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Mid-IR integrated cavity based on Ge-rich graded SiGe waveguides with lateral Bragg grating

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Abstract: We report the design of a Bragg-mirror based Fabry-Perot cavity integrated on SiGe waveguides working at 7.25 μm . The demonstration of such resonant structures will be a major step forward for sensing applications in mid-infrared.

OCIS codes: (130.0130) Integrated optics; (130.3120) Integrated optics devices

1. Introduction

Photonics integrated circuits (PICs) in the mid-infrared (MIR) have attracted a lot of interest, particularly for novel applications in medical diagnosis, chemical and biological sensing, free-space telecommunication or security [1]. The Ge-rich SiGe graded waveguides benefit from a wide transparent window, strong 3rd order nonlinearity, broadband dispersion engineer-ability [2] and compatibility with silicon photonics. Such structures have revealed to be a promising platform to realize complex mid-infrared PICs in a wide wavelength range. For example broadband Mach Zehnder interferometers have been experimentally demonstrated from 5.5 to 8.5 μm wavelength, working in both quasi-TE and TM polarizations [3]. However, some key devices are still required in order to demonstrate the full potential of this platform, among which resonant structures that will be crucial for sensing applications where strong light-matter interaction is desired. In this context, a Fabry-Perot cavity using lateral Bragg grating mirrors might be a promising option to develop mid-IR SiGe cavities with high performance. In this work we design Bragg grating mirror based on graded SiGe waveguide and evaluate the performances of integrated cavities around 7.25 μm .

2. Design and simulation

The waveguide design is based on a 6 μm -thick graded $\text{Si}_{1-x}\text{Ge}_x$ rib waveguide. As illustrated in Fig 1(a) the Bragg mirror is obtained by a lateral corrugation of the waveguide width, permitting simple fabrication using a single etching step to define simultaneously the waveguide and Bragg mirrors, with 1 μm grating period, 4 μm etching depth and with a duty cycle of 50%. The mirror reflectivity at the central wavelength is up to 95%, using a 200 μm -long grating, and the spectral bandwidth is 62 nm. The transmission of a 600 μm -long cavity using these mirrors is plotted in Fig 1(b). Moreover, the theoretical Q-factor around 1×10^4 is expected assuming 1 dB/cm propagation losses.

Fig. 1. (a) Schematic view of Fabry-Perot cavity with lateral grating and (inset) cross-section of waveguide; (b) Transmittance of a Fabry-Perot cavity where $\Lambda = 1 \mu\text{m}$, $L_g = 200 \mu\text{m}$, $L_c = 600 \mu\text{m}$, 5 μm waveguide width, 4 μm rib thickness and 2 μm ridge thickness.

3. References

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