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

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The silicon photonics field is advancing rapidly, with many new devices demonstrated recently [1]. Demonstrations have shown significantly improved performance that is now approaching that of devices on native InP substrates. In addition to the many passive devices, including AWGs, isolators, and circulators, active devices including lasers, modulators, amplifiers and photodetectors are reaching higher levels of integration. Over 400 devices have been integrated onto a single waveguide for applications such as integrated transmitters for datacom and telecom, true time delay PICs for phased array radars, and LIDAR.

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. However, exact on-axis silicon substrates are needed for compatibility with CMOS process flows. We recently reported the first demonstration of an electrically pumped quantum dot laser grown on exact silicon substrates without offcut. The seven layers of quantum dots were grown on a GaP/Si (001) template with MBE. The same active structure was also grown on a GaAs substrate for comparison. 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.

There are five reasons quantum dot lasers may finally replace quantum well lasers: 1) reduced sensitivity to dislocations (important for growth on Si), 2)higher temperature operation, 3) low threshold, 4) reduced reflection sensitivity, 5) reduced sensitivity to surface recombination, allowing smaller, lower power lasers. A comparison of QW and QD lasers will be summarized in the presentation.

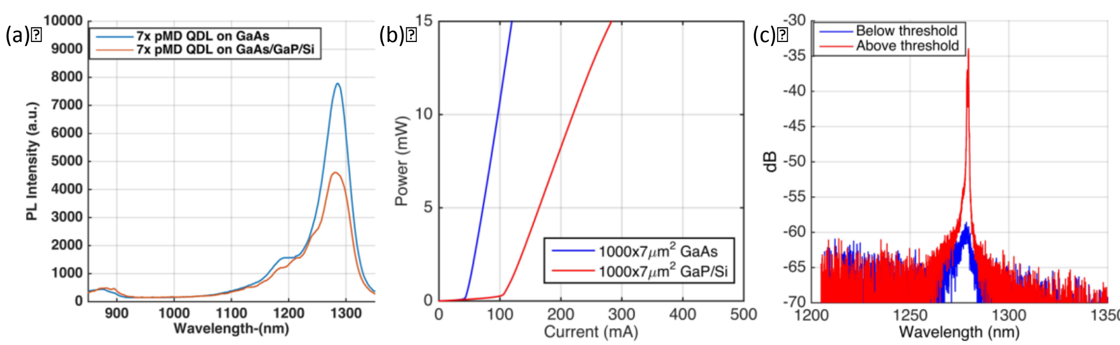

Figure 1: Room temperature PL (a) and LI comparisons (b) of lasers on GaAs vs on GaP/Si. c) Optical spectra of a laser on GaP/Si below and past threshold.

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