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Passive Si_3N_4 Photonic Integrated Platform at 1-μm for Short-Range Optical Interconnects

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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 (> 1km) 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-μm 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 μm 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 Si_3N_4 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 Si_3N_4 low pressure chemical vapor deposited layers on an oxidized Si wafer. Transmission measurements using lensed fibers for butt-copling 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 < 2dB. Figure (c) shows a typical resonance of a 1300nm wide ring resonator with 200-μm radius. The intrinsic Q averaged across the whole bandwidth is around 3 million, indicating waveguide losses <0.2dB/cm. The coupling loss of the inverted taper is for a 480nm wide tip. Figure (d) indicates coupling losses < 2dB over the 30nm bandwidth for this optimized taper. With further work on a vertical coupler interface with <2dB coupling, we foresee an integrated Tx with < 6dB loss, consistent with the VCSEL power levels and sensitivity target requirements for error-free operation (BER < 10^{-12}) in future multi-Tb/s interconnects.

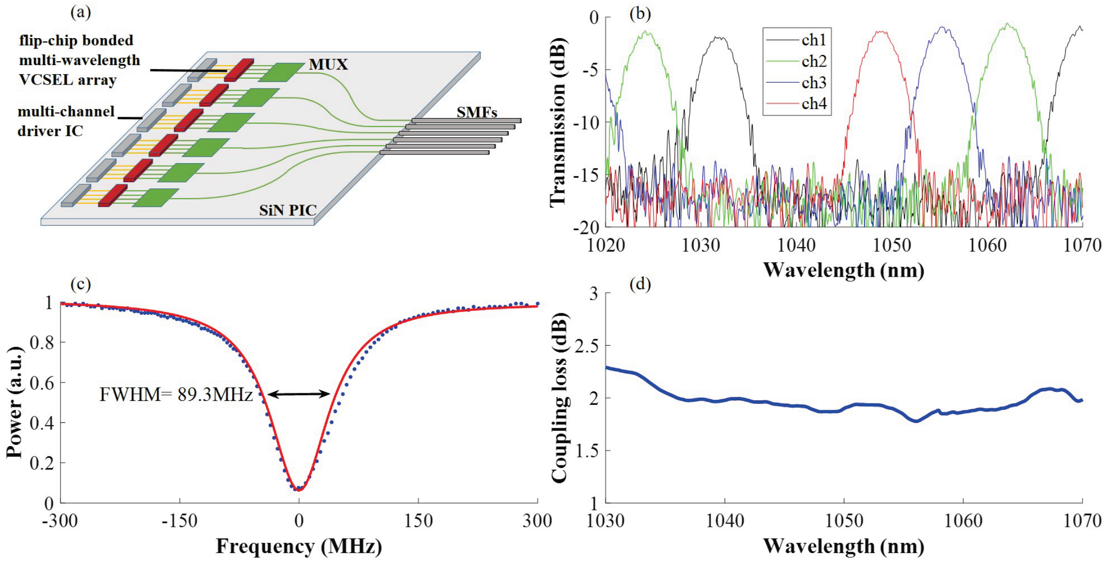

Fig. (a) Envisioned wavelength and space division multiplexing transmitter for VCSEL-based multi-Tb/s short-range interconnects. (b) Transmission of 900nm wide 1x4 AWG. (c) Typical resonance of a high-Q microresonator. (d) Coupling loss of optimized inverted taper with length 300-μm.

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).