InAs/GaAs quantum dot lasers on exact GaP/Si (001)

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III-V quantum dot lasers grown on silicon are proving to be a promising light source for silicon photonics [1]. Previous demonstrations have relied on intentionally offcut silicon substrates to suppress antiphase domains from III-V on silicon heteroepitaxy, while exact on-axis silicon substrates are needed for compatibility with CMOS process flows. We report the first demonstration of an electrically pumped quantum dot laser grown on exact silicon substrates without offcut. The epitaxial laser stack was grown on a GaP/Si (001) template provided by NAsP III-V GmbH, consisting of a 775 µm thick (001) on-axis p-doped Si substrate, with 200 nm thick n-doped Si homo-epitaxial buffer and a subsequent 45 nm thick n-doped GaP nucleation layer. An InAs quantum dot laser embedded in a GaAs/AlGaAs GRINSCH waveguide was then grown in MBE. The active region consisted of seven stacks of InAs quantum dot layers (2.75 MLs deposited at 0.11 ML/s, V/III ratio of 35) embedded in 8 nm $In_{0.15}Ga_{0.85}As$ quantum wells, which were separated by partially p-doped GaAs barriers. The same active structure was also grown on a GaAs substrate for comparison, both of which were concurrently processed into deeply etched ridge waveguide lasers with varying stripe widths. Fig. 1a shows a photoluminescence (PL) comparison of the two as-grown laser structures, showing similar peak wavelengths while the intensity of the laser on GaP/Si is ~60% that of on GaAs. Fig. 1b shows room temperature continuous wave (CW) light-current (LI) comparisons of 1mm long by 7 µm wide ridge lasers on GaAs (I_{th} = 44 mA) and on GaP/Si (I_{th}=105 mA), both with as-cleaved facets. CW lasing spectra measured from a device on GaP/Si is shown in Fig. 1c, confirming a lasing wavelength of ~1280 nm past lasing threshold.

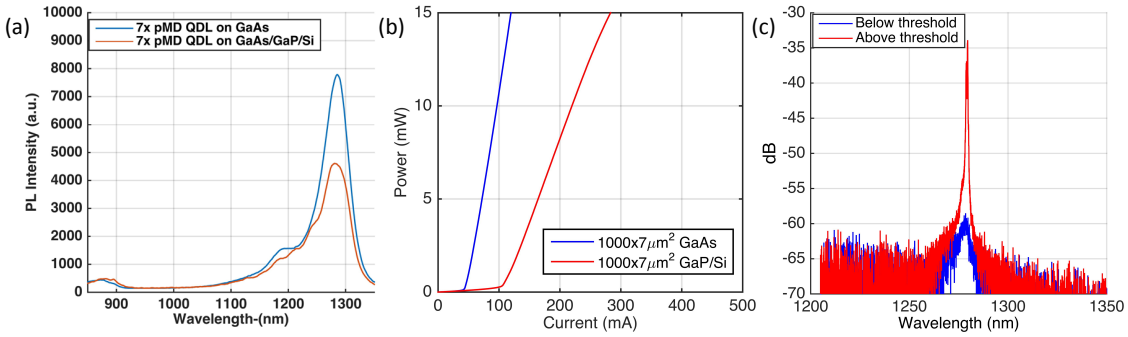

Figure 1: Room temperature PL (a) and LI comparisons (b) of lasers on GaAs vs on GaP/Si. c) Optical spectra of a laser on GaP/Si below and past threshold.

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