OTST

Optical Terahertz Science and Technology

March 14-16, 2005
Rosen Plaza Hotel
Orlando, Florida

Sponsored by: Optical Society of America

Program Committee

Program Chairs

- Mark Allen, *Physical Sciences, Inc., USA*
- Dan Mittleman, *Rice Univ., USA*

Committee Members

- Gwyn Williams, *Jefferson Lab., USA*
- Philip Taday, *Teraview Limited, United Kingdom*
- Qing Hu, *M.I.T., USA*
- Peter Uhd Jepsen, *Technical Univ. of Denmark, Denmark*
  Paul C.M. Planken, *Univ. of Technology Delft, The Netherlands*
- Kodo Kawase, *RIKEN, Japan.*
- Richard Saykally, *Univ. of California – Berkeley, USA*
- Toni Taylor, *Los Alamos National Lab., USA*
- James Gord, *US Air Force, SEC Representative**

*Representative to OSA's Science and Engineering Council

About OTST

This meeting will focus on developments in optical THz sources and their application to spectroscopy, sensing, microscopy, and imaging. Emphasis will be placed on sources and applications at wavelengths between 30 and 3000 microns (0.1-10 THz).

Meeting Topics

Topics to be considered:

The topics to be considered in the main program will include (but not be limited to):

- Advances in free-space time-domain sources (bandwidth, power, emitters, detectors)
- Tunable sources based on frequency conversion (TPG, OPO, new non-linear materials)
- Quantum Cascade Lasers at THz frequencies
- Applications to molecular, biomolecular, and condensed phase spectroscopy
- Imaging technologies
- Portal security applications
- LIDAR/DIAL systems

Invited Speakers

- MA1, **THz Magneto-Spectroscopy of Semiconductor Nanostructures,** *Junichiro Kono, Rice Univ., USA*
- MC1, **Monochromatic Tunable Tera-Photonics sources Toward CW Operation,** *Hiromasa Ito, Tohoku Univ., Japan*
- TuA1, **THz Quantum Cascade Lasers: Developing New Operating Concepts and Advancing Application Technologies,** *Alessandro Tredicucci, Istituto Nazionale per la Fisica della Materia, Italy*
- TUB1, **Probing Condensed Phase Dynamics with THz Spectroscopy,** *Charles Schmuttenmaer, Yale Univ., USA*
- WA1, **Intense Coherent THz Pulses from the NSLS/SDL Linac and Applications in Material Sciences,** *G. Larry Carr, Brookhaven Natl. Lab, USA*
- WB1, **Biomolecular Sensing with Integrated THz Systems,** *Peter Haring-Bolivar, Inst. für Halbleitertechnik, Germany*

Publications

Conference Program

The *Conference Program* is now available on the web.

Technical Digest

The OTST *Technical Digest* on CD-ROM will contain PDFs of paper summaries presented during the meeting as they were submitted by the authors; the *Technical Digest* will be produced only on CD. At the meeting, each registrant will receive a copy of the *Technical Digest* on CD-ROM. Extra copies can be purchased at the meeting for a special price of US$ 45.

Current Exhibitors (as of 3/9/05)

Designs & Prototypes
Headwall Photonics
Newport Corporation
Telops

Agenda

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- Monday, March 14, 2005
- Tuesday, March 15, 2005
- Wednesday, March 16, 2005

Monday, March 14, 2005

Time	Event/Location
7:30 AM - 8:00 AM	Opening Remarks *Salon 4*
8:00 AM - 9:45 AM	**MA**, Spectroscopy I *Salon 4*
9:45 AM - 4:00 PM	Exhibits Open *Salon 8*
9:45 AM - 10:15 AM	Beverage Break *Salon 8*
10:15 AM - 12:00 PM	**MB**, Guided Waves and Plasmons *Salon 4*
12:00 PM - 1:30 PM	Lunch Break (on your own)
1:30 PM - 3:15 PM	**MC**, Sources I *Salon 4*
3:15 PM - 3:45 PM	Beverage Break *Salon 8*
3:45 PM - 5:30 PM	**MD**, Postdeadline Session *Salon 4*
5:30 PM - 7:00 PM	**ME**, Poster Session *Salon 8*

