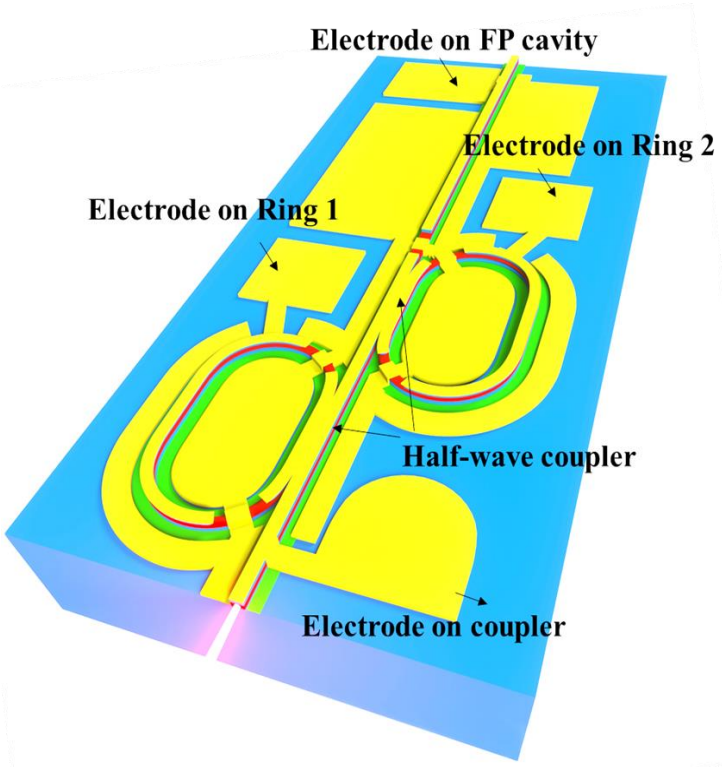
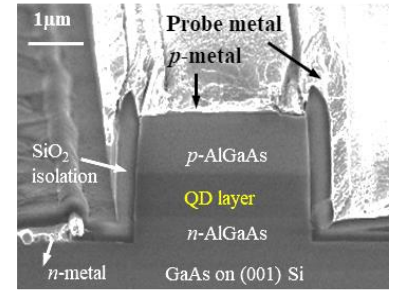
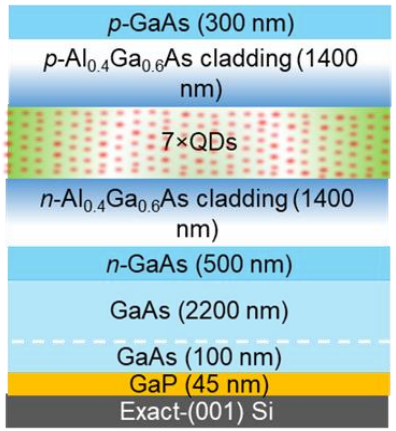
First demonstration of tunable single mode laser grown on Si

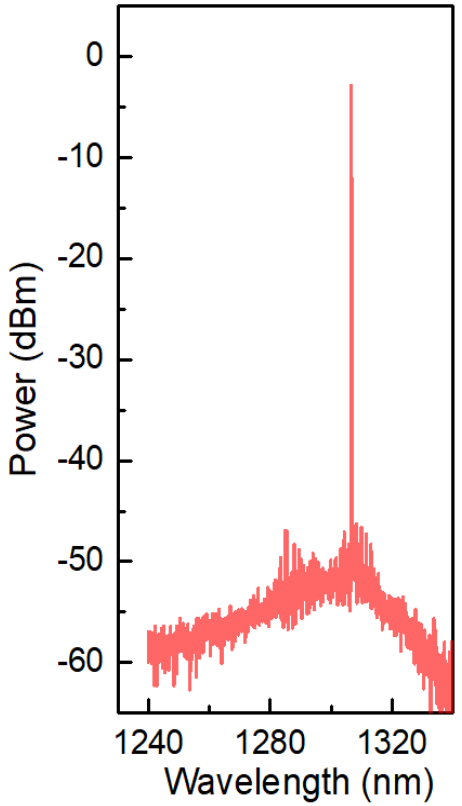
First demonstration of the tunable single mode laser that is directly grown on CMOS compatible Si substrate, no regrowth/EBL patterning required

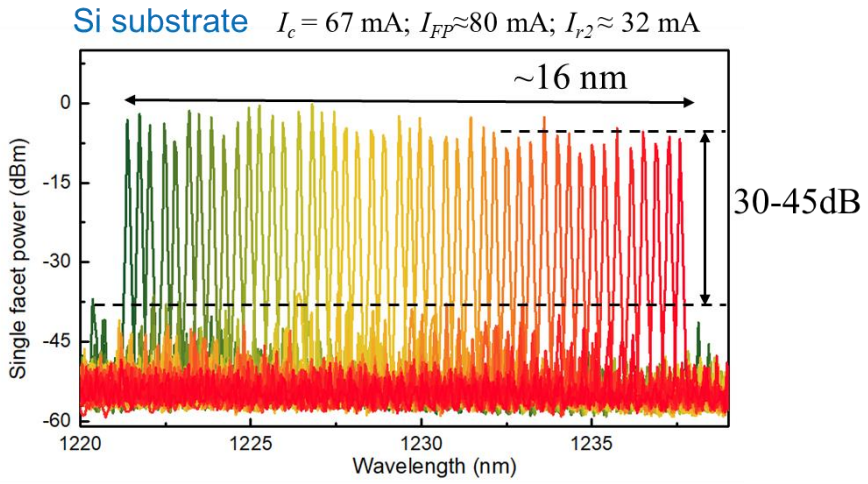
- 16 nm tuning range for devices on Si and 14 nm tuning range for devices on GaAs
- Maximum SMSR of 45 dB and exceeding 2.7 mW per tuning wavelength

