O-band Silicon Photonic Bragg-Grating multiplexers using UV lithograpy

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Abstract: We demonstrate 4 channel Bragg-grating based WDM fabricated using 193 nm lithography on the silicon on insulator platform with small features under 140 nm for use in the O-band.

1. Introduction

1.1. Relevance and place in the greater scheme

Point out that optical filters are needed for WDM.

1.2. State of the Art

Speak about lattice filters, echelle/arrayed waveguides, ring on SOI. None of these are flat top, limited FSR, low bandwidth. Bragg gratings only reflect. Apodized contra-DC only work on E-beam.

Integrated WDM is currently achieved using lattice filters [1] or arrayed waveguides [2], though these methods use a large footprint and have a limited free-spectral range. Others possible approaches include Bragg gratings [3] and micro-ring filter [4].

1.3. Challenges

Small corrugation size and period, expecially at 1310. Accuracy for apodization. Large enough coupling Contra-directional couplers can offer large bandwidth, compact footprint and high sidelobes suppression, but the small feature size needed for gratings limits the performance when fabricated with conventional deep-ultraviolet lithography [5] [6]. This issue is compounded when designing a device for the O-band (around 1310 nm), which is an useful band for lower dispersion in conventional fibers and additional bandwidth, as the small wavelength size requires a proportionally smaller grating step.

2. Device

2.1. Design

Slab and thin waveguides for bigger overlap. Traditional apodized side-wall grating. Figure 1 shows the proposed structure.

The contra-directional coupler consists of two waveguides in close proximity, with a periodic change to the gap in-between them. This causes a wavelength selective contra-directional coupling at $\lambda_c = \Lambda(n_1 + n_2)$, where Λ is the grating pitch, and n_1 and n_2 are the effective refractive indices of the first-order and second-order eigenmodes in the coupler. The waveguides are highly asymmetric to suppress the co-directional coupling that would occur with two identical waveguides.

2.2. Fabrication process

Fabrication using a CMOS compatible UV lithography with a phase-shifted mask.

2.3. Fabrication result

Clear corrugations and the possibility to have a small gap under 140 nm.

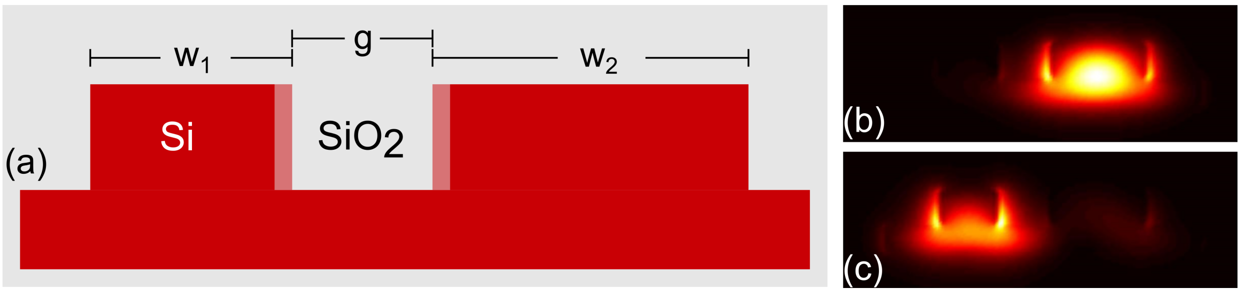

Figure 1. (a)Schematic cross-section: The contra-directional coupler is made of two silicon waveguides of different widths w_1 and w_2 with an average gap g in-between them. The gap varies along the propagation axis. (b) Colored microscope top view of the grating shows the shape of the corrugations after fabrication with ultraviolet lithography.

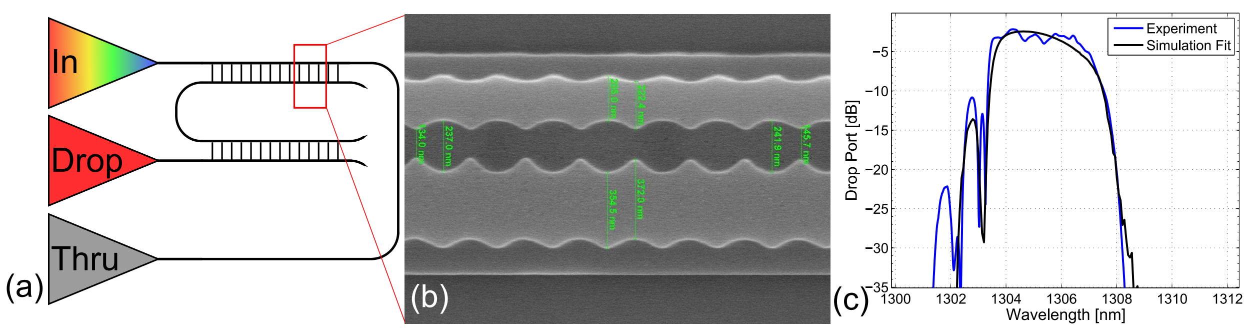

Figure 2. SEM picture of a strong grating. The measurements show that the widths of the waveguides are not the same in the close and far region, resulting in a strong change of index along the propagation direction and a distortion of the apodization profile.

2.4. Filter optical performance

[Plot of the optical response]

2.5. WDM performance

We see in figure 3 the response of the filter using a single filtering stage and also for two filtering stages.

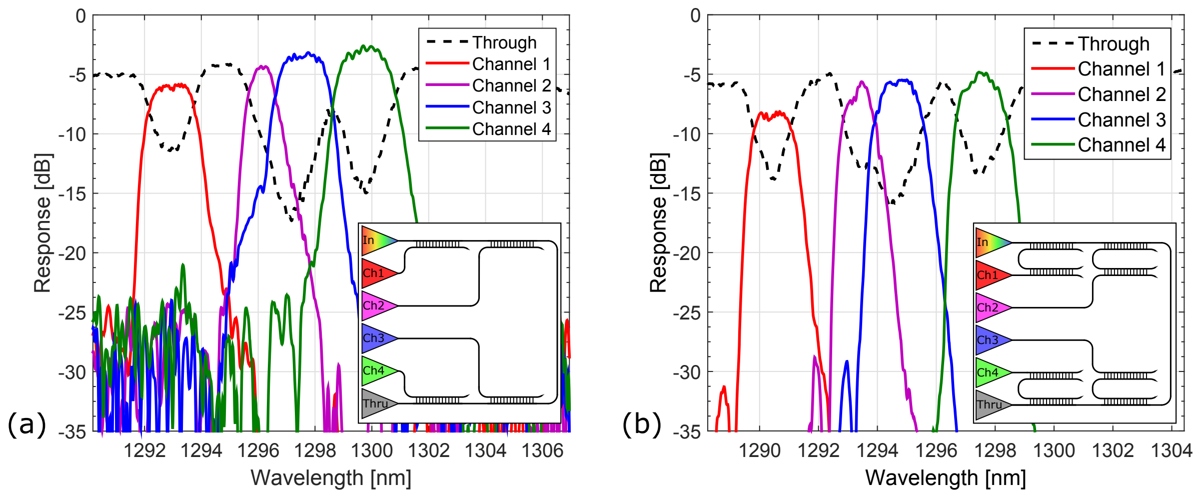

Figure 3. a) Single stage WDM. b) Double staged WDM

3. Conclusion

The demonstrated device open possibilities for wide bandwidth and temperature tolerant filters with a flat top response. Next prototypes promise to offer even larger bandwidth and a more square shape after biasing for lithography.

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