

InAs Quantum Dot Laser Diodes Grown on on-axis Silicon

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Self-assembled InAs quantum dots are a promising light source for silicon photonic devices with low power consumption and superior temperature-dependent performance. Lasers employing quantum dots as the active region demonstrated the lowest threshold current densities and highest lasing temperatures of any semiconductor laser diodes [1-2]. Recently, integrating InAs quantum dot lasers onto silicon has been actively investigated for large scale/low cost fabrication and photonic integrated circuits, and showed high performance lasing at 1.3 μm with low threshold current (16 mA) and high output power (176 mW) at room-temperature, high operating temperature (119 $^{\circ}\text{C}$), and improved reliability (mean-time to failure of ~ 4600 hours) [3-4]. This improved lifetime was mainly enabled by the fact that, compared to conventional quantum well technology, quantum dots are much less sensitive to high density of non-radiative defects ($2\text{-}3 \times 10^8 \text{ cm}^{-2}$) that occur during III-V growth on silicon. These 1.3 μm InAs/GaAs lasers were grown on off-cut ($\sim 6^{\circ}$) silicon

In this invited talk, we will present recent progress on 1.3 μm InAs/GaAs lasers grown on on-axis silicon wafers, which will enable this technology to be more compatible with standard silicon processing. To minimize formation of high defect densities that arise from III-V growth on on-axis silicon, two approaches were taken; 1) pseudomorphic GaP on Si and 2) V-groove patterned silicon. The InAs quantum dot laser diodes grown on GaP/Si template demonstrated promising results, showing high continuous wave lasing up to 90 $^{\circ}\text{C}$. Also, the lasers grown on V-groove patterned silicon showed relatively low threshold current of 45 mA under room-temperature continuous wave operation. Note that this is the first demonstration of InAs quantum laser diodes epitaxially grown on on-axis silicon, operating above room-temperature under continuous wave mode. We expect that the device performance could be further improved by optimizing the initial GaAs buffer growth conditions and by reducing the defect densities below $\sim 10^7 \text{ cm}^{-2}$.

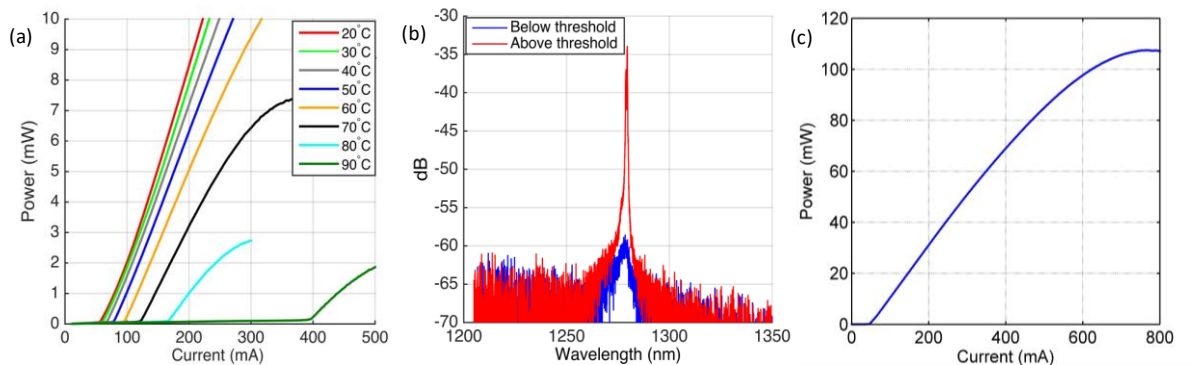


Figure 1 (a) temperature-dependent L-I curves and (b) laser spectra from InAs quantum dot lasers on on-axis GaP/Si substrates, (c) L-I curve measured at room-temperature continuous wave operation for a laser diode grown on V-groove patterned on-axis silicon.

References:

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