Tuesday, March 15, 2005

Time	Event/Location
8:00 AM - 9:30 AM	**TuA**, Quantum Cascade Lasers *Salon 4*
9:30 AM - 10:00 AM	Beverage Break *Salon 8*
9:30 AM - 4:00 PM	Exhibits Open

	Salon 8
10:00 AM - 12:00 PM	**TuB**, Spectroscopy II *Salon 4*
12:00 PM - 1:30 PM	Lunch Break (on your own)
1:30 PM - 3:15 PM	**TuC**, Imaging and Microscopy *Salon 4*
3:15 PM - 3:45 PM	Beverage Break *Salon 8*
3:45 PM - 5:30 PM	**TuD**, Techniques and Applications *Salon 4*
5:30 PM - 7:00 PM	Conference Reception *Poolside*

Wednesday, March 16, 2005

Time	Event/Location
8:00 AM - 9:45 AM	**WA**, Sources II *Salon 4*
9:45 AM - 10:15 AM	Beverage Break *Pre-function Area*
10:15 AM - 12:00 PM	**WB**, Biological Applications *Salon 4*

Monday, March 14, 2005

Salon 4
7:30 a.m.–8:00 a.m.
Opening Remarks

Salon 4
8:00 a.m.–9:45 a.m.
MA • Spectroscopy I
Daniel Mittleman; Rice Univ., USA, Presider

MA1 • 8:00 a.m. (Invited)
THz Magneto-Spectroscopy of Semiconductor Nanostructures
Junichiro Kono; Rice Univ., USA.
I will describe our recent THz magneto-optical experiments on semiconductors. Both THz quantum cascade lasers and time-domain THz spectroscopy were used. The development of an ultracompact optically-detected THz spectroscopy system will be discussed.

MA2 • 8:30 a.m.
Terahertz Emission Spectroscopy of Ultrafast Demagnetization in Iron
David J. Hilton, Richard D. Averitt, Joe D. Thompson, Chad A. Meserole, Greg L. Fisher, David J. Funk, Antoinette J. Taylor; Los Alamos Natl. Lab, USA.
We have observed ultrafast demagnetization of ferromagnetic metals after femtosecond pump pulse excitation by both transmission and emission spectroscopy. We observe demangtization occuring in iron with a 2 ps time constant.

MA3 • 8:45 a.m.
THz Spectroscopy of Excitons in GaAs Systems
Oleg Mitrofanov, Ronen Rapaport, Loren N. Pfeiffer, Ken W. West; Bell Labs, Lucent Technologies, USA.
Distinctive excitonic spectral signature in Terahertz region provides an excellent method to probe the exciton population in semiconductors. We present the study of exciton formation and dynamics in GaAs bulk and quantum well systems.

MA4 • 9:00 a.m.
Broadband THz Attenuation by Optically Excited Charge Carriers in Silicon
Canan Karaalioglu[1], I-Chun Anderson Chen[1], Martin Brucherseifer[1], Rainer Martini[1], Azza Meshal[2]; [1]Stevens Inst. of Technology, USA, [2]US Army RDECOM, USA.
The THz transmittance of a silicon sample could be optically controlled, allowing broadband THz attenuation to less than 1% measured in a standard THz time domain spectroscopy setup.

MA5 • 9:15 a.m.
Enhanced THz Emission from Te Doped GaSb
Ricardo Ascazubi, Ingrid Wilke, Robinson Pino, Partha S. Dutta; Rensselaer Polytechnic Inst., USA.
Strong enhancement of optically excited THz emission from GaSb due to compensation of native acceptors by tellurium donors has been observed. THz emission of compensated GaSb is an order of magnitude stronger than undoped GaSb.

