Engineering sub-wavelength silicon waveguides for sensing applications in the near-infrared and mid-infrared band

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Silicon photonics is one of the most promising candidates to achieve lab-on-a-chip systems. Making use of the evanescent-field sensing principle, it is possible to determine the presence and concentration of substances by simply measuring the variation produced by the light-matter interaction with the real part of the mode effective index (in the near infrared band), or with its imaginary part in a specific range of wavelengths (in the mid-infrared band).

Regardless of which is the operating wavelength range, to maximize the device sensitivity it is essential to select the proper sensing waveguide. In this work we will review the potential of diffractionless sub-wavelength grating waveguides (SWG) for sensing applications by demonstrating its powerful capability to engineer the spatial distribution of the mode profile, and thereby to maximize the light-matter interaction. Among other things, we will demonstrate that the SWG waveguide dimensions used until now in the near-infrared are not optimal for sensing applications.

In the mid-infrared band, due to the unacceptable losses of silicon dioxide for wavelengths longer than 4 μm, an additional effort is required to provide a more convenient platform for the development of future applications. In this sense, we will also show our recent progresses in the development of a new platform, the suspended silicon waveguide with subwavelength metamaterial cladding. A complete set of elemental building blocks capable of covering the full transparency window of silicon ($\lambda < \sim 8.5$ μm) will be discussed.