ITQW 2017
10 - 15 Sep. Singapore
14th International Conference on
Intersubband Transitions in Quantum Wells
Sands Expo and Convention Center
Singapore

CONFERENCE PROGRAM
12:30 – 12:45 Sukhdeep Dhillon (Laboratoire Pierre Aigrain)  
Short THz pulse generation from a dispersion compensated mode locked quantum cascade laser

12:45 – 13:00 Petar Tzonev (Technical University of Munich)  
Gain recovery dynamics and passive mode locking of THz quantum cascade lasers

13:00 – 14:00 Lunch

14:30 – 17:00 Social Events (Free)

Wednesday 13 September 2017

Session 7 THz Frequency Comb-Chair: Harald Schneider

09:00 – 09:30 Jacob Khurgin (Johns Hopkins University) - Invited talk  
Frequency comb-theory

09:30 – 10:15 Hua Li (Shanghai Institute of Microsystem and Information Technology)  
Terahertz intersubband photonic devices for frequency comb operation and fast detection

10:10 – 10:30 Tea break

Session 8 THz Frequency Comb and Spectroscopy-Chair: Jacob Khurgin

10:45 – 11:30 Qing Hu (Massachusetts Institute of Technology) - Plenary talk  
THz frequency comb

11:30 – 12:00 Harald Schneider (Helmholtz-Zentrum Dresden-Rossendorf) - Invited talk  
THz-spectroscopic studies on electron dynamics in a GaAs single quantum well and an InAs single quantum dot

12:00 – 12:45 Jonas Westberg (Princeton University)  
Terahertz multiphoton spectroscopy of molecular samples with quantum cascade laser frequency combs

12:45 – 13:30 Miriam Serena Vitiello (NIST, CNR)  
Spectral purity of terahertz quantum cascade laser sources based on intra-cavity difference frequency generation

13:00 – 14:00 Lunch

14:30 – 17:00 Excursion starts (S.E.A. Aquarium)

18:00 – 21:00 BBQ at beach

Thursday 14 September 2017

Session 9 THz Quantum Cascade Lasers-Chair: Harald Schneider

09:00 – 09:15 J Chen (Lehigh University)  
High brightness THz quantum-cascade lasers utilizing inexpensive custom-made lenses

09:15 – 09:30 Huan Zhu / Gang Yu (Shanghai Institute of Technical Physics)  
Terahertz master-oscillator power-amplifier quantum cascade laser with improved output power

09:30 – 09:45 Yongquan Zeng (Nanyang Technological University)  
Two-Dimensional Multimode Terahertz Random Laser with Metallic Pillars

09:45 – 10:00 Simone Basco (NIST, CNR)  
High-power, low-divergent, single-mode THz quantum cascade wire lasers operating in pulsed and continuous-wave regime

10:00 – 10:30 Tea break

Session 10 Photodetectors-Chair: Yanko Todorov

10:30 – 11:15 Philippe Bois (Thales Research & Technology) - Plenary talk  
Infrared PDs

11:15 – 11:45 Kaz Hirakawa/Zhang Ya (University of Technology) - Invited talk  
Novel bolometric THz detection by MEMS resonators

11:45 – 12:00 Behnam Mirzaei (Delft University of Technology)  
An 8-Beam, 4.7 THz Local Oscillator Using a Quantum Cascade Laser and a Phase Grating

12:00 – 12:15 Pedro Pereira (Pontificia Universidade Católica do Rio de Janeiro)  
Photovoltaic asymmetric superlattice QWIP with confined states in the continuum

12:15 – 12:30 Zahr Aghbari (University Paris Diderot - Paris 7)  
Room Temperature High Performances Quantum Cascade Detectors

12:30 – 14:00 Lunch

Session 11 Mid-IR Quantum Cascade Lasers-Chair: Igor Vurgaftman

14:00 – 14:30 Liu Fengqi (Institute of Semiconductors, CNS) - Invited talk  
History and recent development of QCLs in China

14:30 – 14:45 Dan Botez (University of Wisconsin-Madison)  
4.7 μm Emitting In-Phase Resonant-Coupled, Phase-Locked Arrays of QCLs

14:45 – 15:00 Marco Piccardo (Harvard University)  
Beat spatial hole burning

15:00 – 15:15 Frederic Demmerle (Technische Universität München)  
Surface Emission by Transversally Superimposed Gratings in Nonlinear Quantum Cascade Lasers

15:15 – 15:30 Dan Botez (University of Wisconsin-Madison)  
High Internal Efficiency Mid-IR Quantum Cascade Lasers
High power frequency comb based on a bi-functional QCL

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Frequency combs based on QCLs open an alternative and elegant way to facilitate mid-infrared spectroscopy for compact or ultimately single-chip sensing instruments [1,2]. The detection of the beating between laser lines in a multi-heterodyne scheme allows the simultaneous down-sampling of the entire optical spectrum to the RF-domain, where state-of-the-art FPGA based electronics can be used to recover the spectral information.

The idea of this work is to merge our efforts on bi-functional devices [3,4] with frequency combs for future integrated sensors. The on-chip detection capability allows a straightforward integration and quantum cascade detectors are ideal candidates for multi-heterodyne detection. They allow direct and efficient on-chip coupling from the strong local oscillator and due to the short intersubband lifetimes, they have high electric bandwidths in the gigahertz range, as well as saturation intensities that allow linear detection over a large dynamic range.

Our new device generation is capable of room-temperature operation in continuous wave at 8 μm with watt level output power. The achieved continuous wave wall-plug efficiency of 7% is the highest reported value for lattice matched material at this wavelength. In detector operation, the device has a responsivity of 14 mA/W at the emission wavelength and a noise equivalent power of 0.14 nW/√Hz, which results in a dynamic range of 9 orders of magnitude.

In frequency comb operation the devices emit up to 400 mW in epi-side down and 80 mW in epi-side up mounted configurations. Beyond 400 mW, the device switches to the noisy dome regime, where phase locking is lost due to the larger effect of self-phase modulation onto the dispersion. The epi-side up mounted device are frequency combs in the entire bias region between the single mode regime and roll-over. The harmonic mode regime, which seems to be present in nearly all conventional QCLs [5], has not been observed in any of those devices and the second threshold of the frequency comb regime is extremely low (30-50 mA above laser threshold). This shows, that four-wave mixing induced phase-locking can kick in at relatively low power levels close to threshold in dispersion compensated QCLs and dominates their spectral behavior.

In conclusion, we demonstrate a quantum cascade device with record laser performance, as well as high speed zero bias detection and frequency comb operation capabilities. This makes our device a perfect candidate to realize a dual comb spectroscopy on a single chip.

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Fig. 1: Beat-mode measurement of an epi-side down mounted device showing narrow beat modes on a 50 dB scale. At high intensities the comb regime switches off due to the lack of dispersion compensation resulting in an increased self-phase modulation. This occurs at output powers between 200-400mW for the tested devices.

References