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High power heterogeneously integrated mode-locked laser enabled by a booster amplifier

Integrated mode-locked lasers have been shown to be very interesting frequency comb sources with many potential applications, such as telecommunication and dual-comb spectroscopy. Over recent years, we have been working on integrating these comb sources on a silicon nitride chip using a special technique called Micro-transfer printing. Although these lasers show stable mode-locking performance, their performance has been limited in output power. In this talk, we demonstrate a III/V-on-SiN heterogeneously integrated mode-locked laser in a ring topology with a repetition frequency of 3 GHz. This repetition rate requires a long (~4 cm) extended cavity, which was created in a 300 nm silicon nitride sample using electron beam lithography. The heterogeneous integration is done by means of the versatile micro-transfer printing technique, which is employed to integrate not only the III/V amplifier, but also a silicon interposer layer, which is required to enable efficient evanescent coupling between the silicon nitride and the III/V semiconductor optical amplifier. With the same two-step micro-transfer printing approach, a booster amplifier is integrated at the same time, enabling us to boost the mode-locked laser output power by up to 9 dB, to 6 dBm average power on chip, with little to no deterioration of the original frequency comb.

References

[1] For more, see us at ECIO 2025 in Cardiff. Title of talk: High power heterogeneously integrated mode-locked laser enabled by a booster amplifier – S. Poelman, T. Reep, M. Billet, B. Kuyken

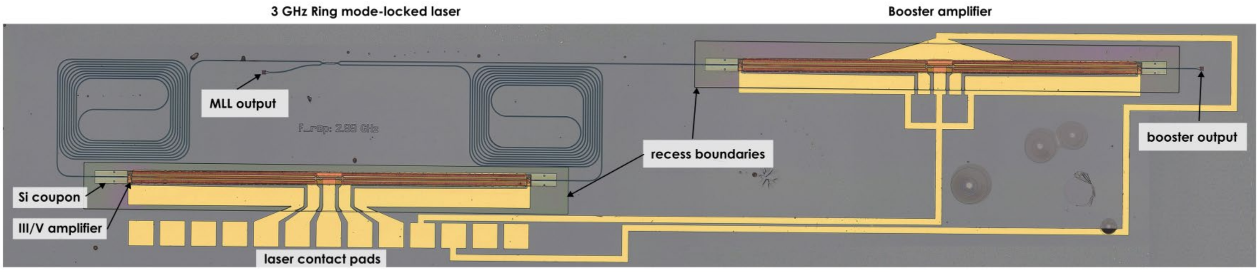

Figure 1: Microscope image of the 3 GHz mode-locked laser with a booster amplifier. Local openings in the oxide cladding enable the heterogeneous integration of the silicon intermediate coupons and the III/V amplifiers. The metal contacts are routed in a such a way that both amplifiers can be biased using a single probe.

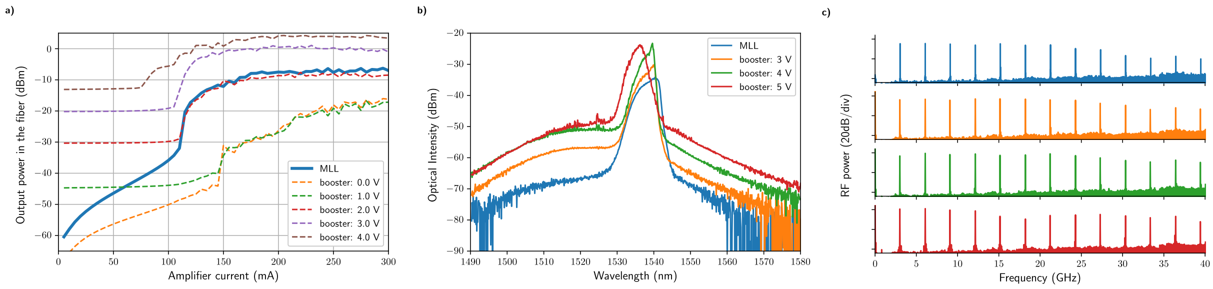

Figure 2: (a) LI curve comparing the output power as a function of MLL amplifier current, for the MLL output and the booster output, with different bias on the booster amplifier. (b) Optical spectra and (c) RF spectra for different bias on the booster amplifier.