

Fabrication and Characterization of Vertical Cavity Surface Emitting Laser

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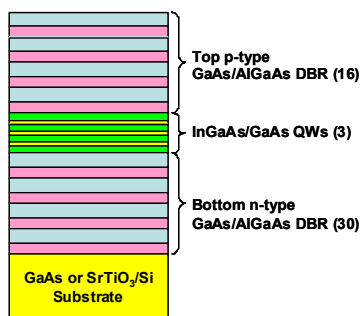
Gerard Dang, Paul Shen, and Wayne Chang

Army Research Laboratory

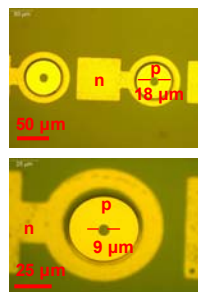
Objective

To develop a high power Vertical Cavity Surface Emitting Laser (VCSEL) for the high-speed optical interconnect and Light Detection and Ranging (LIDAR) imaging using GaAs and Si platform.

VCSEL Structures

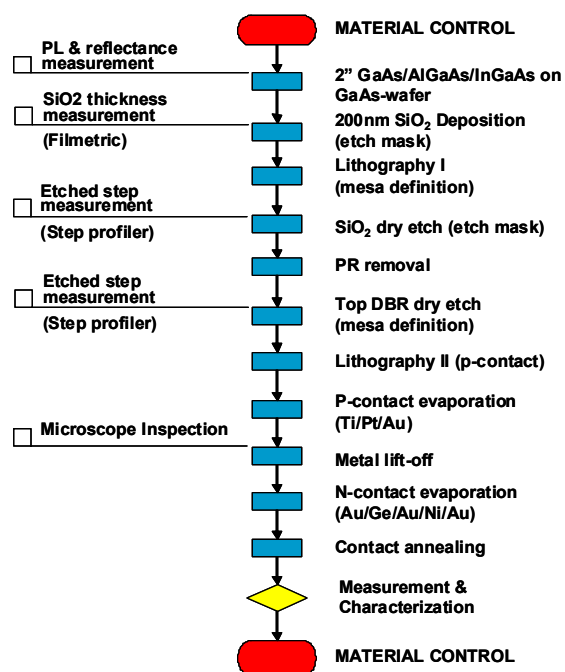


Fabricated Devices

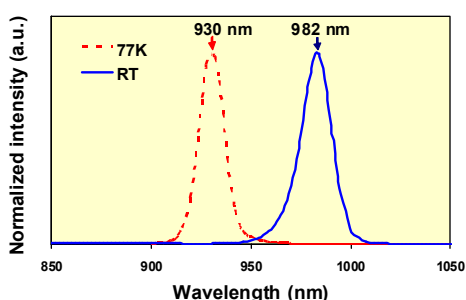


- Two different aperture diameters: 9 μm and 18 μm

Fabrication Process Flow

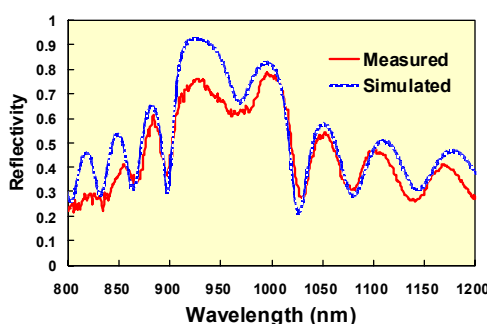


Photoluminescence Characterization



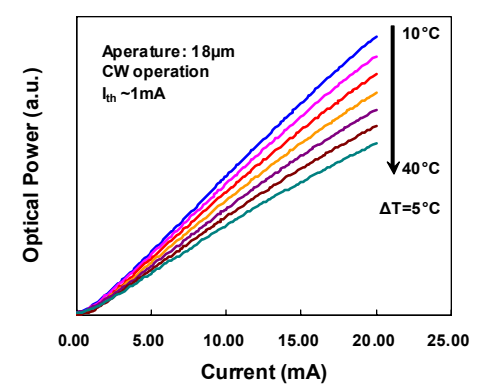
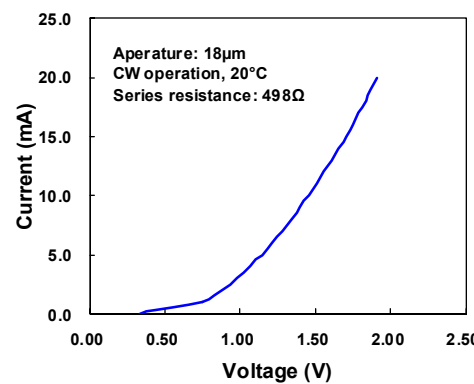
- Photoluminescence measured from VCSEL test structure (without top DBR mirrors)

Reflectivity Characterization



