Subwavelength waveguide devices for Near and Mid-Infrared applications

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Subwavelength gratings (SWGs) are periodic structures with a pitch (Λ) smaller than half the wavelength of the propagating wave (λ_m), so diffraction effects are suppressed. SWGs behave as artificial birefringent metamaterials with optical properties which depend on the geometry of the structure [1, 2]. They have found a myriad of applications in the field of integrated optics [3], most of them implemented in the silicon-on-insulator platform (SOI). Refractive index engineering based on SWGs has contributed to significant improvements in the performance of fiber-to-chip couplers, which is known as one of the major challenges in integrated optics. The same technique has been applied to design low loss waveguide crossings, integrated planar lens and evanescent field sensors. A refinement of the design technique enables engineering not only the refractive index, but also the dispersion profile of the SWG structure, thus paving the way toward ultra-broadband integrated optical components, such as directional couplers or multimode interference (MMI) devices. If the designer takes advantage of the inherent birefringence of SWGs, these structures can be used to implement high performance integrated polarization beam splitters, polarization rotators and polarizers. Currently, most of the practical devices based on SWG waveguides have been proposed for near-infrared (NIR) telecom wavelengths. For the designer, the main limitation is the minimum feature size that can be reliably fabricated (~100 nm), which constrains the SWG structures to periods larger than 200 nm. This is very close to the Bragg period at telecom wavelengths ($\Lambda_B = \lambda_m /2 \sim 280$ nm for the SOI platform), so the degrees of freedom for the design are often quite limited. Nevertheless, it is worth to note that the subwavelength condition ($\Lambda < \lambda_m /2$) is much easier to meet for mid-infrared (MIR) wavelengths than for the comparatively shorter near-infrared wavelengths, so it can be expected that SWG techniques will have a relevant impact in the design of MIR integrated optical devices in the near future. In this talk we give an overview of some of our recent advances in the development of high performance subwavelength waveguide devices for near and mid-infrared applications [4-15] (see Fig. 1). Practical issues of the design process, such as the relevance of substrate leakage losses and the effects of the random jitter, inherent to any fabrication process, will be also covered [16, 17].

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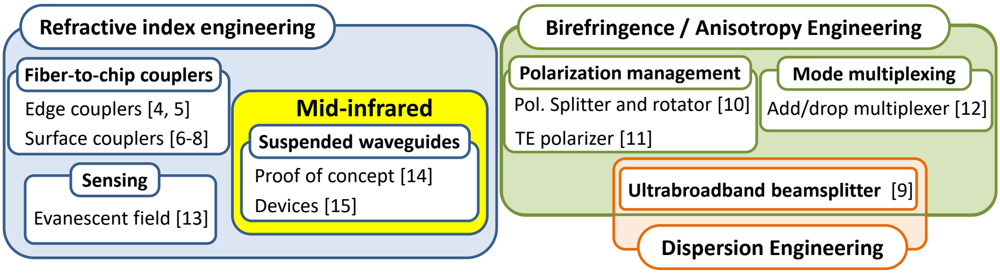

Fig. 1. Classification of our recent work in subwavelength grating waveguide devices.

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