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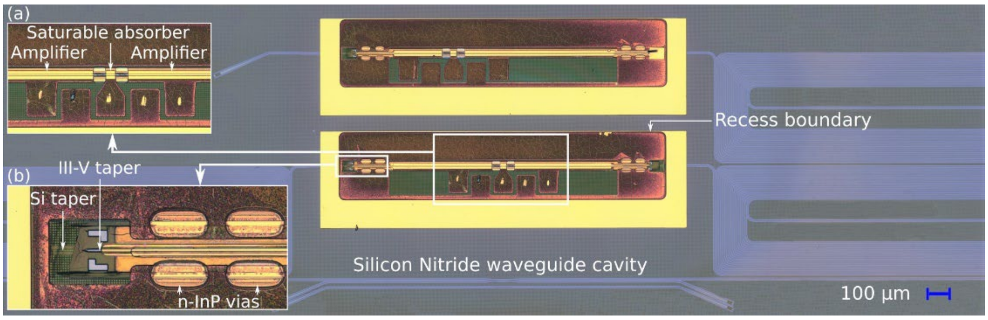
III-V-on-Silicon-Nitride Mode-Locked Lasers

In this work, we highlight our recent results on heterogeneously integrated III-V-on-silicon-nitride (Si3N4) modelocked lasers [1, 2]. In particular, we demonstrate a III-V-on-Si3N4 mode-locked laser with a sub-GHz repetition rate and unprecedented noise performance [1] as well as energetic pulsed lasers. In contrast to earlier reported III-V-on-Si mode-locked lasers [3], silicon nitride waveguides can routinely achieve ultra-low losses close to 1 dB/m and do not suffer from nonlinear absorption, paving the way for a new generation of improved on-chip mode-locked lasers

The low-noise comb laser employs a ring cavity and fabry-perot geometry, consisting of long silicon nitride spirals on top of a patterned silicon-on-insulator wafer, as shown in Fig. 1. Here, the 330 nm thick silicon nitride waveguides are defined using deep-UV lithography, permitting low-cost and high-volume wafer-scale manufacturing. We enable heterogeneous integration, by defining a recess locally defined in the 4.2 µm SiO2 top cladding using dry etching techniques. Furthermore, given the large refractive index difference between the silicon nitride waveguide and the III-V gain waveguide, an intermediate silicon taper is introduced to ensure efficient evanescent coupling.

This process relies on the kinetically controlled adhesion of an elastomeric stamp to pick devices from the source InP wafer and print them on the silicon nitride target chip. In contrast to bonding techniques, microtransfer printing allows for integrating a III/V coupon in a recess. Moreover, this approach supports massively parallel integration, enabling wafer-scale fabrication. After transfer printing, the coupon is post-processed to isolate a saturable absorber. Furthermore, vias are etched to access the n-InP layer and electrical contacts are added to enable biasing of the device.



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