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金属ストライプを介した接合法によるsilicon-on-insulator基板上電流注入型InAs/GaAs量子ドットレーザ

Electrically Pumped InAs/GaAs Quantum Dot Lasers on Silicon-on-Insulator Substrate by Metal-Stripe Wafer Bonding

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Silicon photonic, the most attractive technology for the industrial-scale fabrication of the photonic integrated circuits (PICs), is promising for use in high-speed optical components for data communications and networking. Among all silicon photonics, the active silicon photonic device functions as an efficient light source for optical application, whereas the fabrication of active device is a challenge due to the indirect bandgap of silicon. III-V semiconductor with the nature of direct bandgap is suitable for achieving the active silicon photonic device compared to other materials. Furthermore, quantum dot (QD) laser [1] is the most powerful light source among all kinds of III-V semiconductor due to its properties of low lasing threshold current density, temperature insensibility and large modulation bandwidth. To realize the active silicon device with QD laser, wafer bonding technology [2-4] provides a simple method of integrating two different wafers even with large lattice-constant mismatch. The performance of bonded device is close to the ones homoepitaxially grown on lattice-matched III-V substrates. We have reported QD lasers on silicon via metal-mediated bonding method [4] with merits of simple fabrication, strong bonding strength, and good electrical properties. However, it is limited to achieve the optical mode evanescently coupled from active layer to Si waveguide. In this report, we introduce metal-stripe bonding method [5], which applies metal strips as the intermediate layer, providing hermetic bonding and simple implementation of back-side electrodes. The QD lasers are successfully integrated with silicon-on-insulator (SOI) wafers by directly bonding metal stripe and semiconductor without any alignment technology.

Fig. 1 shows a schematic structure and a SEM cross-sectional image of the bonded laser, which shows the laser structure is bonded on metal strips. We assume the current can be uniformly distributed due to the high conductivity GaAs bonding layer. A Si rib structure is also introduced in this work for the evanescent coupling to Si waveguides in the future. Fig. 2 shows the performance of the laser with pulsed injection current under room temperature. According to the assumptive current flow, we can estimate that the threshold current density is 880 A/cm^2, and the spectrum shows the lasing wavelength of 1270 nm.

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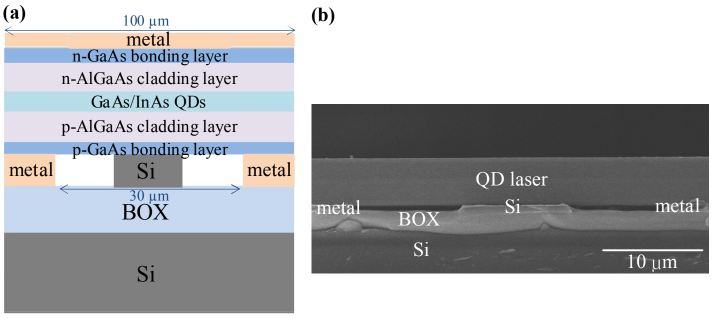

Fig. 1: Cross-sectional (a) schematic diagram and (b) SEM image of the QD laser on SOI substrate by metal-stripe wafer bonding.

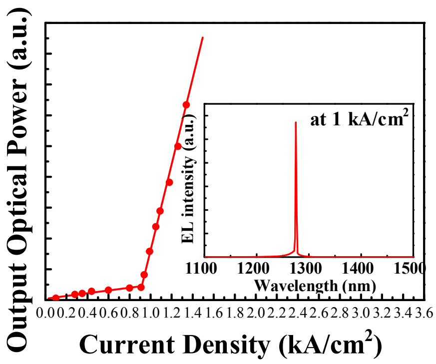

Fig. 2: L-*I* characteristics of the bonded laser with pulsed injection at room temperature, and the inset shows the lasing spectrum at 1 kA/cm^2.

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