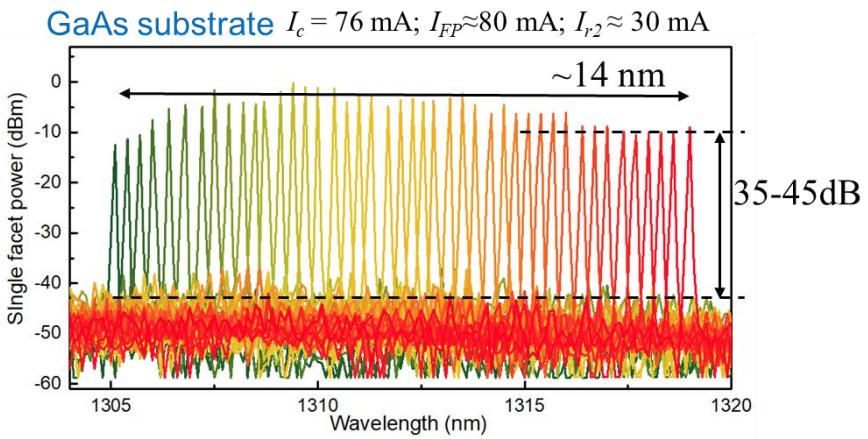








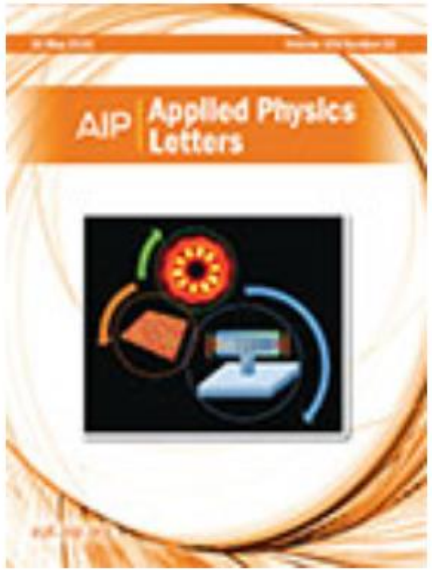


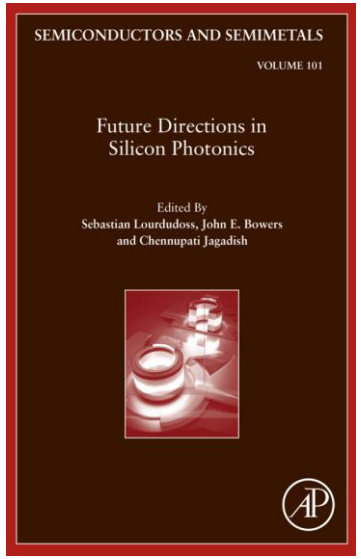


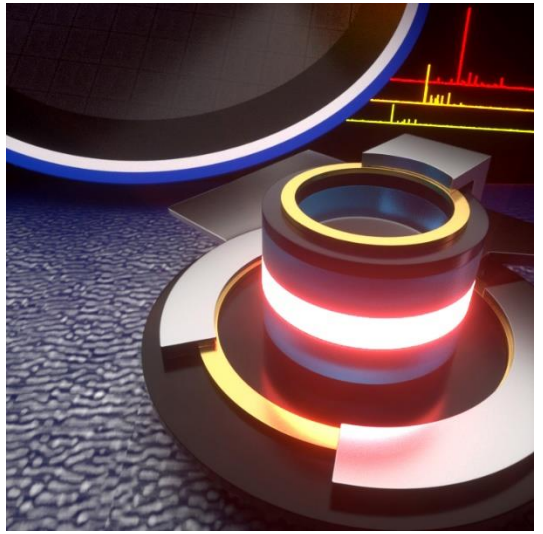
Y. Wan, *et.al*, "Tunable quantum dot lasers directly grown on Si", Optica, accepted

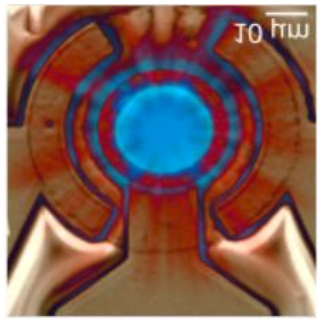
High performance QD micro-ring laser on (001) Si

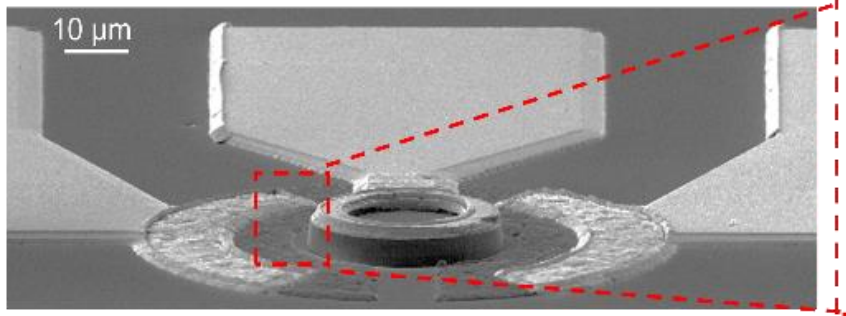
- Series of work has been selected as journal/book covers for 4 times
- Continuous-wave lasing up to 100°C, T_o of 175 K, 3dB bandwidth of 6.5 GHz
- Submilliamp threshold down to 0.6 mA, single-mode operation near 1.3 μm

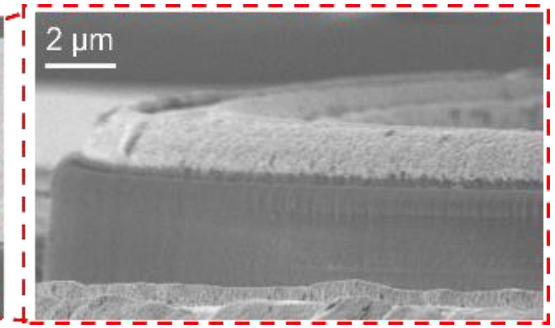


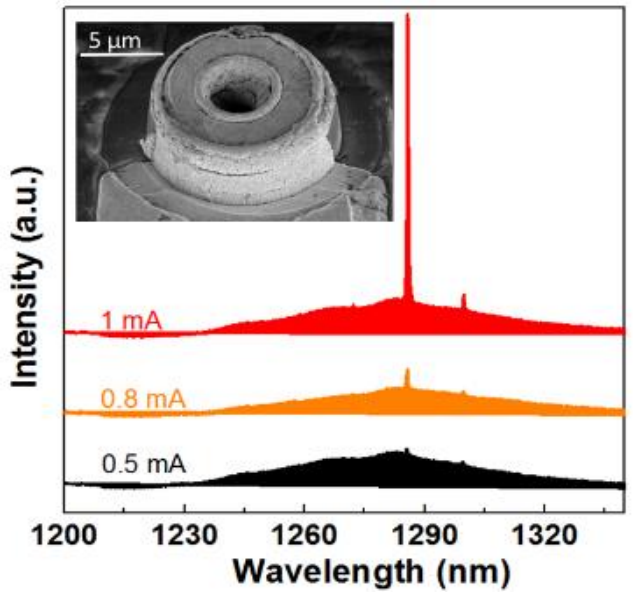








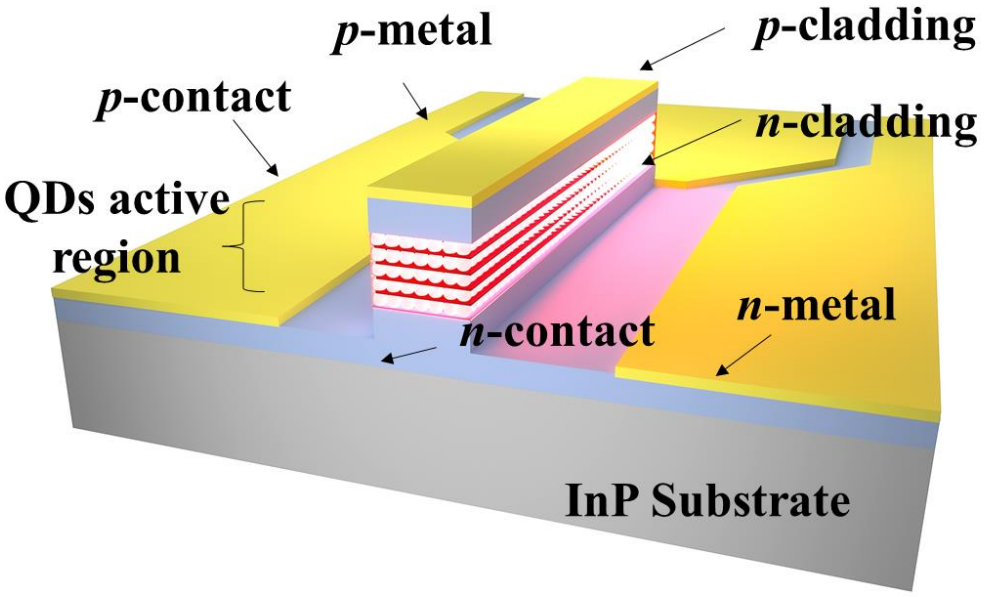


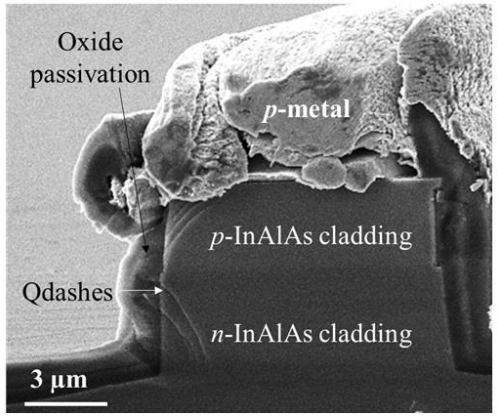


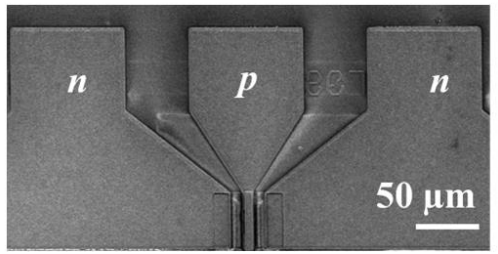
Y. Wan, *et.al*, "Quantum dot microcavity lasers". Future Directions in Silicon Photonics (2019): 305.

