High Extinction Ratio Polarization Selective TE/TM Bragg Gratings filters on silicon-on-insulator.

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Integrated optical filters such as Bragg gratings are widely used in silicon-on-insulator technology for signal processing [1], telecommunications [2] and quantum processing [3]. Sidewall gratings offer a simple geometry that has been widely used for fabricating TE filters with high extinction ratios and accurate control over the grating stop-band and central wavelength [4]. However, a major drawback of this design stems from the weak interaction of the TM mode with the sidewalls of the waveguides, which makes it unsuitable for fabricating TM filters. This feature severely limits the maximum extinction ratio of the filter because of the strong polarization scattering typical of highly confined optical waveguides [5]. To this aim, top surface relief waveguide gratings provide an interesting alternative as they strongly interact with the TM mode with a negligible influence on the TE polarised mode. Integrating surface and sidewall gratings on the same waveguide not only substantially improves the extinction ratio of the filters but also provides a powerful design tool to independently manipulate TE and TM polarised light.
The devices were fabricated with standard silicon photonic fabrication processing. The gratings for the TE polarised light were defined as a sinusoidal perturbation on the waveguide sidewalls, while shallow etched holes on the top of the waveguide acted as a filter for the TM polarised light. When TE filters are measured with a TE input, experimental results show an increase of the extinction-ratio with the *kL* product until the extinction-ratio saturates to a value of 20-30 dB (Fig. 1, blue line). Further analysis of the output signal indicates that the residual signal inside the stop-band is mostly propagating as TM polarised light as a consequence of the scattering. A further increase of the extinction-ratio up to 55-65 dB can be achieved with dual TE/TM gratings designed to filter both polarizations (Fig 1, green line). This figure is limited by the substrate scattering.

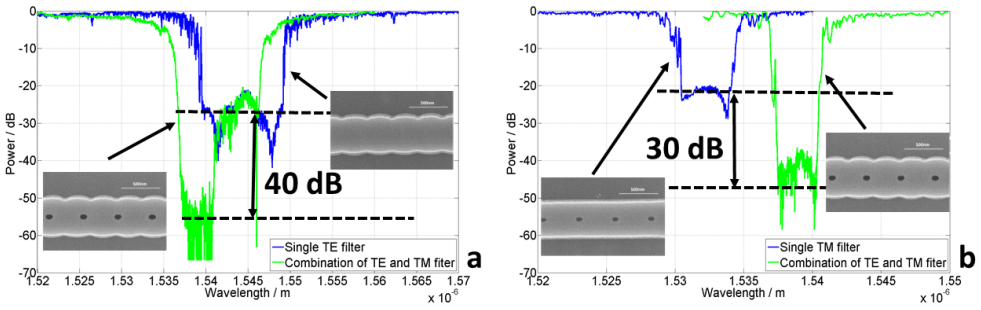

Fig. 1 The transmission spectra of (a) TE propagation and (b) TM propagation for a single filter (blue line) and for dual TE/TM filters (green line).

In summary, we have investigated the limitations on the extinction ratio of Bragg gratings filters. These devices show a limited extinction-ratio in the order of 30 dB because of the strong polarisation scattering that occurs in high refractive index waveguides. A further increase of the extinction-ratio up to 60 dB for the TE and 50 dB for the TM polarised light has been achieved by integrating sidewall and surface relief waveguide gratings to achieve dual TE/TM filters. Because of the very different interaction with TE and TM polarised light, the integration of top and sidewall gratings offers a powerful and flexible design approach to independently manipulate the polarisation state of the propagating light on-chip.

References

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