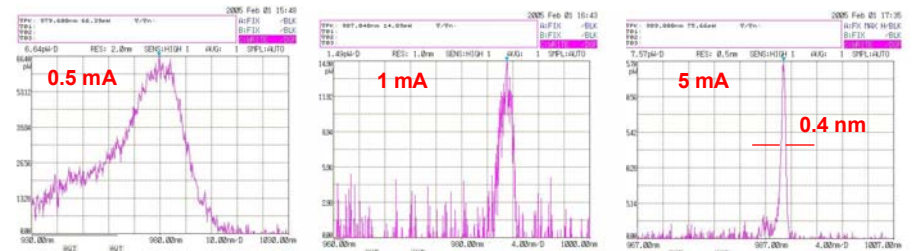
- Reflectivity spectrum is measured from VCSEL test structure
- Reflectivity spectrum is simulated by Transfer Matrix Method (TMM)
- Absorption dip is due to the optical confinement of the Fabry-Perot resonance

Current-Voltage-Power Characteristics



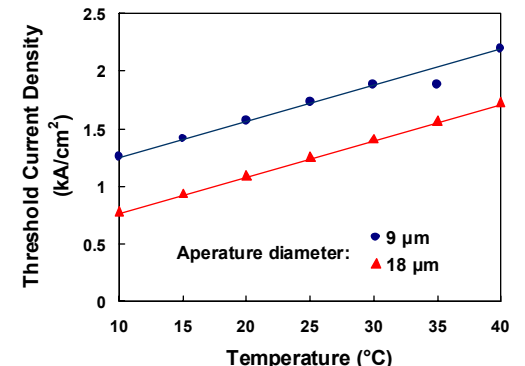
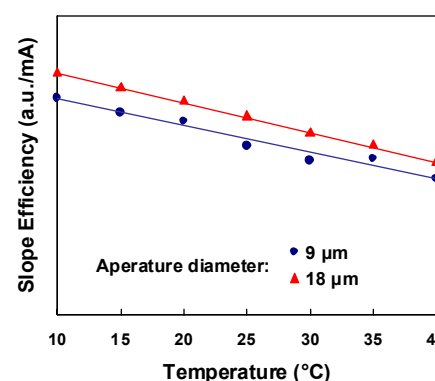
- Series resistance has linear dependence with temperature
- Threshold current density: 1.10 kA/cm² at 20°C.

Emission Spectrum

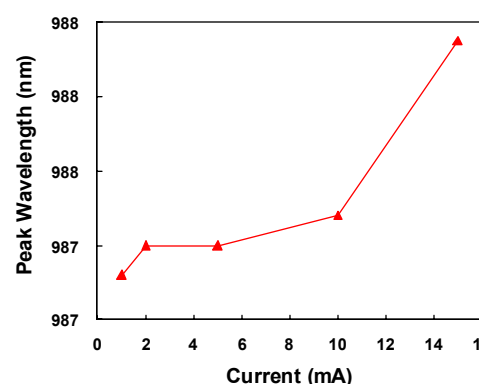


- Lasing wavelength: 987 nm
- Linewidth: 0.4 nm
- Threshold current: ~1 mA

Thermal Properties



- Higher threshold current density for aperture diameter of 9 μm
- Linear change of slope efficiency and threshold current density as the increase in temperature
- The red-shift behavior of emission wavelength at higher injection current



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