High-speed VCSEL Photonics for Datacenter Networks

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A VCSEL is a key component in hyper-scale datacenter and supercomputer networks because of its fascinating properties [1, 2], which provides high-speed operations, low power consumption, small footprint, wafer-scale testing, low-cost packaging, ease of fabrication into arrays. Co-packaged optics (CPO) has been attracting much attention in datacenter and edge computing networks since CPO brings optics much closer to switch ASICs in a single package, so that power consumption could be saved by reducing the reach [3]. In particular, a VCSEL solution gives us high-speed and low-power consumption, which will meet requirements in CPO. We started the NICT project toward high-speed and low-power consumption CPO transceivers based on VCSEL array and multi-core fiber (MCF), which could deliver advantages on power consumptions and capacity density per module. In this paper, we present our recent activity on high-speed transverse-coupled-cavity (TCC) VCSEL array [4, 5] for co-packaged optics as shown in Fig. 1. A single-mode 1060nm metal-aperture VCSELs array shown in Fig. 2 is developed, which offers high-density I/O platform with a multi-core fiber. Figure 3 shows the scaling in CPO transceiver capacity per module. By further increase in the modulation speed of VCSEL and in a number of MCF, we expect a possibility of ultrahigh capacity CPO of beyond 1 Tbps.

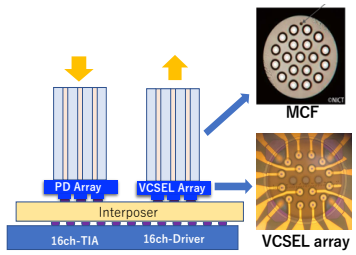

Fig. 1 CPO transceiver based on VCSEL array and MCF.

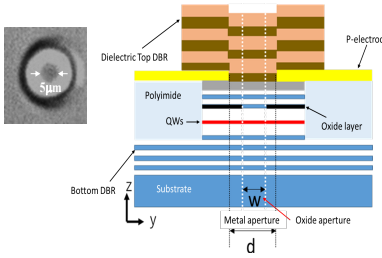

Fig. 2 Metal aperture transverse coupled cavity VCSEL.

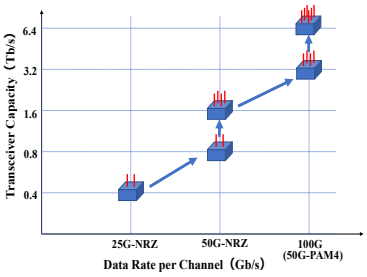

Fig. 3 Scaling toward Tbps capacity transceivers.

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References

1. K. Iga, "Vertical-cavity surface-emitting laser: Its conception and evolution," Jpn. J. Appl. Phys. 47(1R), 1-10 (2008).
2. F. Koyama, "Recent advances of VCSEL photonics," J. Lightw. Technol. 24(12), 4502-4513 (2006).
3. D. Kuchta et al., "Multi-Wavelength Optical Transceivers Integrated on Node (MOTION)," OFC 2019, M4D.6 (2019).
4. H. Dalir, and F. Koyama, "29GHz directly modulated 980nm vertical-cavity surface emitting lasers with bow-tie shape transverse coupled cavity," Appl. Phys. Lett., vol. 103, 091109-1-4, Aug. 2013.Appl. Phys. Lett. 103, 091109 (2013).
5. H. Ibrahim, A. M. A. Hassan, X. Gu, S. Shinada, M. Ahmed, F. Koyama, "1060nm Single-mode Metal-aperture VCSEL Array with Transverse Resonance and Low Power Consumption below 50 fJ/bit," ECOC 2021, Tu3D.5 (2021).