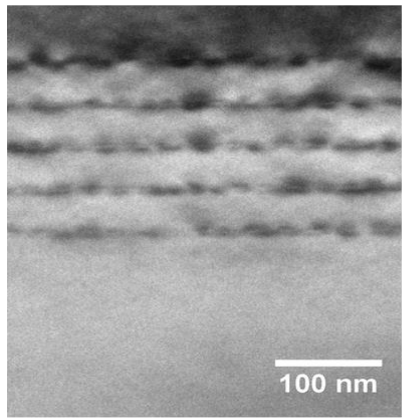
Low-dark current 1.55 μm InAs quantum dash waveguide photodiodes

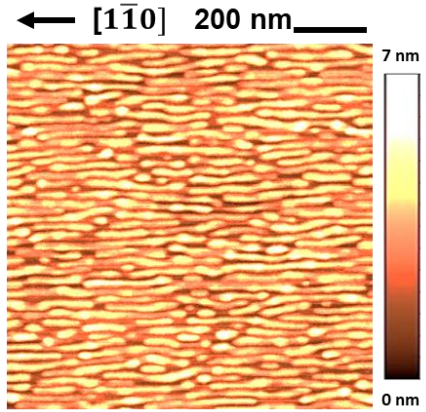
- Clear eye opening up to data-rate of 10 Gbit/s
- Ultra-low dark current of 5pA @ -1 V, five orders of magnitude lower than the competing Ge PDs and comparable to state-of-art InGaAs PDs.

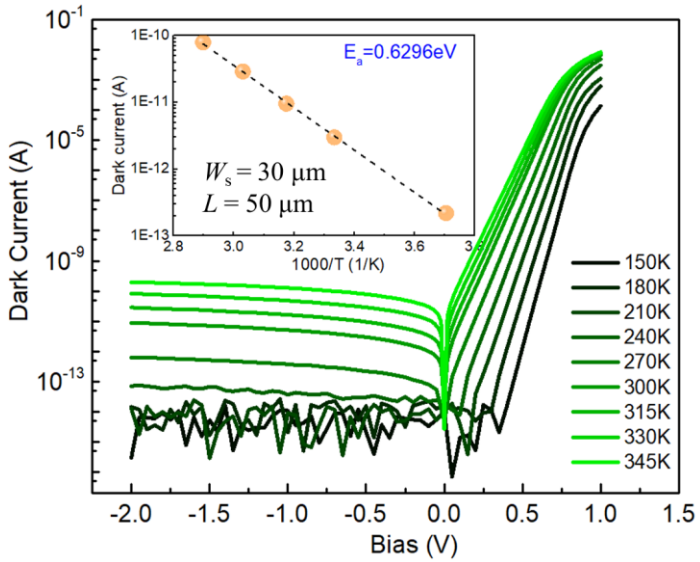






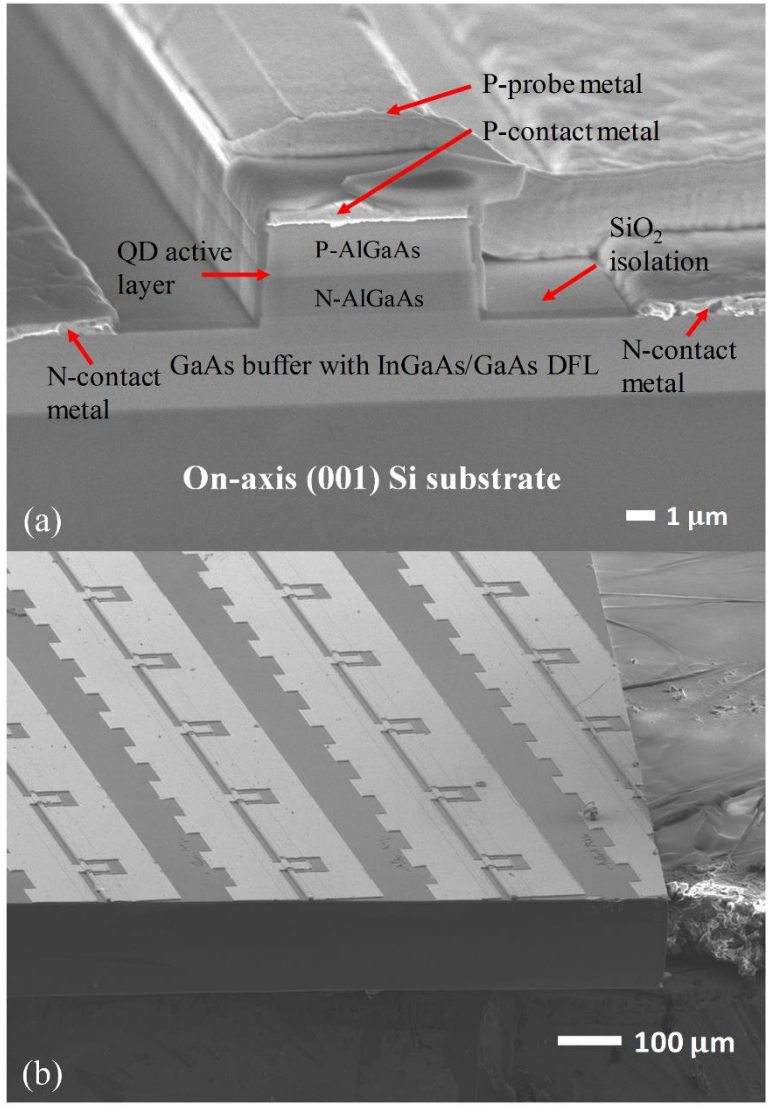




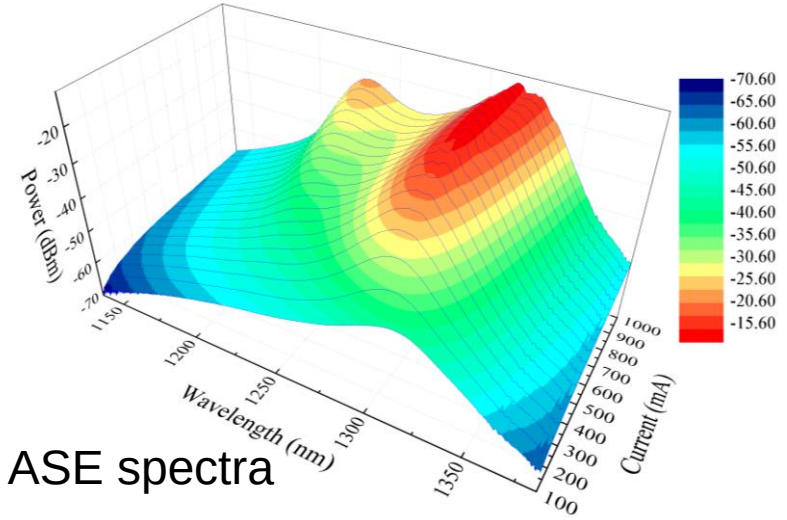


Yating Wan, *et.al*, "Low-dark current 1.55 μm InAs quantum dash waveguide photodiodes", plan to be submitted to *ACS photonics*

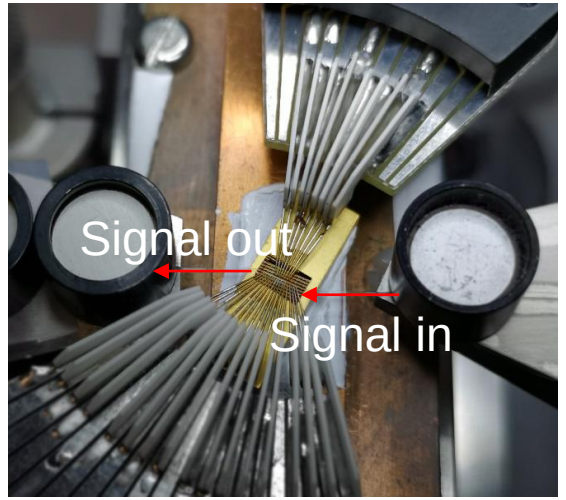
QD SOA grown on Si with 39dB gain,>100nm amplification bandwidth



