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Near-IR and mid-IR subwavelength engineered Si photonics

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Abstract— Periodically patterning Si with a pitch small enough to suppress diffraction, we synthesize an effective photonic medium with refractive index between those of Si and the cladding material. This technique releases new degrees of freedom in engineering of light-matter interaction, chromatic dispersion and light propagation in Si photonic waveguides. We present an overview of our recent results in the realization of novel devices including filters and waveguides for near- and mid-infrared wavelength range.

Keywords— *Integrated optics devices; Waveguides, planar; Bragg reflector; Silicon.*

The large transparency window of silicon (1.1 - 8 μm wavelength range) makes it a promising material for the implementation of a wide range of applications, including datacom, nonlinear and quantum optics, or sensing in the near- and mid-infrared wavelength ranges. Structuring silicon with features smaller than half of the wavelength releases new degrees of freedom to tailor material properties, allowing the realization of innovative high-performance Si devices [1].

Here, we exploit subwavelength nanostructuring to engineer light confinement, allowing the realization of two types of high-performance Si filters for quantum and sensing applications in the near- and mid-infrared. First, we will present subwavelength engineered Bragg filters that exploit an innovative differential corrugation width configuration to yield narrow-band rejection with a single etch step and relaxed fabrication constraints [2]. These filters exhibit remarkably narrow bandwidth of 1.1 nm with a rejection exceeding 40 dB. Then, we will present a corrugated Si membrane waveguide for single-mode operation in near- and mid-IR. Single-mode propagation in the mid-IR is allowed by choosing a 500-nm-thick and 1100-nm-wide silicon waveguide. A novel waveguide corrugation approach radiates out the higher order modes in the near-IR, resulting in an effectively single-mode operation in near-IR.

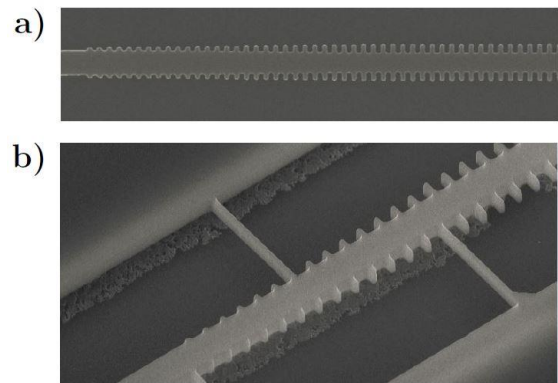


Fig. 1: Scanning electron microscope image of: (a) high pump-rejection filter for quantum photonics, and (b) Si membrane waveguide for applications in the near- and mid-infrared.

In conclusion, we exploit the subwavelength nanostructuring of Si to demonstrate efficient waveguide Bragg grating filters for several applications. Our achievements open a new route for the implementation of high-performance on-chip devices tailoring the flow of light in nanostructured silicon photonic waveguides.

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