MA6 • 9:30 a.m.
Quantitative THz Spectroscopy of Explosive Materials
David J. Cook, Brian K. Decker, Mark G. Allen; Physical Sciences Inc., USA.
Quantitative terahertz absorption spectra of the commonly encountered high explosives pentaerythritoltetranitrate and cyclotrimethylenetrinitramine are presented. Different matrix materials were investigated and data analysis methods for extraction of the complex index of refraction are discussed.

Salon 8
9:45 a.m.–4:00 p.m.
Exhibits Open

Salon 8
9:45 a.m.–10:15 a.m.
Coffee Break

Salon 4
10:15 a.m.–12:00 p.m.
MB • Guided Waves and Plasmons
Gwyn Williams; Jefferson Lab, USA, Presider

MB1 • 10:15 a.m.
Prism Coupled Terahertz Waveguide Sensor
Christian Rau[1], Garik Torosyan[1], René Beigang[1], K. Nerkararyan[2]; [1]Kaiserslautern Technical Univ., Germany, [2]Yerevan State Univ., Armenia.
A THz wave guide element has been used as a sensitive sensor for adsorbates on surfaces. The sensitivity to phase shifts makes this waveguide sensor very attractive for the detection of very thin adsorbates.

MB2 • 10:30 a.m.
Time-Domain Analysis of Terahertz Propagation on Metal Wire Waveguides
Kanglin Wang, Daniel M. Mittleman; Rice Univ., USA.
Guided propagation of terahertz (THz) pulses on metal wires is observed and characterized with time-domain spectroscopy. This new type of terahertz waveguide shows low loss, negligible group velocity dispersion, and remarkable structural simplicity.

MB3 • 10:45 a.m.
Photoconductive Terahertz Antenna with Radial Symmetry
Jason A. Deibel, Matthew D. Escarra, Daniel M. Mittleman; Rice Univ., USA.
The use of coaxial waveguides with terahertz pulses is hindered by the difficulty in exciting the radially polarized fundamental mode. We propose a radially symmetric terahertz antenna and present simulations predicting a radially polarized beam.

MB4 • 11:00 a.m.
Terahertz Surface Plasmon Polariton Coupling via Gratings and Prisms
John F. O'Hara, Richard D. Averitt, Antoinette J. Taylor; Los Alamos Natl. Lab, USA.
Terahertz time-domain spectroscopy is used to study coupling to surface plasmon polaritons via silicon prisms and metallic gratings. Grating measurements indicate efficient, narrowband coupling, while prism measurements show broadband coupling and propagation over ~6.3cm.

MB5 • 11:15 a.m.
Resonantly Suppressed Terahertz Transmission through a Subwavelength Aperture Surrounded by Periodic Surface Corrugations
Amit K. Agrawal, Hua Cao, Ajay Nahata; Univ. of Utah, USA.
In sharp contrast to results obtained at optical frequencies, we demonstrate resonantly suppressed terahertz transmission through a single sub-wavelength aperture surrounded by periodic corrugations. The suppression occurs approximately at the wavelength corresponding to corrugation periodicity.

MB6 • 11:30 a.m.
Terahertz Guided Resonances in Photonic Crystal Slabs
Zhongping Jian, Daniel M. Mittleman; Rice Univ., USA.

Two-dimensional photonic crystal slabs with hexagonal-lattice air-hole arrays are studied experimentally using coherent single-cycle terahertz pulses. Transmission measurements reveal the properties of guided resonances, in both time and frequency domain.

MB7 • 11:45 a.m.
Highly Flexible and Strongly Polarization-Preserving Teflon Photonic Crystal Fiber Waveguide for Terahertz Radiation
Gilbert Diwa, Alex Quema, Masahiro Goto, Hidetoshi Murakami, Shingo Ono, Nobuhiko Sarukura; Inst. for Molecular Science, Japan.
The construction of highly flexible and strongly polarization-preserving Teflon photonic crystal fiber (PCF) waveguide is discussed. This PCF has a low-loss coefficient thereby making it feasible to construct long and efficient waveguide for terahertz radiation.