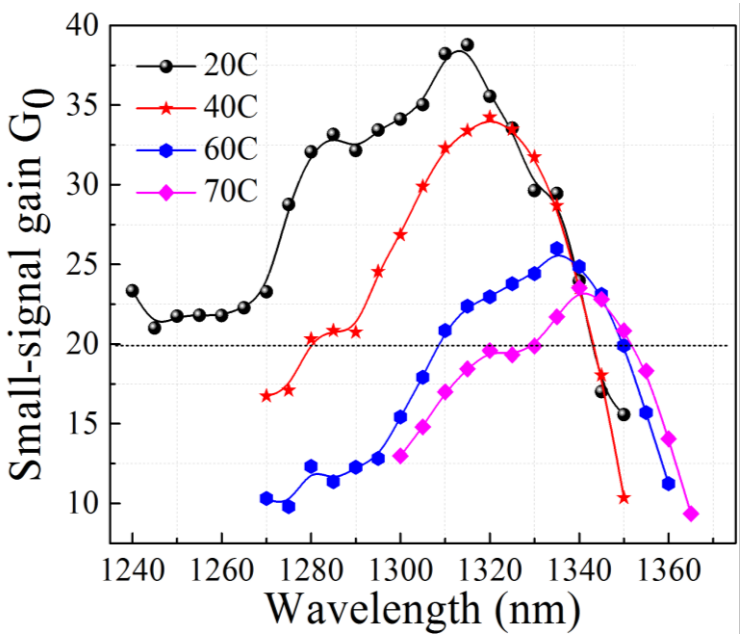
Device SEM photographs



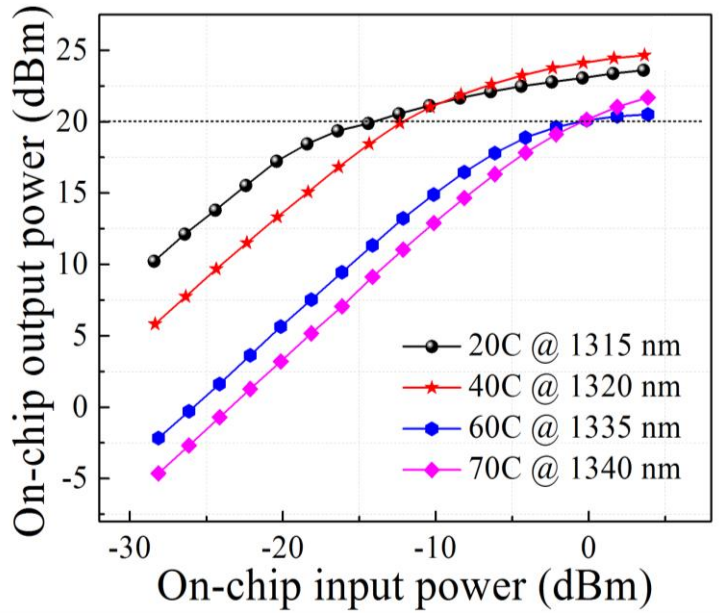
ASE spectra



Test setup



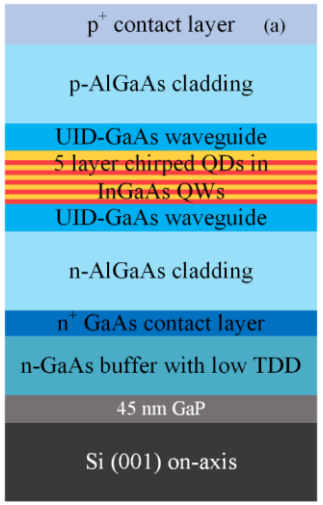
Gain vs wavelength & temperature

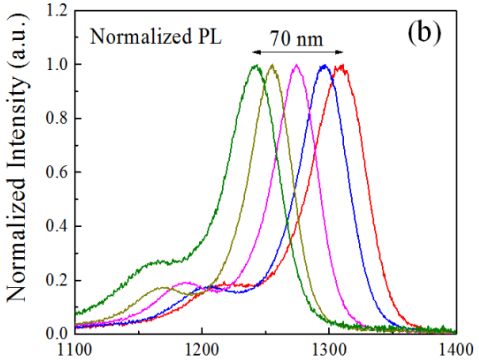


P_{out} vs P_{in} & temperature

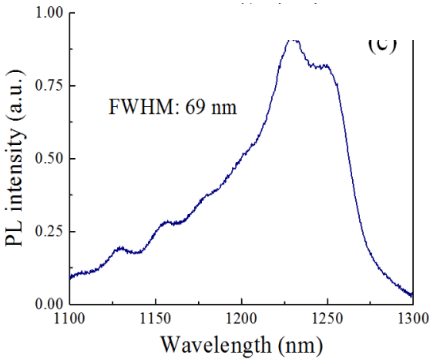
S. Liu, *et.al*, "High-Performance O-band Quantum-Dot Semiconductor Optical Amplifiers Directly Grown on a CMOS Compatible Silicon Substratei", *ACS photonics, 2019*

20 GHz mode locked QD laser grown on Si

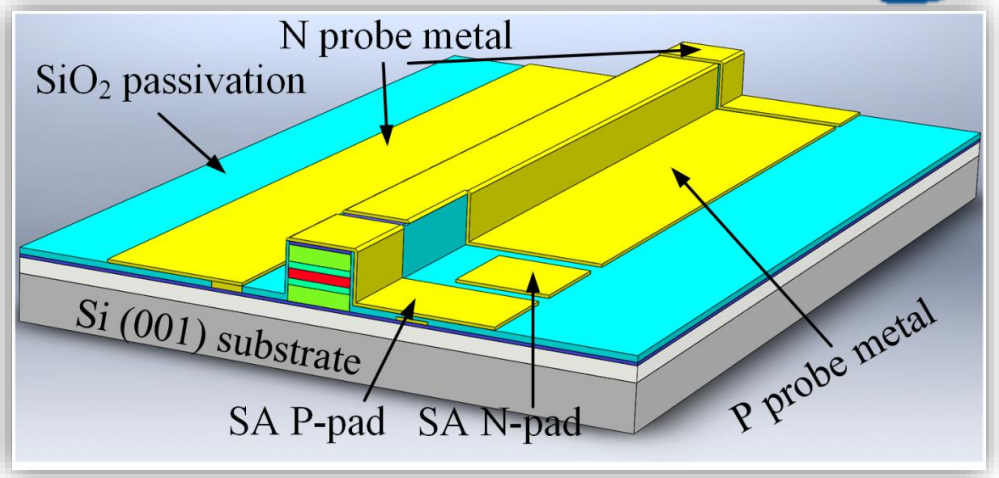




PL emission spectra of a single InAs DWELL layer with different InGaAs thicknesses in a test run

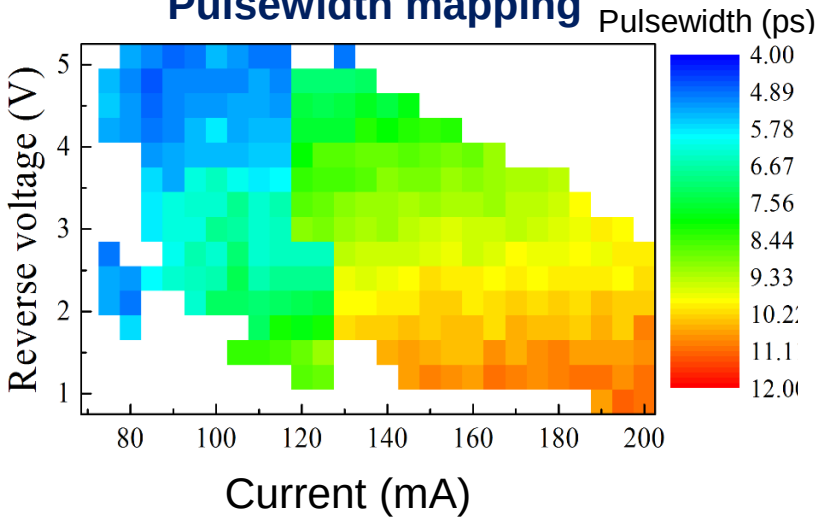


PL spectrum of the material used.

