Quantum Dot Lasers and Integrated Guided-Wave Devices Monolithically Grown on Si

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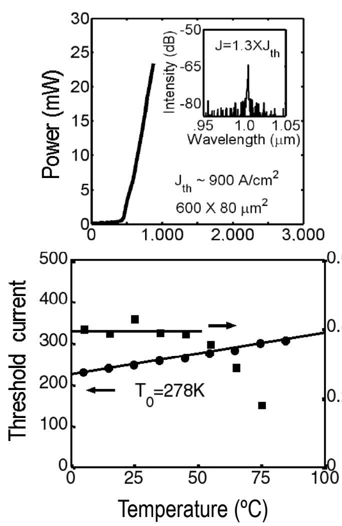
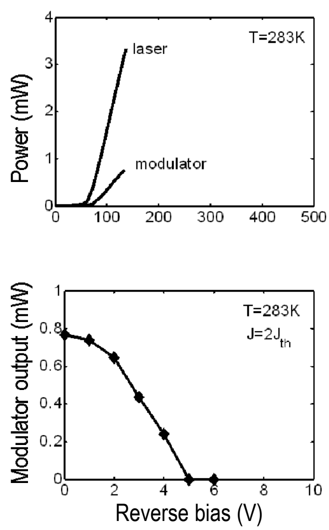
Future high-speed systems based on optical interconnects, a promising substitute for current microelectronic chips, require chip-scale integration of optical and electronic components. Some key technologies that are required include electrically injected lasers and the monolithic integration of lasers, waveguides, and modulators on Si with Si-based electronic devices in a CMOS-compatible process. Utilizing multiple layers of InAs quantum dots as effective dislocation filters, we have demonstrated high-performance quantum dot lasers grown directly on Si that exhibit relatively low-threshold current (J_{th} = 900A/cm^2), large characteristic temperature (T_0 = 278K), and output slope efficiency (0.3W/A). We have demonstrated a groove-coupled laser/modulator on Si that exhibits a coupling coefficient greater than 20% and a modulation depth of ~100% at 5V reverse bias by using molecular beam epitaxy (MBE) growth and regrowth, and focused-ion-beam milling. We have also demonstrated the monolithic integration of amorphous Si waveguides with quantum dot lasers by using plasma-enhanced-chemical-vapor deposition (PECVD). This project is being supported by the Defense Advanced Research Projects Agency under award number W 911NF-04-1-0429.



Light-current and output spectrum (top) and threshold current versus temperature (bottom) for QD lasers on Si.



Light-current (top) for output from the integrated laser and QCSE-based modulator, respectively, and modulated output versus reverse bias (bottom).