Announcing the Final Examination of Rowel Go for the degree of Doctor of Philosophy

Time & Location: July 6, 2020 at 12:00 PM in Virtual Defense
https://us02web.zoom.us/j/87217816251?pwd=MEE2YWtXb3pBWWR3SE1Zby9WZXgyVzZz09
Title: Indium Phosphide Based Quantum Cascade Lasers Grown on Silicon Substrate

Quantum Cascade Lasers (QCLs) are semiconductor devices that, currently, have been observed to emit radiation from ~ 2.6 um to 250 um (1 to 100 terahertz range of frequencies). They have established themselves as the laser of choice for spectroscopic gas sensing in the mid-wavelength infrared (3-8 um) and long-wavelength infrared (8-15 um) region. In the 4-12 um wavelength region, the highest performing QCL devices, in terms of wall-plug efficiency and continuous wave operation, are indium phosphide (InP) based. The ultimate goal is to incorporate this InP-based QCL technology to silicon (Si) substrate since most opto-electronics are Si-based. The main building blocks required for practical QCL-on-Si integrated platforms were demonstrated and will be covered in this presentation. The experimental results of a 40-stage indium phosphide based quantum cascade laser grown on a lattice-mismatched germanium-coated silicon substrate with metamorphic buffer (M-buffer) will be discussed. The QCL's strain-balanced active region was composed of Al0.78In0.22As/In0.73Ga0.27As and an 8 um-thick all-InP waveguide. Since the M-buffer was insulating, the wafer was processed into ridge-waveguide chips with lateral current injection scheme. Lasing was observed from 78K up to 170K for QCL-on-Si devices. Also in this presentation is the first room temperature operation of QCL grown on a lattice-mismatched gallium arsenide (GaAs) substrate with metamorphic buffer (M-buffer). Similar to QCL-on-Si, lateral injection scheme was utilized since M-buffer was insulating. Lasing was observed from 78K up to 303 K for QCL-on-GaAs. Material characterization of QCL-on-InP, QCL-on-GaAs, and QCL-on-Si using Transverse Electron Microscopy (TEM) will also be covered in this presentation. A very small section, 10 um x 10 um, of the QCL active region was used to give an estimate of the defect density for each of the QCL configuration. Lastly, characterization of the material quality of the remaining 6-inch wafer of QCL-on-Si using photoluminescence spectroscopy (PL) will be discussed. This method helped determined the best portion of the material for subsequent processing into ridge waveguide devices.

Major: Electrical Engineering

Educational Career:
Bachelor's of Physics, BS, 1999, University of California, Los Angeles
Master's of Optics and Photonics, MS, 2018, University of Central Florida

Committee in Charge:
Arkadiy Lyakh, Chair, Physics / ECE / CREOL
Kalpathy Sundaram, ECE
Jiann-Shiun Yuan, ECE
Swaminathan Rajaraman, NanoScience / Materials Science / ECE
Laurene Tetard, NanoScience / Physics / Materials Science

Approved for distribution by Arkadiy Lyakh, Committee Chair, on June 19, 2020.

The public is welcome to attend.