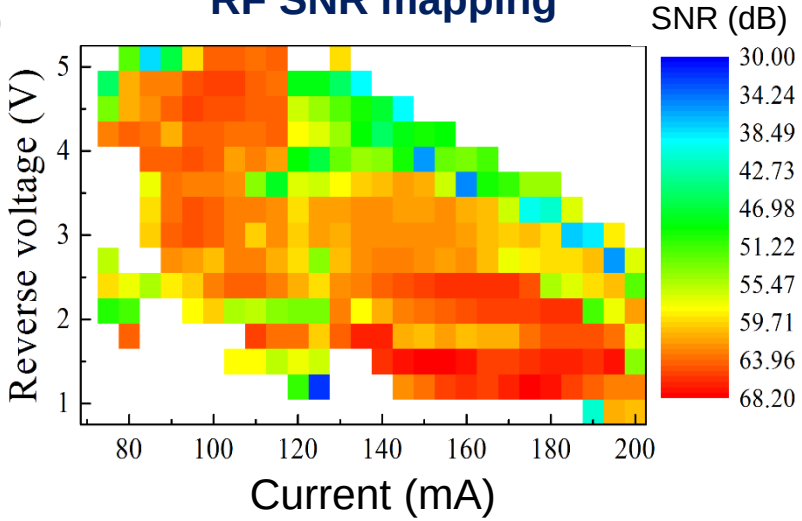


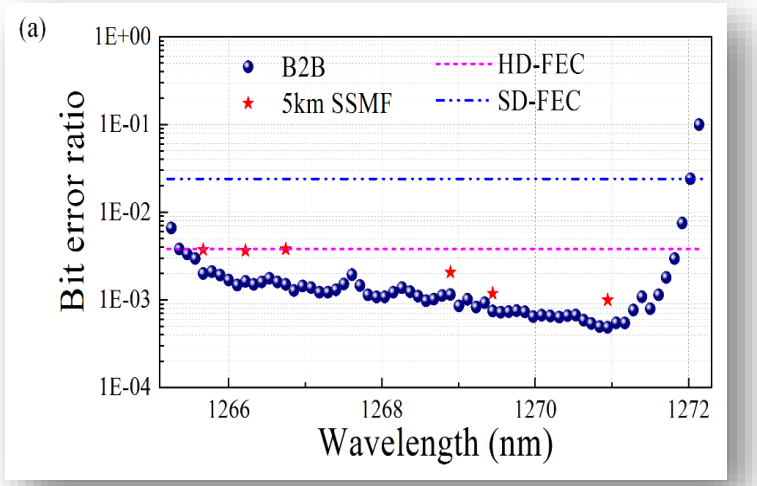
4.1 Tbps 64-wavelength 32 Gaud PAM-4 transmission

Pulsewidth mapping



RF SNR mapping

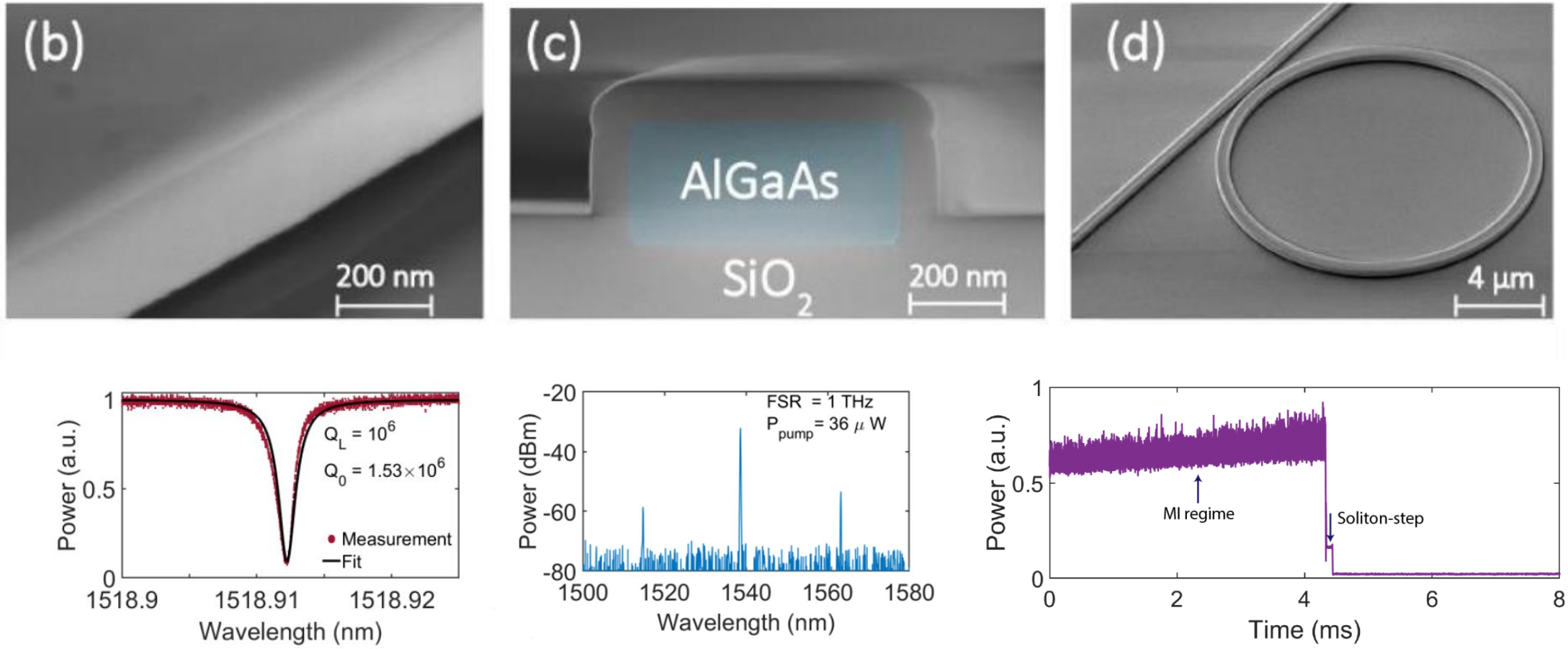




S. Liu, *et.al*, "High-channel-count 20 GHz passively mode-locked quantum dot laser directly grown on Si with 4.1 Tbit/s transmission capacity", *Optica 6 (2), 128-134, 2019*

Ultra-efficient frequency comb generation in AlGaAs-on-insulator micro-resonators

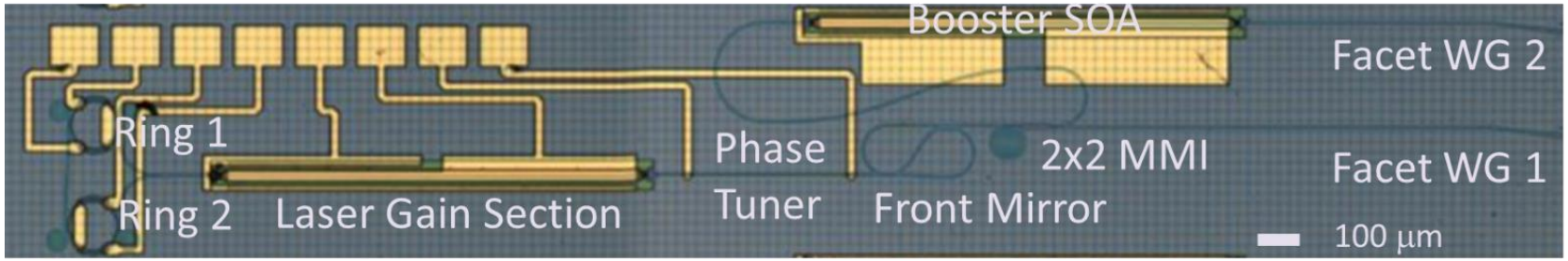
- AlGaAs-oninsulator microresonators with *Q* factors beyond 1.5×10^6
- A record low Kerr frequency comb generation threshold of ~36 μW for a resonator with a 1 THz free spectral range (FSR),~100 times lower compared to that in previous semiconductor platform.

