# High-speed Double Transverse Coupled Cavity VCSELs

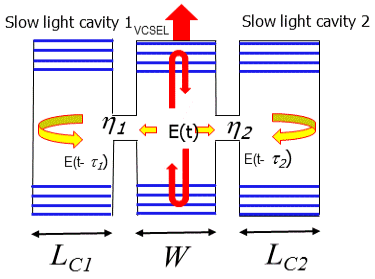
H. R Ibrahim[1], M. Ahmed[2] and F. Koyama[1]

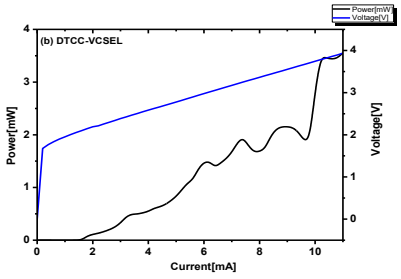
1 Laboratory for Future Interdisciplinary Research of Science and Technology, Tokyo Institute of Technology

4259-R2-22Nagatsuta, Midori-ku, Yokohama 226-8503, Japan

2 Faculty of Science, Minia University, Egypt

1. Introduction: VCSELs have the advantages of small packaging, low cost, ease of fabrication into arrays, small footprint, wafer-scale testing, and low power consumption [1,2]. Therefore, VCSELs are attracting much attention for use in data center networks and cost-effective radio over fiber (RoF) networks. VCSELs with bandwidth in the mm-waveband are required for Broadband RoF links to enable dense information transmission. The modulation bandwidth of VCSELs is restricted to less than ~ 20 GHz due to the limited intrinsic carrier-photon resonance (CPR). OFB has been used for increasing the modulation bandwidth of VCSELs. We demonstrate the enhancement of modulation bandwidth of a SM VCSEL with a passive optical-feedback cavity.
2. Structure of DTCC- VCSEL: The proposed structure of the TCC-VCSEL is schematically illustrated in Fig. 1. The VCSEL is laterally coupled with two external cavities through an oxide aperture.
3. Results and discussions.



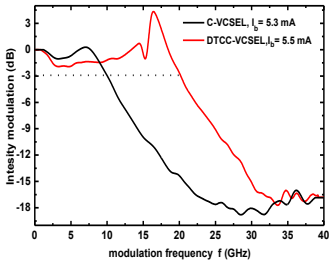




Fig.1. Schematic of DTCC-VCSEL Fig.(2) L-I curve for DTCC- VCSEL. Fig. 3. IM responses of C-VCSEL and DTCC-VCSEL.

Fig. 2. shows L-I curve for DTCC-VCSEL with dimension 3x3 μm$^2$ with external cavities dimensions 8x3 μm$^2$ and 7x3μm$^2$. L-I curve of C-VCSEL is smooth and the power increase linearly with injection current. On the other hand, L-I curves for DTCC-VCSEL are not smooth and many kinks appear due to the effect of photon photon resonance of OFB. The small-signal modulation response curves of DTCC-VCSEL are shown in fig.(3). C-VCSEL IM modulation response is measured for comparison. the modulation bandwidth of C-VCSEL is 10 GHzand the modulation bandwidth increased to 21GHz due to the coupling between VCSEL and external cavities.

4. Conclusions: The transfer function of IM response in VCSELs can be tailored by double transverse coupled cavities, which exhibit a large enhancement in the modulation bandwidth. The 3-dB modulation bandwidth can reach to 21 GHz, which is more than two times larger than a conventional VCSEL without optical feedback.

5. 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).