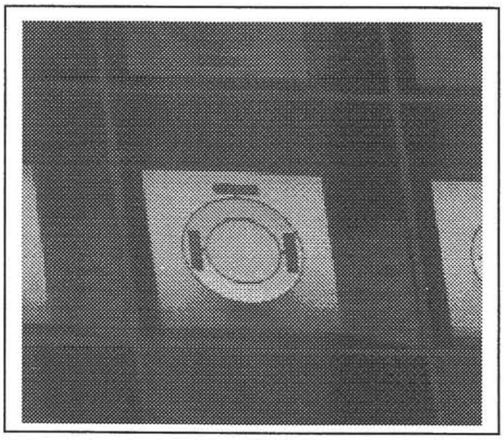

Fig.4 Movable mirrors and torsion springs[5].

3. Optical MEMS for input/output devices

Sensor-communication Society, which will be realized by combining MEMS based sensors/actuators with information technology (IT) is anticipated[6]. These MEMS devices will be connected with each other and a center machine by wireless systems such as *Bluetooth*. Sensor-communication Society will support to the global environment preservation, the service of medicine and welfare, and the creation of new business. Especially in medical fields, I think that the medical IT in corporation with MEMS devices will support a comfortable healthy life as shown in Fig. 5[7].

An integrated laser Doppler blood flow-meter that would be applied for the e-Life Creation system has been developed by NTT as shown in Fig.6[8]. In-vivo experiments concerning blood perfusion in a finger confirm the feasibility of the blood flow meter.

4. Conclusions

Optical MEMS devices such as switching systems will be very important in optical broadband networks. I foresee the great possibility of medical services and the global environment preservation, resulting from the MEMS technology in corporation with IT .

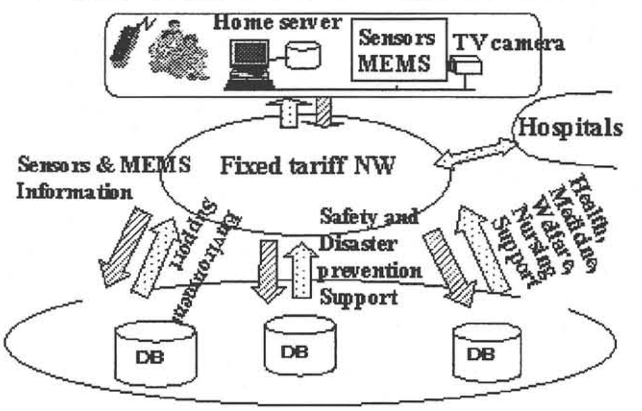

Fig. 5 Medical information sharing system (e-Life Creation System)[7].

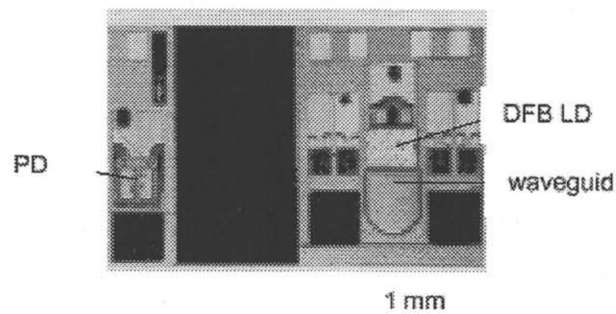

Fig. 6 Photograph of the integrated laser Doppler blood flow-meter chip[8].

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