

Record Low Power Consumption 1060nm Single-mode Intracavity Metal Aperture VCSEL with Transverse Resonance

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1.Introduction: Vertical-cavity surface emitting lasers (VCSELs) is a key component for datacenter networks due to their advantages such as low cost and low power consumption [1-2]. Recently, we found the intracavity metal aperture provides the transverse resonance for the bandwidth enhancement and for the transverse mode control [3-4]. In this paper, we obtained the enhancement of the modulation bandwidth with low power consumption thanks to the optical-transverse resonance. Eye opening was observed up to 40 Gbps NRZ. We demonstrate low power consumption 1060nm intracavity metal-aperture VCSELs with high-speed modulations of NRZ 40Gbps and PAM4 60Gbps in single-mode operations. The intracavity metal-aperture causes the transverse resonance which provides the modulation bandwidth-enhancement. We achieve a record low power consumption of less than 42 fJ/bit.

2.Results: The schematic structure and infrared image of a fabricated single-mode MA-VCSEL are illustrated in Fig.1 (a) and (b). Figure 1 (c) illustrates the L-I of MA-VCSEL so that the distance of the metal from the oxide aperture is as small as 1-2 μm . A single-mode operation was obtained in the entire current range as shown in Fig. 2(a). Although $f_{3\text{dB}}$ of C-VCSEL is 12.5GHz as shown in Fig. 2(b), the bandwidth for MA-VCSELs fabricated on the same wafer is over 22 GHz even at a low bias current of 0.9 mA. We also measured a large signal modulation (NRZ) at 40 Gbps NRZ as show in Fig. 2(c). The power consumption at $I_b=0.9\text{mA}$ is as small as 1.66 mW, corresponding to an energy efficiency of less than 42 fJ/bit. It is the record number ever reported.

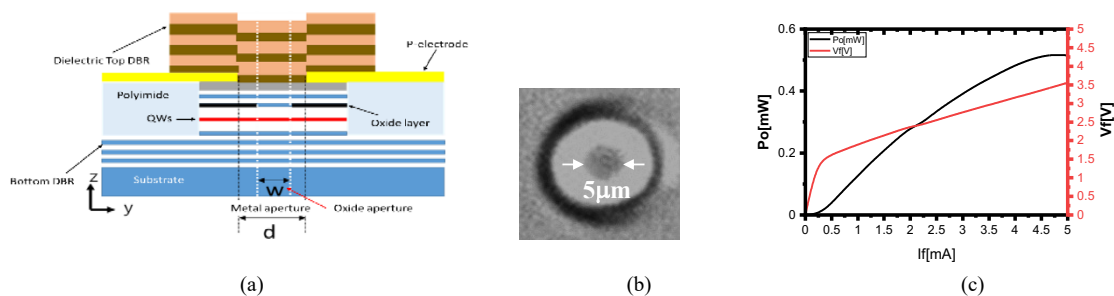


Fig.1 (a) Schematic of MA VCSEL, (b) Infrared image and (b) L/I characteristics.

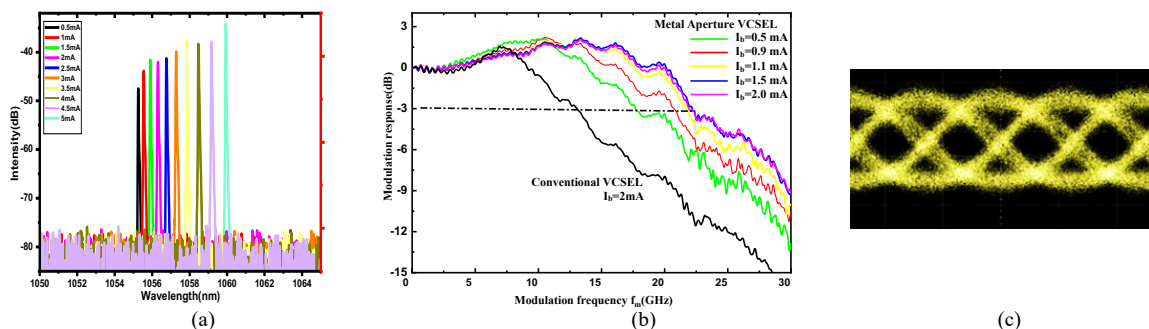


Fig. 2(a) Lasing spectra, (b) small signal response and (c) eye pattern at 40Gbps NRZ.

3.Conclusion: We demonstrated the high-speed and single-mode VCSEL with a record low power consumption. The bandwidth can be double thanks to the coupled cavity effect. Clear eye opening can be observed up to 40 Gbps (NRZ).

4. References

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