

## **Abstract**

In this work, a set of 2  $\mu\text{m}$  GaSb-based diode lasers are successfully designed, fabricated and investigated, including conventional ridge waveguide lasers, two-section mode-locked lasers (MLLs), and external cavity tunable lasers. Chapter 3 introduces the epitaxial structures used for fabricating all the devices in this work as well as a standard fabrication process of single-section ridge waveguide lasers. Chapter 4 gives a detailed overview of the fabricated single-section lasers. In addition, the carrier recombination behaviors within these lasers are investigated in both electrical (ideality factor) and optical way (sidewall spontaneous emission). In Chapter 5, monolithic two-section MLLs are fabricated and fully characterized. Their mode gain, working regimes, phase noise/timing jitter, frequency tuning are carefully investigated. Chapter 6 focuses on two III-V/silicon integration methods: wafer bonding and edge coupling. A tapered waveguide laser structure, bonded onto silicon waveguides, is simulated. An external cavity III-V/silicon tunable vernier laser is fabricated and characterized.