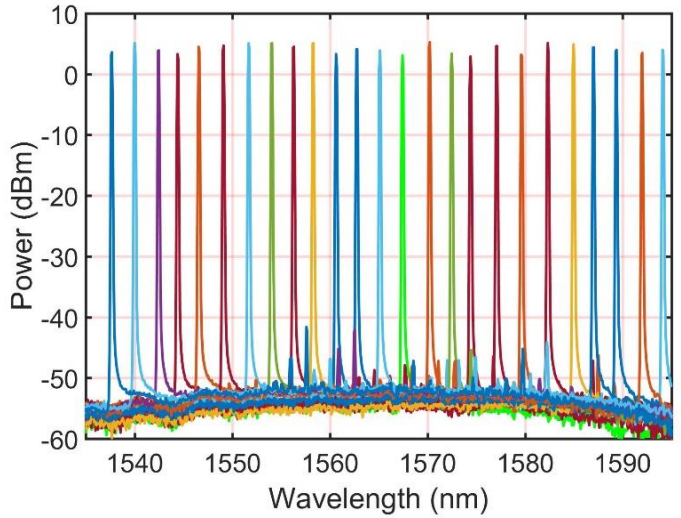


L. Chang, *et.al*, "Ultra-efficient frequency comb generation in AlGaAs-oninsulator microresonators." arXiv preprint arXiv:1909.09778 (2019)

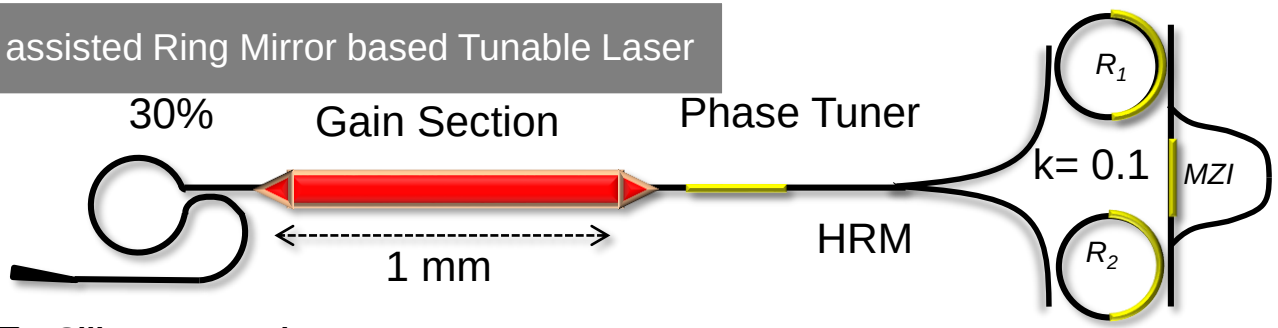
Widely tunable, narrow linewidth heterogeneous silicon/III-V lasers

QW-based device on Si by heterogeneous integration: world record results of 2.1 kHz Lorentzian linewidth; >16mW output; 55 nm tuning range

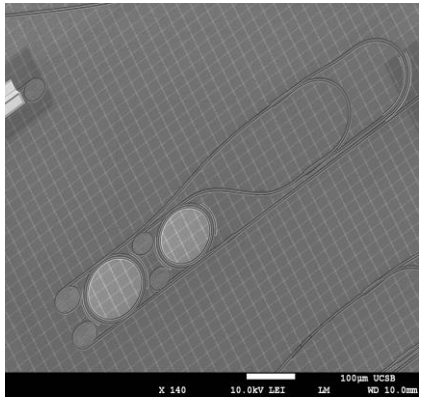


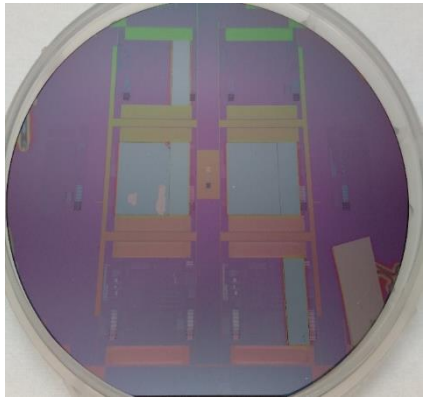


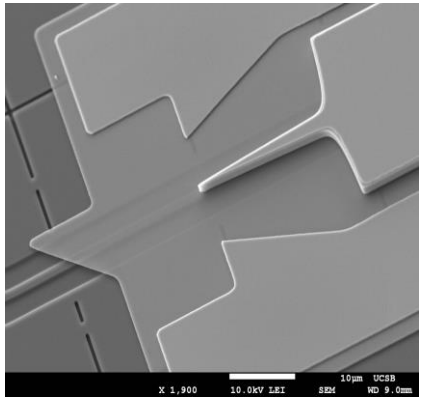
MZI assisted Ring Mirror based Tunable Laser

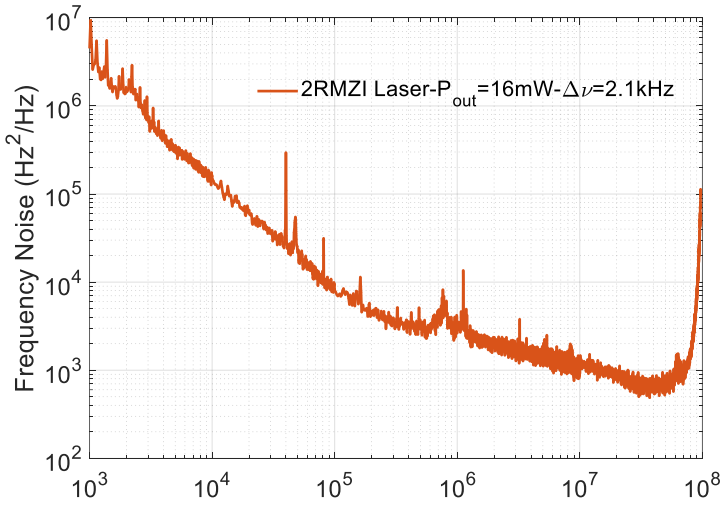


- ❑ **Silicon Patterning**
- ❑ **III-V/Si Bonding**
- ❑ **III-V Process**





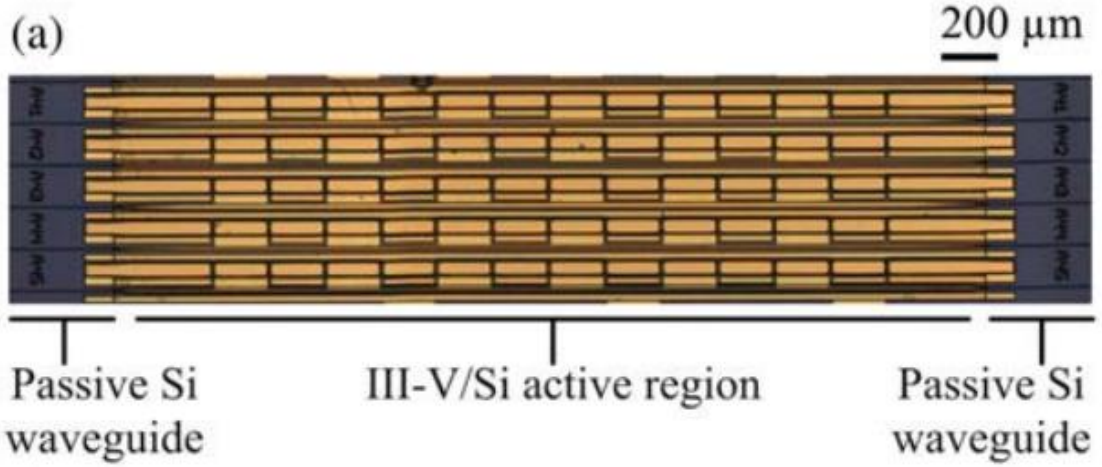


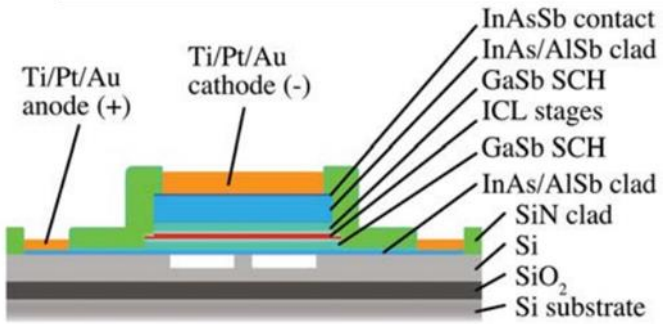


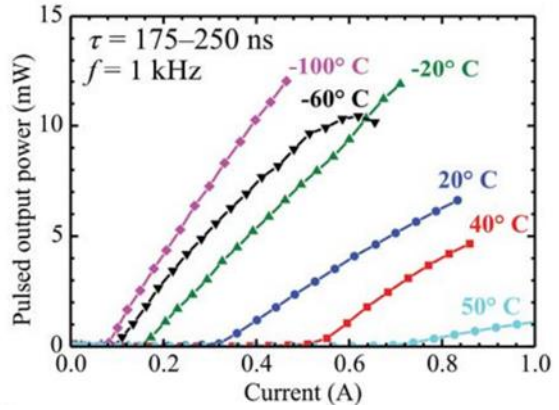
M. A. Tran, *et.al*, "Ring-Resonator Based Widely-Tunable Narrow-Linewidth Si/InP Integrated Lasers", IEEE Journal of Selected Topics in Quantum Electronics 26 (2), 1-14, 2019

