Integrated corner mirrors physically micromachined in silica-on-silicon

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Abstract

In integrated photonics, compact redirection of light can be achieved by corner (turning) mirrors, providing a route to higher density optical components. Corner mirrors have been demonstrated in both silicon-on-insulator and hollow waveguides with reported losses of 0.9dB [1] and 0.8dB [2] respectively. We report a novel method of fabricating mirrors on a silica-on-silicon substrate. The method utilises the complementary techniques of physical micromachining and direct UV writing, both providing rapid prototyping outside the cleanroom environment.

The corner mirrors presented here are cut into the silica-on-silicon substrate using a precision dicing saw. The combination of precision sample translation and diamond impregnated blades produce grooves with high sidewall verticality and average surface roughness of <30nm [3]. A prototype device was fabricated by physical micromachining of the mirrors into the silica-on-silicon substrate. Two grooves are diced at 90° with respect to each other. The waveguides and Bragg gratings are then defined using DUVW into the germanium doped planar core layer. During the DUVW process the groove edges are located via electronic monitoring of the reflected UV light from the sample surface. The Goos-Hänchen shift at each mirror interface is accounted for by a waveguide offset and is designed for 1550nm. A schematic of the device showing the location and wavelength of the gratings is shown in Fig. 1 (a). The addition of Bragg gratings provide an accurate method of measuring the loss of the mirrors [4]. This novel loss measurements technique is non-destructive, ratiometric and provides information about the spectral bandwidth of the device.

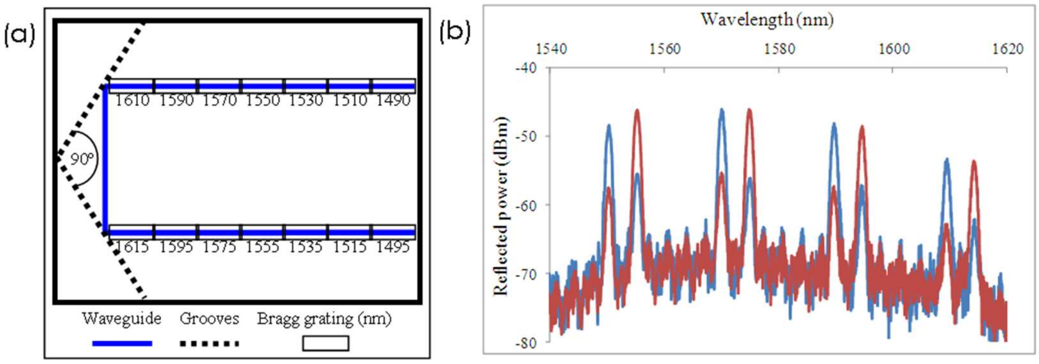

Fig. 1(a) schematic showing waveguides, Bragg gratings and corner mirrors,(b) reflection spectra of the gratings collected from each port.

To determine the loss of the device a broadband light source was sequentially launched into each facet of the device and the reflection was spectrally analysed, see Fig. 1 (b). A Gaussian fitting algorithm is then used to determine the magnitude of the Bragg reflections. The insertion loss of both mirrors can be calculated from the ratio of these amplitudes [4]. For the TM mode the average insertion loss for an individual mirror was found to be ~0.96dB for wavelengths between 1550nm and 1615nm. This result is comparable to prior results [1,2]. By improving the sidewall roughness via dicing machine parameter optimisation, the insertion loss can be further reduced. We shall present our latest results in the fabrication and characterisation of these corner mirrors.

References

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