Towards telecom frequency comb generation in AlGaAs microrings

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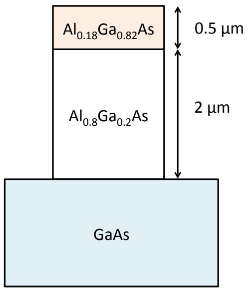
Optical frequency combs (OFCs) offer a unique way of generating coherent light over a broad spectral range and have revolutionized laser-based spectroscopy, making it possible to achieve an unprecedented precision in measurements. [1] Frequency combs can be generated in different ways, either using mode-locked femtosecond lasers, by using four-wave mixing (FWM) in highly nonlinear fibers [2], or by pumping a microresonator cavity made by a nonlinear material using a continuous-wave (CW) laser (see Fig.1). OFCs have numerous intriguing prospects for applications to optical communications, spectroscopy, frequency metrology, optical clocks and waveform synthesis [1, 3].

We aim at demonstrating FWM-based fully integrated frequency comb sources for the near infrared (NIR) spectral range that could be used as wavelength division multiplexed source for telecom and datacom coherent communication systems [4]. To this end we have designed bandgap engineered AlGaAs microrings, with special care for suppressing two-photon absorption and the related free carrier generation [5]. The simultaneous presence of strong quadratic and cubic response will permit for the first time to effectively generate a single frequency comb extending from the visible to the NIR.



(a)

(b)

Fig. 1 Waveguide structure (a) and planar bus-ring geometry for FWM-based frequency comb source (b).

With the ridge guiding structure sketched in Fig 1a, we fabricated the bus-resonator device of Fig. 1b by molecular-beam epitaxy, electron-beam lithography and ion etching. We resorted to this race-track geometry because it allows for a better compromise between technological constraints and critical coupling. Thank to its high nonlinear coefficient ($n_2 \approx 1.55\times10^{-13}$ cm^2/W at 1.55 um) the AlGaAs platform promises a considerable reduction in the power requirements of a WDM source, compared to other semiconductor materials such as silicon nitride. In other applications the simultaneous presence of strong quadratic and cubic nonlinearities could also permit, for the first time, to effectively generate a single frequency comb from the visible to the NIR.

Besides presenting and discussing our preliminary results, we will provide a comparison between the different material platforms for a frequency comb source in the optical telecom range, with a perspective view on the full optoelectronic integration of an electrically injected pump.

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