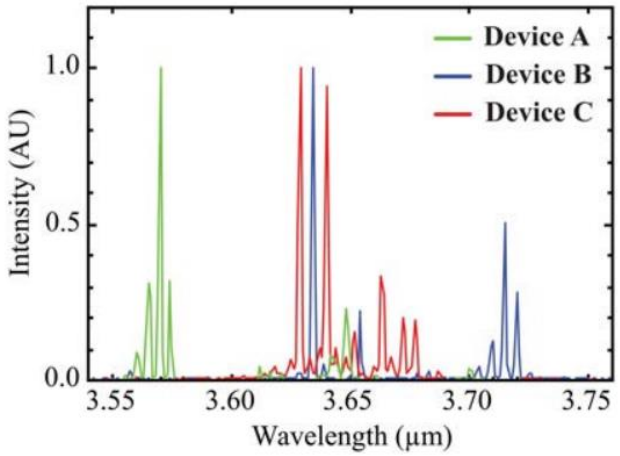
Interband cascade laser on silicon

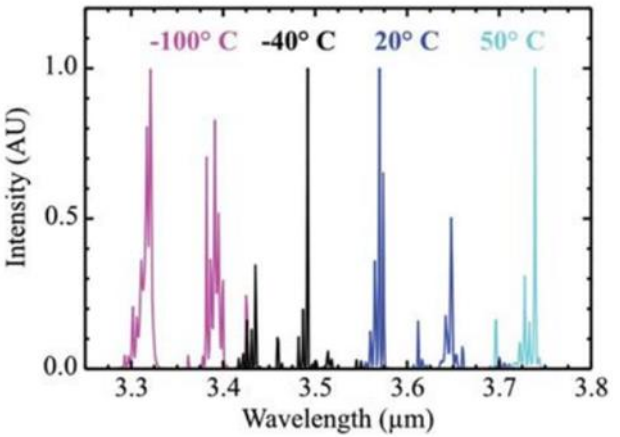
Integration of ICLs on a silicon substrate. These lasers emit 3.6 μm light into silicon-on-insulator waveguides in pulsed mode at temperatures up to 50°C.







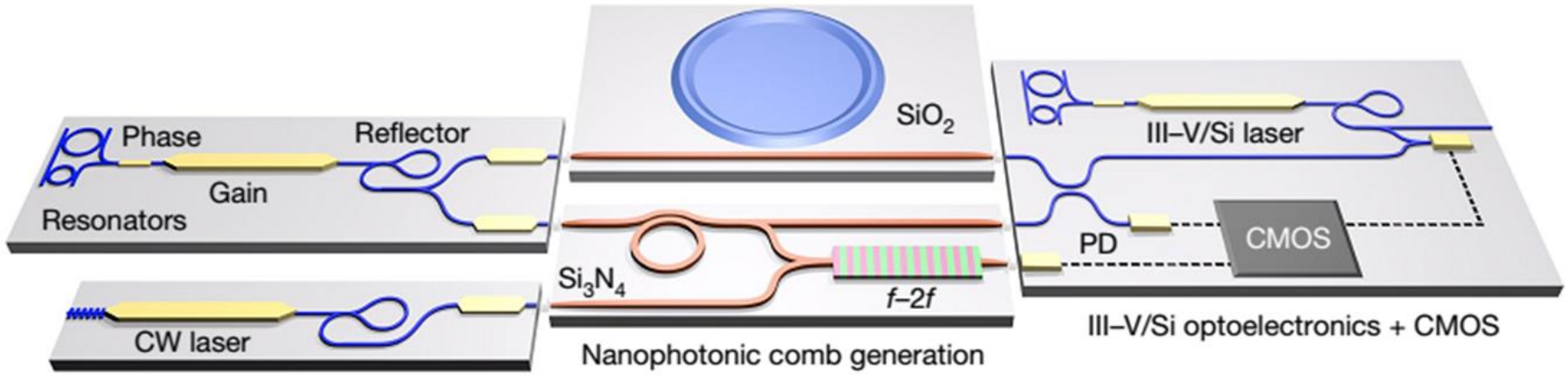


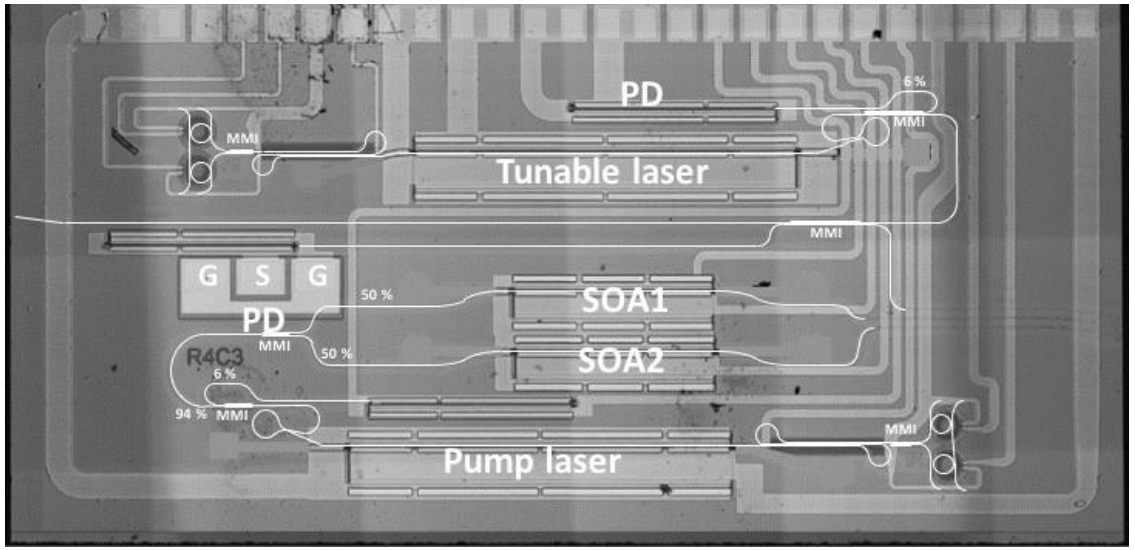


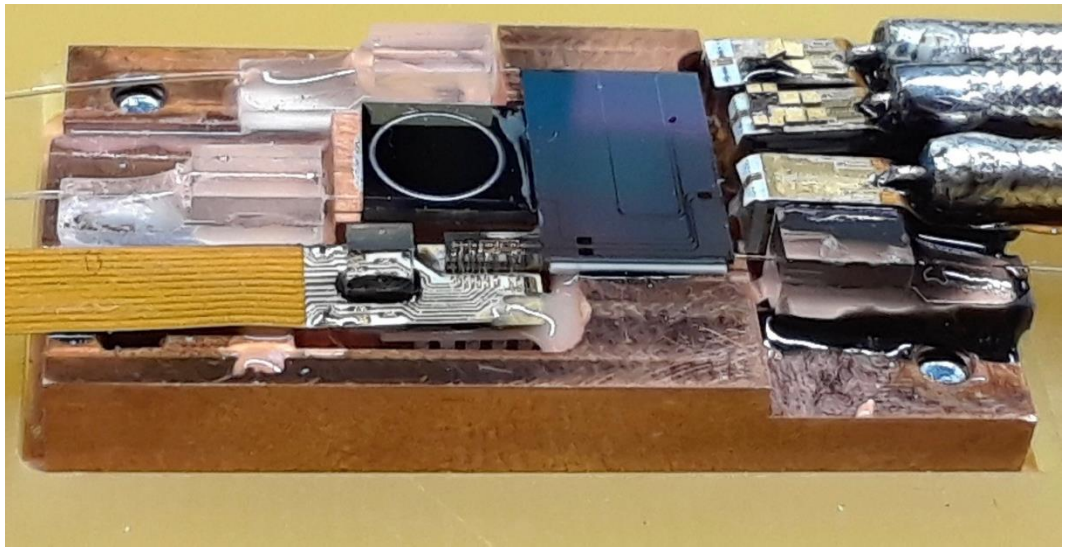
A. Spott , *et.al*, "Interband cascade laser on silicon" Optica, 5.8 (2018)

