シリコン基板上量子ドットレーザにおける 6 Gbps 直接変調動作

Direct Modulation (6 Gbps) in Quantum Dot Lasers on Silicon

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III-V semiconductor light sources hetero-integrated onto silicon is an excellent solution for the realization of the active silicon photonic devices and the photonic integrated circuits. For the integration methods, the wafer bonding technology provides an effective and simple way compared to the heteroepitaxial growth method, which is usually limited by the material properties such as lattice-constant mismatch. We have integrated InAs/GaAs quantum dot (QD) lasers [1] on silicon substrates by both direct bonding [2] and metal bonding [3], and demonstrated that the bonded lasers have comparable pulsed-pumped performances as for the as-grown lasers. However, in order to realize the low-power-consumption and compact communication system, the direct-modulated lasers are more desired compared to the use of the external modulators. In this study, we demonstrated the first direct modulation experiment in QD lasers on silicon.

In the fabrication, both the InAs/GaAs QD laser wafer and silicon wafer were first deposited with gold as the bonding intermediate layer, and then the laser were integrated onto silicon by metal bonding and the layer-transfer method. A 4-μm-wide ridge structure was introduced on the bonded laser for the lateral current confinement. The bonded laser was then manually cleaved into a 600 μm × 500 μm chip, which was assembled on a submount for the following modulation measuring. Fig. 1 shows the cross-sectional SEM image of the bonded laser, where the laser is firmly bonded on silicon with the bonding metal. Fig. 2 shows the room-temperature laser output power and applied voltage versus injection current of the 600-μm-long bonded laser under continuous-wave pumping. The clear kink indicates a lasing threshold current of 130 mA, and the inset in Fig. 2 gives electroluminescence spectra from the device at currents of 180 mA, in which the room-temperature lasing is observed at 1.3 μm. Fig. 3 shows the measured eye diagram for the direct-modulated bonded laser with a bit rate of 6 Gbps at a bias current of 180 mA.

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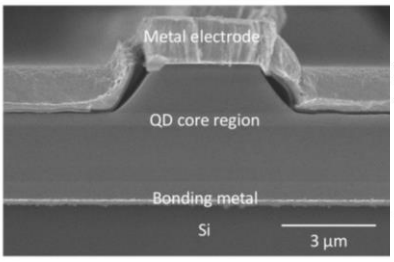

Fig 1. Cross-sectional SEM image of the QD laser on the silicon substrate by metal bonding.

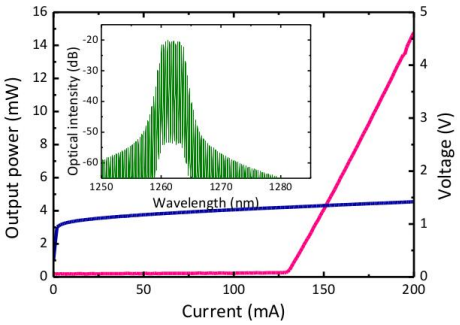

Fig 2. Room-temperature L-I-V curve and (inset) electroluminescence spectra of the 600-μm-long bonded laser under continuous-wave pumping,

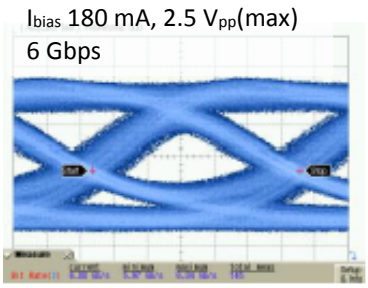

Fig 3. Eye diagrams of a directly modulated bonded QD laser at 6 Gbps.

References

[1] Y. Arakawa and H. Sakaki, Appl. Phys. Lett. **40**, 939 (1982).
[2] K. Tanabe, K. Watanabe, and Y. Arakawa, Sci. Rep. **2**, 349 (2012).
[3] Y. H. Jhang, K. Tanabe, S. Iwamoto, and Y. Arakawa, IEEE Photon. Technol. Lett. **27**, 875 (2015).