OPTICAL CHARACTERIZATION OF SEMICONDUCTOR MICRORESONATERS WITH SELF-ASSEMBLED QUANTUM DOTS

Abstract

by

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Micro cavities (MCs) with a small effective volume (V_{eff}) and a high quality factor (Q) are promising for applications in nonlinear optics, sensing, low-threshold lasers, single photon sources, quantum information processing and cavity quantum electrodynamics (CQED) for individual quantum dots (QDs) in the low temperature emission spectra. Near-field mapping of the emission spectra from embedded self assembled QD provides a better means to understand and control those applications.

This thesis is largely focused on the development of a variety of optically-pumped micro-cavities, including photonic crystals (PCs), microdisks (MDs), and microrings (MRs), utilizing an asymmetric waveguide structure of InAs/AlGaAs or InP/GaInP with ultra-small V_{eff} and high-Q. Good isolation of the waveguide layer from substrate by using a wafer bonding technique with a spin-on-glass or wet oxidation of AlGaAs to produce a stable structure for subsequent device

development has been achieved. Both far-field and near-field luminescence have been carried out as a function of temperature, along with near-field imaging and finite-difference-time domain (FDTD) calculations to study the PC defect and Whispering Gallery Modes (WGMs) inside of the MCs. Optically-pumped lasing of microdisk structures has been investigated in both semiconductor systems. Ultra-low lasing thresholds for InP MD and MR lasers at both room temperature and low temperature are demonstrated for the first time.