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Modulation Bandwidth Enhancement of Laterally-coupled Cavity VCSELs for Radio over Fiber Applications

HamedDalir, Akihiro Matsutani and Fumio Koyama

Precision & Intelligence Lab., Tokyo Institute of Technology

4529-R2-22 Nagatsuta, Midori-ku, Yokohama 226-8503, Japan

Email:dalir.h.ab@m.titech.ac.jp

1. Introduction

Recently, a radio over fiber technology has attracted considerable attention as an integration of wireless and optical systems that has been developed to offer broadband wireless services [1,2]. It is a challenge to develop ultra-high speed lasers operating in millimeter wave high frequencies. In this paper for the first time a compact lateral feedback resonator has been integrated with a VCSEL to enhance the modulation efficiency, which shows an enhancement of over 25dB beyond 26GHz.

2. Device Structure

Figure 1 illustratesthe schematic structure of our proposed 980nm coupled cavity VCSEL. Lateral optical confinement is formed using an oxide layer and a bowtie un-oxidized connection, which leads to a leaky traveling wave in the transverse direction. The end oxidized region makes the lateral optical feedback into aVCSEL. It isfigured out that the group velocity of lateral traveling light in a Bragg reflector waveguide can be reduced [3], thus we are able to shrink the optical feedback resonator. The total lateral length of the coupled cavities is below 30μm.

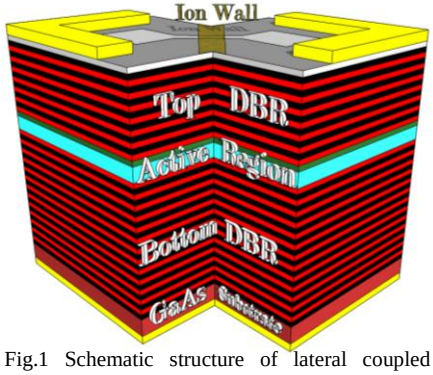

Fig.1 Schematic structure of lateral coupled cavity VCSEL.

3. Results

Figure 2 shows the calculated and experimental data of small signal response for conventional VCSEL and laterally-coupled cavity VCSEL. We could see multiple resonance peaks in the modeling and the experiment due to lateral optical feedback. Large enhancement in modulation amplitudes over 20dB can be experimentally obtained at resonances beyond 20GHz, which is also supported by the modeling.The modeling shows the position of resonances is dependent on the phase of feedback light as shown in Fig. 2. Figure 3(a) shows the position shift of resonances as a function of coupling strength and phase. Figure 3(b)shows the position ambulation as a function of feedback current while the VCSEL current is fixed at 10mA. From Figure 3 (a) and (b) we figured out that the resonance position periodically changes between 21.2 GHz and 25.5GHz by altering the feedback current. A difference in the experiment and modeling would come from the multi-mode operation of the present device.

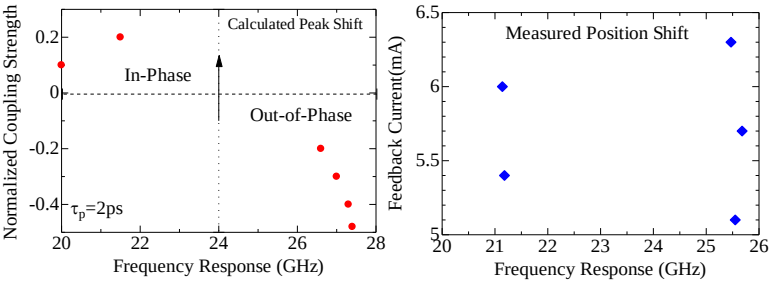

Fig.3 (a) Calculated resonance peaks as a function of coupling strength and phase and (b) experimental resonance peaks vs. feedback current, while the VCSEL current is fixed at 10mA.

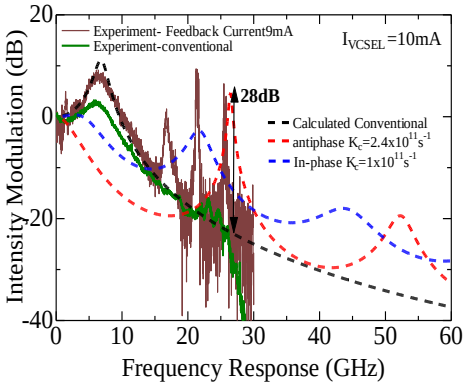

Fig.2 Calculated and Measured small-signal modulation response of 980 nm conventional VCSEL and lateral coupled cavity VCSEL.

4. Conclusion

We demonstrated the modulation enhancementof a lateral coupled cavity VCSEL for radio over fiber applications. An enhancement over 25dB in modulation efficiency beyond 25GHz is attained while two peaks at 21GHz and 26GHz could correspond to different phase conditions. Calculation results are in agreement with the experiment. It is anticipated to get 50GHz response with 25dB>enhancement.

References

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