12:00 p.m.–1:30 p.m.
Lunch Break (on your own)

Salon 4
1:30 p.m.–3:15 p.m.
MC • Sources I
Junichiro Kono; Rice Univ., USA, Presider

MC1 • 1:30 p.m. (Invited)
Monochromatic Tunable Tera-Photonics Sources Toward CW Operation
Hiromasa Ito; Tohoku Univ./RIKEN, Japan.
Using THz parametric oscillation of a $LiNbO_3$ crystal pumped by a Q-switched Nd:YAG laser, we have realized widely tunable coherent THz-wave sources. Continuous-wave THz-wave generation using DFM with periodically poled $LiNbO_3$ is also discussed.

MC2 • 2:00 p.m.
Tunable Narrow-Band Terahertz-Wave Generation in Periodic GaAs via Synchronous Optical Rectification
Konstantin L. Vodopyanov[1], D. Simanovskii[1], M. M. Fejer[1], V. G. Kozlov[2], Y. S. Lee[3]; [1]Stanford Univ., USA, [2]Microtech Instruments Inc., USA, [3]Oregon State Univ., USA.
We demonstrate efficient generation of narrow-band THz wave packets at 1-3 THz, via optical rectification mechanism in periodically-inverted GaAs structures. As a pump source, we have used 100-femtosecond pulses between 2 and 4 microns.

MC3 • 2:15 p.m.
Terahertz Spectroscopic Studies and Molecular Modeling of the Far-Infrared Properties of Electro-Optic Polymers
Megan R. Leahy-Hoppa, Xuemei Zheng, L. Michael Hayden; Univ. of Maryland, Baltimore County, USA.
We present far-infrared spectra obtained through terahertz spectroscopy of electro-optic polymers and compare those measurements with molecular modeling simulations of the spectra in the 0-5 THz region.

MC4 • 2:30 p.m.
Generation and Detection of Gap-Free Broadband Terahertz Radiation Using Poled Polymer Films
Xuemei Zheng, Alexander M. Sinyukov, L. Michael Hayden; Univ. of Maryland, Baltimore County, USA.
We present a terahertz generation and detection system using poled electro-optic polymer films as the terahertz emitter and sensor, respectively. The system provides > 10 THz gap-free spectrum band.

MC5 • 2:45 p.m.
Terahertz-Radiation Generation from Zinc Oxide Photoconductive Switch
Shingo Ono[1], Hidetoshi Murakami[1], Alex Quema[1], Gilbert Diwa[1], Nobuhiko Sarukura[1], Ryujiro Nagasaka[2], Yo Ichikawa[2], Eriko Ohshima[3], Hiraku Ogino[3], Akira Yoshikawa[3], Tsuguo Fukuda[3]; [1]Inst. for Molecular Science, Japan, [2]Nagoya Inst. of Technology, Japan, [3]Tohoku Univ., Japan.

Generation of terahertz pulses from photoconductive switch on zinc oxide (ZnO) single crystal is demonstrated. High transparent nature of ZnO in visible, near-infrared, mid-infrared and terahertz region will unravel the prospect of integrated active optics.

MC6 • 3:00 p.m.
MBE Grown InN: A Novel THz Emitter
Ricardo Ascazubi[1], Ingrid Wilke[1], Hai Lu[2], William J. Schaff[2]; [1]Rensselaer Polytechnic Inst., USA, [2]Cornell Univ., USA.
Strong optically excited terahertz emission has been observed from InN thin films. The emission mechanism has been determined to be photocarrier acceleration. This observation implies that InN has a bandgap smaller than 1.5 eV.

Salon 8
3:15 p.m.–3:45 p.m.
Coffee Break

Salon 4
3:45 p.m.–5:30 p.m.
MD • Postdeadline Session
Daniel Mittleman; Rice Univ., USA, Presider

Salon 8
5:30 p.m.–7:00 p.m.
ME • Poster Session

ME1 • 5:30 p.m.
Phase-Matching Condition of Terahertz Generation of CdTe with Near-Infrared Pulse Excitation
Shingo Saito[1], Masaya Nagai[2], Atsushi Syouji[1], Hideyuki Ohtake[3], Toshiaki Bessho[3], Toshiharu Sugiura[3], Tomoya Hirosumi[3], Makoto Yoshida[3], Koichiro Tanaka[2], Kiyomi Sakai[1]; [1]Kansai Advanced Res. Ctr., Japan, [2]Kyoto Univ., Japan, [3]Aishin Seiki Co. Ltd., Japan.
The enhancement and spectral change of terahertz wave generation were observed under the phase-matching condition of 1mm-thick <110> CdTe wafer and NIR laser pulse excitation. For terahertz generation and tuning, the phase-matching condition is important.

