Stevens Institute of Technology

Nanotechnology Graduate Program

Interband Cascade Lasers: From concept to devices and applications

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Burchard 118, 11:00 am

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Nanotechnology has been recognized by many as the future technology, critical for areas such Interband cascade (IC) lasers take advantage of the broken band-gap alignment in type-II quantum wells to reuse injected electrons in cascade stages for photon generation with high quantum efficiency. Unlike intraband quantum cascade lasers, IC lasers use interband transitions for photon emission without involving fast phonon scattering, making it possible to significantly lower the threshold current density. In addition, IC lasers offer a wide wavelength tailoring range without being limited by the conduction-band offset in the wavelength region of 3-4 micron where there are hydrocarbon signatures important for life detection in space exploration. Theoretical calculations projected the feasibility of IC lasers to operate in continuous wave (cw) mode up to room temperature with high output power. Since the proposal of IC lasers in 1994 and the first demonstration in 1997, significant progress has been achieved toward high-performance mid-IR laser devices. Some outstanding performance features such as low threshold current densities (e.g. ~5 A/cm^2 at 80 K) and high wall-plug efficiency (e.g. >31% at 80 K) partially verified the advantages of IC lasers. Single-mode distributed feedback (DFB) IC lasers have been demonstrated in cw operation for the wavelength range from ~3.2 to 3.5 µm. These DFB IC lasers have been employed for the detection of gases such as methane (CH_4), Ethane (C_2H_6), hydrogen chloride (HCl), and formaldehyde (H_2CO), and have been flown on aircraft and high-altitude balloon instruments and measured atmospheric CH_4 and HCl profiles. More recently, single-mode DFB IC lasers have been demonstrated at thermoelectric (TE) cooler temperatures (up to 261 K) near 3.3 microns. These single-mode DFB lasers with TE coolers in a very compact package can operate at room temperature with a total power consumption (including both the laser and TE cooler) less than 5W, representing a significant progress for applications. In this talk, the development of mid-infrared interband cascade lasers from concept to devices and applications will be reviewed. Their current status and future prospects will be discussed.

Professor Rui Q. Yang received the B.Sc. degree in physics from Zhejiang University in 1982, and the M.Sc. and Ph.D. degrees in physics from Nanjing University in 1984 and 1987, respectively. He is the inventor of interband cascade lasers with research activities ranging from condensed matter physics to semiconductor quantum devices such as tunneling diodes, mid-infrared lasers and detectors. Prior to joining the University of Oklahoma as a professor in 2007, he was a Principal Member of Engineering Staff and a Task Manager at the Jet Propulsion Laboratory (JPL), where he led the development of advanced mid-IR interband cascade lasers for applications in Earth sciences and planetary explorations. He received the Edward Stone Award in 2007 from JPL for outstanding research publication and the successful accelerated infusion of cutting-edge interband cascade semiconductor laser technology into flight mission readiness.

Light refreshments will be served prior to seminar

For additional information please contact Prof. Stefan Strauf, strauf@stevens.edu

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