With the rapid development of optical communications, all-optical switching networks have become more important. The wavelength switching architecture is one of the most promising methods because it enables the management of optical networks at the wavelength level. One of the key modules in the optical network is the wavelength-selective switch (WSS).

Various technologies have been explored in order to achieve the WSS function, such as free-space grating micro-electro-mechanical system (MEMS) micromirror array-based wavelength-selective switch (WSS) is presented. The WSS is composed of a polarization-independent transmission grating and a high fill-factor micromirror array. The WSS is successfully demonstrated based on the fabricated high fill-factor micromirror array. Test results show that the polarization-dependent loss (PDL) is less than 0.3 dB and that the insertion loss (IL) of the wavelength channel is about –6 dB. The switching function between the two output ports of WSS is measured. The forward switching time is recorded to be about 0.5 ms, whereas the backward switching time is about 7 ms.


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electrode, a bumper, and limiting planes are designed. Compared with traditional parallel-plate electrodes, the multi-terraced electrode is designed to reduce the driving voltage. To prevent the stick or damage caused by the pull-in effect or some instances of vibration, a bumper, which is silicon salient with two micron silicon oxide film, and limiting plane structures have also been introduced. The cantilever-type structure is utilized for micromirror rotation and high fill-factor of the micromirror array. The resonance frequency of the micromirror was selected to be 4 kHz to achieve a good anti-vibration performance. Figure 3 shows the comparison of the driving voltage of the micromirror with parallel-plate and multi-terraced electrodes. The test results also demonstrated a better and more desired performance.

In previous studies, surface micromachining has been frequently used to fabricate the micromirror. However, the residual stress of surface micromachined thin films causes wrap and reliability problems. Figure 4 shows the scanning electron microscope (SEM) images of the fabricated micromirror array using bulk micromachining technology, including a wafer bonding process. The fabricated micromirror array with a high fill-factor of 97% is shown in Fig. 4(a). The cross-section view of the micromirror is illustrated in Fig. 4(b), which shows the cantilever-type micromirror plate, multi-terraced bottom electrodes, the bumper, as well as limiting plane.

In conclusion, a novel WSS based on a high fill-factor micromirror array is proposed and achieved successfully. The WSS contains polarization-independent transmission grating and micromirror array. The grating has the advantages of low PDL and having no requirement for additional polarization controlling devices. High fill-factor micromirror arrays are designed and fabricated using bulk micromachining technology, including a wafer bonding process. The measurement results show that the IL and PDL of the novel WSS are $\leq -6$ and $< 0.3$ dB, respectively. The forward switching time is
Fig. 5. The IL and PDL test results of WSS by using a DWDM test system.

Fig. 6. Measured dynamic responses of the WSS. (a) mirror switched from the first stable position to the second stable position and (b) mirror switched from the second stable position to the first stable position.

about 0.5 ms, while the backward switching time is about 7 ms.

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References