ME2 • 5:30 p.m.
Studying the Mechanism of the Effects of Far Infrared Ray Laser (FIRL)-Biological System Interaction
Lingyun Zhou[1], Lin Xu[1], Guangmin Wu[1], Yiying Zhou[2]; [1]Kunming Univ. of Science and Technology, China, [2]Georgia State Univ., USA.
We analyzed the order-disordering variance due to resonance effect and the nonlinear behavior of FIRL-biological System interaction. The theoretic analysis is consistent with the result of FIRL mutagenesis breeding test.

ME3 • 5:30 p.m.
The Effects of Spatially Patterned Excitation in THz Generation from Photoconductive Sources
Dae Sin Kim, David S. Citrin; Georgia Tech, USA.
We investigate the interplay of the carrier dynamics and screening, and determine the optical spot shape needed to optimize the emitted THz transients based on a simulation from a detailed Monte Carlo-Poisson solver.

ME4 • 5:30 p.m.
Moved to TuD7.

ME5 • 5:30 p.m.
High Frequency Component of Terahertz-Radiation Spectrum Enhanced by Using an Excitation Source with Short Pulse Duration on an n-Type InAs Immersed in Magnetic Field

Shingo Ono[1], Hiroshi Takahashi[1], Alex Quema[1], Gilbert Diwa[1], Hidetoshi Murakami[1], Nobuhiko Sarukura[1], Michael Hasselbeck[2]; [1]Inst. for Molecular Science, Japan, [2]Univ. of New Mexico, USA.
Using femtosecond laser with short pulse duration enhances the high-frequency component of THz-radiation spectrum from *n*-type InAs immersed in magnetic field. Such high-frequency component is found to originate from the hybrid plasmon-longitudinal optical phonon modes.

ME6 • 5:30 p.m.
Study of Morphological Effects on Terahertz Spectra Using Ammonium Nitrate
Amartya Sengupta, Aparajita Bandyopadhyay, John F. Federici, Robert B. Barat; New Jersey Inst. of Technology, USA.
The effect of morphology on Terahertz spectra in the region from 0.2 to 1.2 THz was studied using Ammonium Nitrate of different grain sizes. The results agree with Mie scattering theory for small grain sizes.

ME7 • 5:30 p.m.
Terhertz Emission from Femtosecond Laser-Induced Plasma Channels
Walter Hoyer[1], Jerome V. Moloney[1], Ewan M. Wright[1], Mackillo Kira[2], Stephan W. Koch[2]; [1]Univ. of Arizona, USA, [2]Philipps-Univ., Germany.
Luminescence as a mechanism for terahertz emission from femtosecond laser-induced plasmas is studied by using a fully microscopic theory, including a quantized light field which takes into account the string geometry.

ME8 • 5:30 p.m.
THz-Range Instability from the Coupling of High Mobility Streaming Carriers with Acoustic Lattice Vibrations
Spilios Riyopoulos; Science Applications Intl. Corp., USA.
Unstable interaction of streaming electron plasma waves with acoustic lattice waves causes THz excitation in high mobility semiconductors. The coupled plasmon-phonon dispersion yields the instability growth rate and bias threshold. Convective amplification occurs in transit.

ME9 • 5:30 p.m.
Paper withdrawn.

ME10 • 5:30 p.m.
Time-Resolved Terahertz Spectroscopy of Explosives
Ying Hu, Cunlin Zhang, Liangliang Zhang, Lantao Guo, Xiaohong Wang; Capital Normal Univ., China.
We present a time-resolved ultra fast measurement in terahertz (THz) frequency region by means of the free-space electro-optic sampling (FSEOS). The transmission spectra of the four explosive samples were obtained.