Integrated optical isolators and circulators on silicon

The laser frequency output of the optical-frequency synthesizer can be programmed by a microwave clock across 4 terahertz near 1,550 nanometres with 1 hertz resolution



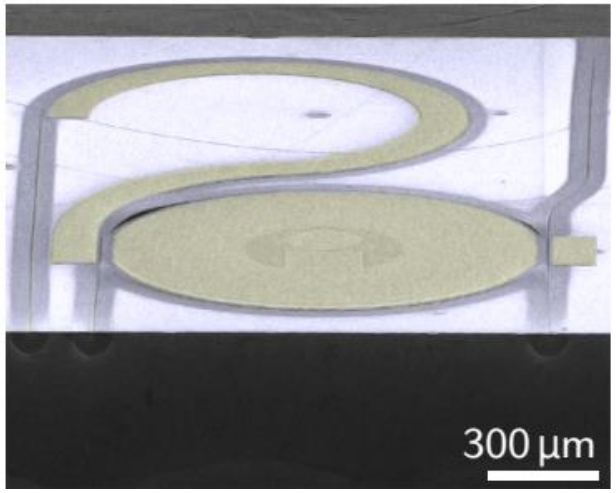


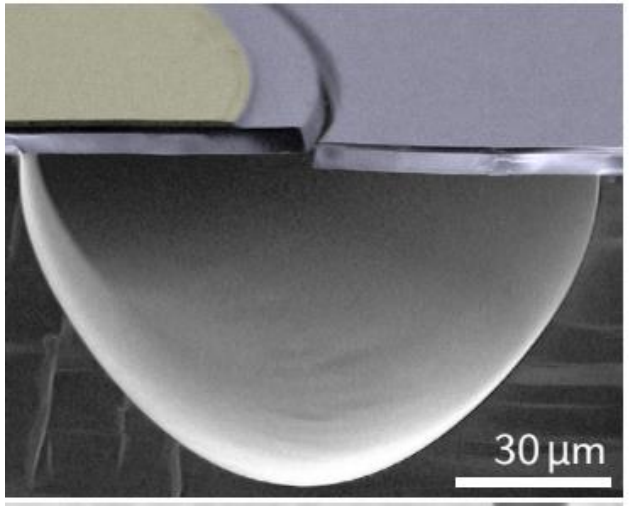


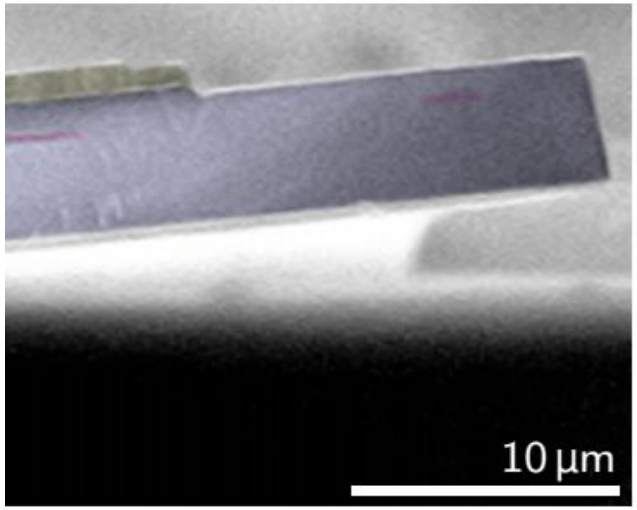
D. T. Spencer et al., *et.al*, "An optical-frequency synthesizer using integrated photonics", Nature 557.7703 (2018): 81-85.

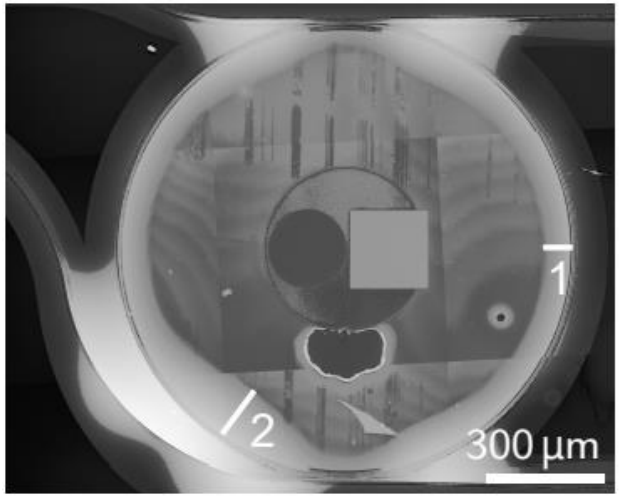
Piezoelectrically tuned silicon nitride ring resonator

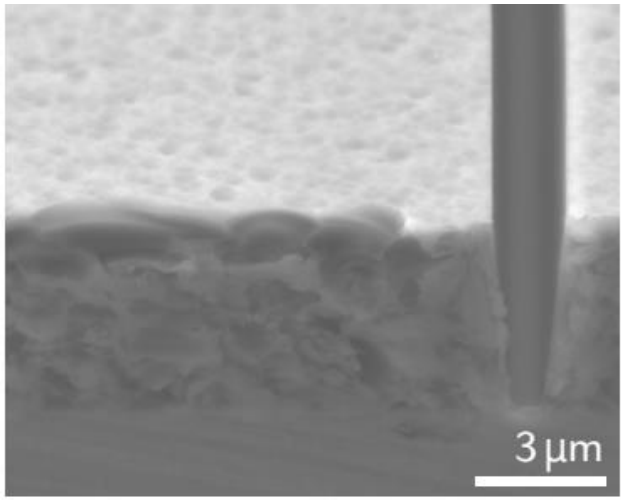
Record performance with VFSR = 16 V, Vπ L = 3.6 V dB, Vπ Lα = 1.1 V dB, tuning current below 10 nA, and unattenuated tuning response up to 1 MHz.

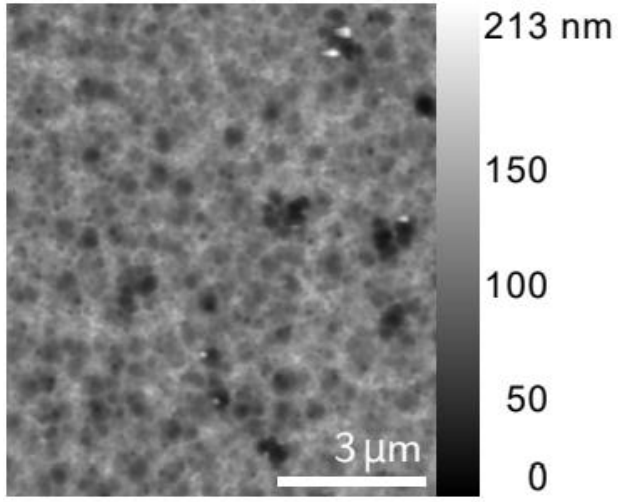












J. Warren, *et.al*, "Piezoelectrically tuned silicon nitride ring resonator." Optics Express 26.3 (2018): 3174-3187.