



Passive Si₃N₄ photonic integrated platform at 1μm for short-range optical interconnects

Downloaded from: <https://research.chalmers.se>, 2025-12-04 22:50 UTC

Citation for the original published paper (version of record):

Hu, X., Ye, Z., Girardi, M. et al (2019). Passive Si₃N₄ photonic integrated platform at 1μm for short-range optical interconnects. 2019 Conference on Lasers and Electro-Optics Europe and European Quantum Electronics Conference, CLEO/Europe-EQEC 2019, Part F140-CLEO_Europe 2019. <http://dx.doi.org/10.1109/CLEOE-EQEC.2019.8872184>

N.B. When citing this work, cite the original published paper.

Passive Si₃N₄ Photonic Integrated Platform at 1- μ m for Short-Range Optical Interconnects

Xiaonan Hu¹, Zhichao Ye¹, Marcello Girardi¹, Pascual Muñoz², Anders Larsson¹, Victor Torres-Company¹

1. Department of Microtechnology and Nanoscience, Chalmers University of Technology, SE-41296 Göteborg, Sweden

2. Photonics Research Labs, Universitat Politècnica de València, c/ Camino de Vera s/n, 46021 Valencia, Spain

With the increasing development of cloud services, a large number of high-speed optical interconnects are needed in large-scale datacenters. Future datacenters will require short-range links with multi-Tb/s interconnect capacity, i.e. more than an order of magnitude higher than what is available today with vertical-cavity surface-emission lasers (VCSELs) or silicon photonics. In addition, large-scale datacenters will require longer (> 1 km) transmission links. Single-mode GaAs VCSELs today provide transmission speeds ~ 100 Gb/s, close to their fundamental limit. The recent development of high-speed GaAs VCSELs at a slightly longer wavelength of 1- μ m opens a path forward for low-energy dissipation, high-speed, long-reach optical interconnects because the chromatic dispersion and attenuation in fibers are significantly reduced compared to shorter wavelengths [1]. In order to meet the future capacity prospects, we envision the use of multi-wavelength GaAs VCSEL arrays at 1- μ m with advanced multi-fiber cables. This vision requires the use of a low-cost, low-loss passive integrated photonic platform for laser integration, multiplexing, and fiber interfacing, as sketched in Figure (a). Here, we present a silicon nitride (henceforth SiN) platform that can meet these requirements.

The motivation to choose SiN is its CMOS-compatibility and transparency in the near infrared region [2]. Several components are investigated, including 4-channel arrayed-waveguide-gratings (AWGs), microring resonators and inverted tapers. The AWG will serve as multiplexer and the inverted taper as the fiber interface. The ring resonators provide a viable approach to infer the linear loss of the new platform. The thickness of the Si₃N₄ waveguide core is chosen as 160nm to give sufficient confinement of the fundamental mode and low bending losses while staying within the fabrication tolerances. The devices are patterned using electron-beam lithography on Si₃N₄ low pressure chemical vapor deposited layers on an oxidized Si wafer. Transmission measurements using lensed fibers for butt-coupling are performed. A tunable single mode laser between 1020-1070nm is used as the light source. Figure (b) shows the transmission of the 900nm wide 1x4 AWG. The measured channel spacing and free spectral region (FSR) are 8 and 40nm, and the loss < 2 dB. Figure (c) shows a typical resonance of a 1300nm wide ring resonator with 200- μ m radius. The intrinsic Q averaged across the whole bandwidth is around 3 million, indicating waveguide losses < 0.2 dB/cm. The coupling loss of the inverted taper is for a 480nm wide tip. Figure (d) indicates coupling losses < 2 dB over the 30nm bandwidth for this optimized taper. With further work on a vertical coupler interface with < 2 dB coupling, we foresee an integrated Tx with < 6 dB loss, consistent with the VCSEL power levels and sensitivity target requirements for error-free operation ($\text{BER} < 10^{-12}$) in future multi-Tb/s interconnects.

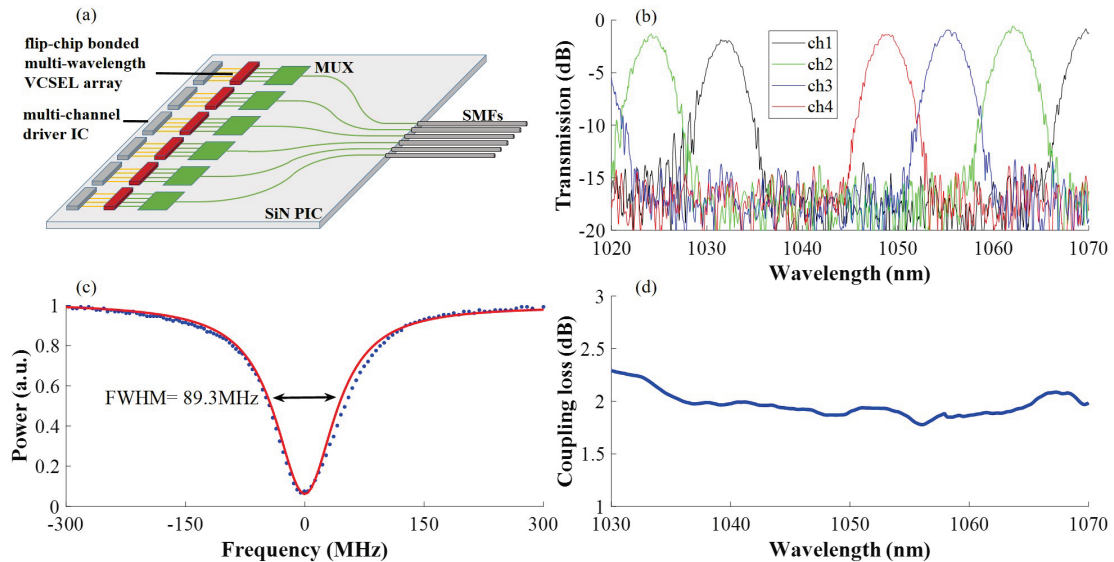


Fig. (a) Envisioned wavelength and space division multiplexing transmitter for VCSEL-based multi-Tb/s short-range interconnects. (b) Transmission of 900nm wide 1x4 AWG. (c) Typical resonance of a high-Q microresonator. (d) Coupling loss of optimized inverted taper with length 300- μ m.

References

- [1] E. Simpanen et al., "1060 nm single-mode vertical-cavity surface-emitting laser ...," *Electron. Lett.* **53**, 869-871 (2017).
- [2] A. Rahim et al., "Expanding the silicon nitride photonics portfolio with silicon nitride...", *J. Lightwave Technol.* **35**, 639 (2017).