Tuesday, March 15, 2005

Salon 4
8:00 a.m.–9:30 a.m.
TuA • Quantum Cascade Lasers
Paul Planken; Univ. of Technology Delft, Netherlands, Presider

TuA1 • 8:00 a.m. (Invited)
THz Quantum Cascade Lasers: Developing New Operating Concepts and Advancing Application Technologies
Alessandro Tredicucci; Inst. Nazionale per la Fisica della Materia, Italy.
Technological advances in THz quantum cascade lasers are targeting application requirements. Specific low emission frequencies, high-performance single-mode DFB devices, lasers with Bragg mirrors, solutions for broad tuneability, are relevant aspects now being addressed.

TuA2 • 8:30 a.m.
Advances in Terahertz Quantum-Cascade Lasers Using Metal-Metal Waveguides

Benjamin S. Williams[1], Sushil Kumar[1], Hans Callebaut[1], Stephen Kohen[1], Qing Hu[1], John L. Reno[2]; [1]MIT, USA, [2]Sandia Natl. Labs, USA.
We report the progress of terahertz quantum cascade lasers that use resonant-phonon depopulation, including the fabrication of metal-metal waveguides using Cu-Cu thermocompression wafer bonding to extend cw operation up to a temperature of 97 K.

TuA3 • 8:45 a.m.
Demonstration of an External Cavity Terahertz Quantum Cascade Laser
Joel M. Hensley[1], Douglas J. Bamford[1], Mark G. Allen[1], J. Xu[2], A. Tredicucci[2], H. E. Beere[3], D. A. Ritchie[3]; [1]Physical Sciences Inc., USA, [2]NEST-INFM and Scuola Normale Superiore, Italy, [3]Cavendish Lab, Univ. of Cambridge, [UK].
A THz QCL coupled to an external cavity emits an average of 1mW and can be frequency tuned by changing the grating angle. We demonstrate a tuning range of 1 wavenumber at fixed injection current.

TuA4 • 9:00 a.m.
Evaluation of a Quantum Cascade Laser as Local Oscillator for Heterodyne Detection of THz Radiation
Aurele J. Adam[1], Jacob N. Hovenier[1], Tjeerd O. Klaassen[1], Merlijn Hajenius[1,2], Juan R. Gao[1,2], Benjamin S. Williams[3], Sushil Kumar[3], Qing Hu[3], John L. Reno[4]; [1]Kavli Inst. of Nanoscience, Delft Univ. of Technology, The Netherlands, [2]SRON Natl. Inst. for Space Res., The Netherlands, [3]MIT, USA, [4]Sandia Natl. Labs, USA.
Optical properties of a 2.8 THz QCL are reported and evaluated to investigate the applicability of such a source as local oscillator for THz heterodyne detection. Preliminary results pumping a Hot Electron Bolometer are presented.

TuA5 • 9:15 a.m.
Quantum Cascade Raman Injection Laser for Mid/Far-Infrared Generation
Alexey Belyanin[1], Mariano Troccoli[2], Federico Capasso[2], Ertugrul Cubukcu[2], Deborah L. Sivco[3], Alfred Y. Cho[3]; [1]Dept. of Physics, Texas A&M Univ., USA, [2]Div. of Engineering and Applied Sciences, Harvard Univ., USA, [3]Bell Labs, Lucent Technologies, USA.
We report theory and experimental realization of the first Raman injection laser. It integrates quantum cascade active regions with Raman-active sections where Stokes component of the fundamental laser frequency is generated via intersubband Raman scattering.

