# 1.9 ㎜長量子ドットレーザのシリコン基板上への転写プリント集積

## Transfer printing of a 1.9-millimeter-long quantum dot laser on a silicon substrate

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The silicon photonics platform is widely used in telecommunications but lacks efficient light emitters. Among various light sources, III-V quantum dot (QD) lasers [1] are highly attractive to be integrated into silicon photonics due to their low threshold and high-temperature operation stability. So far, various integration techniques for QD lasers, such as wafer bonding [2], direct epitaxial growth [3] and transfer printing [4-5], have been investigated. Transfer printing is a process by which completed optical devices can be transferred from their original substrate onto an optical circuit in a pick-and-place manner using an elastomeric stamp. However, transferring a few millimeters long laser devices is difficult due to their fragility, as they are often made of sub-micron thin films. So far, the transfer of 1.2 mm long InP quantum well lasers on SiN has been reported [5]. Here, we report the transfer printing of a 1.9 mm long InAs/GaAs QD laser over $SiO_2$ on a Si substrate.

The lasers are fabricated on a GaAs substrate by adhesive bonding an InAs/GaAs QD wafer and a commercial GaAs substrate using Fox-15. After curing, the Fox-15 layer can be used as a sacrificial layer. After patterning the QD lasers with standard lithography processes, they are encapsulated with photoresist for etching the sacrificial layer with vapor HF, which permits their release from the GaAs substrate. The lasers are picked up by a PDMS stamp and placed on the Si substrate. We slide the Si substrate horizontally with respect to the stamp to release it. This technique increases the success rate for transfer printing millimeter long devices. Figure 2 shows the transferred laser's L-I characteristics. For a pulsed operation at room temperature, we observed 82 mA threshold current and 1259 nm lasing wavelength.

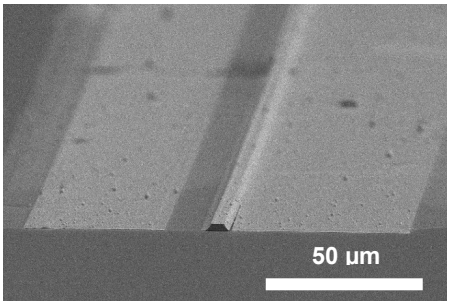


Fig. 1) SEM photo of a transfer printed laser

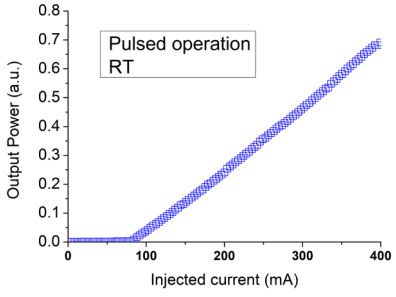


Fig. 2) L-I characteristics of the transfer printed laser

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