A compact Ge-rich graded-index SiGe platform with broadband low-loss propagation in the mid infrared

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Abstract: Ge-rich SiGe platforms with broadband and flat propagation loss of 2-3 dB/cm from $\lambda = 5.5 \mu\text{m}$ to $8.5 \mu\text{m}$ are demonstrated. Such mid-IR integrated circuits are promising for many application including sensing or telecommunications.

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Mid-IR integrated photonics is recently gaining attention due to the wide range of applications foreseen including chemical and biological sensing, thermal imaging, early medical diagnosis or secure communications [1]. Among others, the possibility to use the mature CMOS technology to develop novel photonic integrated circuits exploiting the unique molecular mid-IR absorption bands present in several chemical substances rises as one of the driving forces pushing this research field. This approach would enable ultra-sensitive label-free photonic integrated sensors which could be integrated along with other components in a single photonic chip, hence opening the route towards multifunctional photonic systems. For that, however, a suitable platform capable of integrating several photonic components such as waveguides, Bragg filters, resonators or Mach-Zehnder interferometers should be implemented. Promising mid-IR integrated platforms to carry out this task stand for Ge-on Si, suspended Si or SiGe alloys with tailored Ge concentration, among others [2-4]. This latter approach is expected to offer high versatility and broadband transparency [5], and important photonic building blocks such as low-loss waveguides and wideband Mach-Zehnder interferometers have already been demonstrated in the mid infrared [6, 7]. In spite of the progress achieved so far using SiGe alloys, there are still several open questions that require further exploration, such as the disclosure of the platform transparency bandwidth or the investigation of the nonlinear properties in the mid-IR, taking advantage from the absence of two-photon absorption [8].

Thus, we will present our latest results on the development of a novel mid-IR photonic integrated platform based on Ge-rich graded-index SiGe alloys with compact dimensions. Compact waveguides were fabricated in this platform, showing broadband and flat low-loss propagation of 2-3 dB/cm over a wavelength range from $\lambda = 5.5 \mu\text{m}$ to $8.5 \mu\text{m}$. Moreover, waveguide dispersion engineering was performed to obtain broadband tight mode confinement and flat anomalous condition in the mid-IR [9]. These waveguides show promising features to be used as mid-IR nonlinear optical sources exploiting the third-order nonlinearities for supercontinuum generation [10].

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