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16-ch 1060nm 2D VCSEL Array for Multi-core Fiber Transmission Toward Co-packaging Optics Transceivers

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1. Introduction

With the fast development of big date, the Internet of Things (IoT) and 5G mobile networking, edge datacenters which contain all the functions of datacenters with smaller scale become an important approach for high stability and low latency transmission. Conventional optics transceivers are no longer suitable because of large volume and high power consumption. Co-packaging optics (CPO) has been attracting much attention to solve this problem. Optical transceivers for CPO must be small enough and densely implemented near the ASIC chip. VCSELs play a key role for low-power transceivers[1), 2)] and are considered as a good choice.

In this paper, we present a single-mode 16-ch 1060 nm VCSEL array as a light source toward high-speed and low-power consumption co-packaging optics transceivers. To realize a high-density transmission with space-division multiplexing, the coupling between a VCSEL array and a multi-core fiber is considered.

2. Device structure

Figures 1(a) and 1(b) show the schematic of a 16-ch VCSEL array coupling to a multi-core fiber and top-view of a fabricated 16-ch VCSEL array. The spacing between adjacent channel is as small as 40 μm. The operation wavelength of the VCSELs here is 1060 nm for a low fiber dispersion and low loss in single-mode transmission in conventional single-mode fibers (SMF).

3. Results and discussions

The current-light output (IL) characteristic and lasing spectra of the 16-ch VCSEL array are shown in Fig. 2. The device shows single mode operation for the whole current range. The typical output power is 0.6 mW, which could be increased by a few times after optimizing the VCSEL top-mirror reflectivity. Power fluctuation comes from reflection at the polished substrate, which can be avoided. The low-loss coupling between VCSEL array and a SMF is important for the CPO transceivers. The main cause of the coupling loss is mismatching of mode field diameter (MFD) between VCSEL and SMF. In Fig.3, we show the calculated coupling loss between VCSELs with different MFD to an SMF with MFD of 9.2 μm. In our preliminary measurement, the maximum coupling efficiency is 3.0 dB, which is limited by the MFD mismatch of a fabricated array. We estimate the current VCSEL MFD is about 4 μm. We utilize intra-cavity metal-aperture structure[3)] that allows us to achieve single-mode operation even for large aperture sizes. It enables us to reduce the coupling loss to nearly zero.

4. Conclusion

A densely integrated 16-channel VCSEL array was demonstrated, which show good single mode characteristics at 1060 nm-band. A minimum of 3.0 dB coupling loss was obtained experimentally, which can be decreased to almost zero after optimizing the VCSEL MFD design. A bottom emitting VCSEL is also under developments, which enables flip-chip mounting for use in high-speed and compact CPO transceivers.

Acknowledgement:

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References

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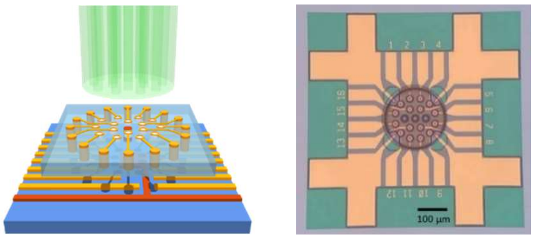
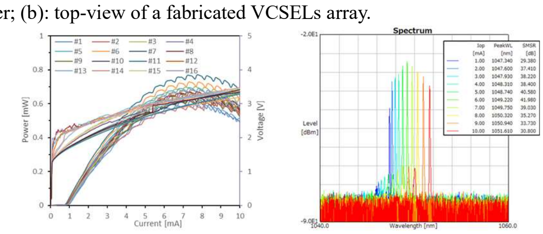


(a) (b)

Fig. 1: (a) The schematic view of a VCSEL array coupling to a multi-core fiber; (b): top-view of a fabricated VCSELs array.



(a) (b)

Fig. 2. (a) IL characteristics of all 16 devices in an array and (b) lasing spectra for a typical device with different currents.

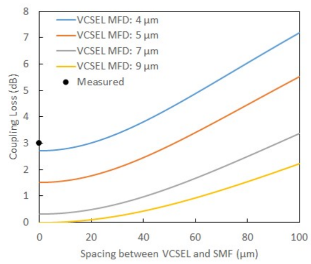


Fig. 3. Calculated/measured coupling loss from VCSEL to SMF.