Salon 8
9:30 a.m.–4:00 p.m.
Exhibits Open

Salon 8
9:30 a.m.–10:00 a.m.
Coffee Break

Salon 4
10:00 a.m.–12:00 p.m.
TuB • Spectroscopy II
Peter U. Jepsen; COM Res. Ctr., Technical Univ. of Denmark, Denmark, Presider

TuB1 • 10:00 a.m. (Invited)
Probing Condensed Phase Dynamics with THz Spectroscopy
Charles Schmuttenmaer; Yale Univ., USA.
Intramolecular electron transfer dynamics in liquids and magnetization dynamics in metallic films have been studied with THz emission spectroscopy. In liquids, the solvent influences electron transfer. In magnetic samples, there are surface and bulk contributions.

TuB2 • 10:30 a.m.
Photoconductive Anisotropy and Carrier Capture in Self-Assembled InGaAs Quantum Dot Chains

David G. Cooke[1], Frank A. Hegmann[1], Yu I. Mazur[2], W. Q. Ma[2], X. Wang[2], Z. M. Wang[2], G. J. Salamo[2], M. Xiao[2], T. D. Mishima[3], M. B. Johnson[3]; [1]Univ. of Alberta, Canada, [2]Univ. of Arkansas, USA, [3]Univ. of Oklahoma, USA.
We use terahertz pulses to probe ultrafast carrier dynamics in InGaAs quantum dot chains. The terahertz polarization is used to explore the anisotropy in the photoconductive response as a function of temperature and excitation density.

TuB3 • 10:45 a.m.
Carrier Dynamics in Self-Assembled ErAs Nanoislands Measured by Optical Pump-THz Probe Spectroscopy
Rohit P. Prasankumar[1], Anthony Scopatz[1], David J. Hilton[1], Antoinette J. Taylor[1], Richard D. Averitt[1], Joshua Zide[2], Arthur C. Gossard[2]; [1]Los Alamos Natl. Lab, USA, [2]Univ. of California at Santa Barbara, USA.
We use optical pump-THz probe spectroscopy to study carrier dynamics in self-assembled ErAs:GaAs nanoislands. Sub-picosecond carrier capture times are measured, indicating the potential of these devices as THz detectors comparable to low temperature grown GaAs.

TuB4 • 11:00 a.m.
Ultrafast Carrier Dynamics in Disordered Semiconductors Determined by Time-Resolved THz and NIR Spectroscopy
A. V. Vasudevan Nampoothiri, Susan L. Dexheimer; Washington State Univ., USA.
We determine ultrafast carrier dynamics characteristic of disordered semiconductors, including both dispersive transport and bimolecular recombination, via self-consistent modeling of time-resolved measurements in both the far-infrared (THz) and near-infrared spectral regions.

TuB5 • 11:15 a.m.
Terahertz Time-Domain Spectroscopy of Ionic Liquids
Kohji Yamamoto, Masanori Hangyo; Inst. of Laser Engineering, Osaka Univ., Japan.
We investigated the terahertz permittivity of ionic liquids by the terahertz time-domain spectroscopy. It is suggested that dynamical ion-ion correlations are necessary for representing the ultrafast dynamics of ionic liquids.

TuB6 • 11:30 a.m.
Ultrafast Dynamics of Nonlinear Excitations in Quasi-One-Dimensional Molecular Solids Probed by Time-Resolved THz Spectroscopy
Susan L. Dexheimer, A. V. Vasudevan Nampoothiri; Washington State Univ., USA.
We present time-resolved spectroscopic studies of the evolution of charge carriers and localized nonlinear excitations in a quasi-one-dimensional molecular system using femtosecond time-resolved THz techniques.

TuB7 • 11:45 a.m.
Ultrafast Photogeneration and Band-like Transport of Mobile Charge Carriers in Organic Semiconductors
Oksana Ostroverkhova[1], David G. Cooke[1], Svitlana Shcherbyna[1], Ray F. Egerton[1], Frank A. Hegmann[1], Rik R. Tykwinski[1], John E. Anthony[2], Vitaly Podzorov[3], Michael E. Gershenson[3], Oana D. Jurchescu[4], Thomas T. Palstra[4]; [1]Univ. of Alberta, Canada, [2]Univ. of Kentucky, USA, [3]Rutgers Univ., USA, [4]Univ. of Groningen, The Netherlands.
We report on sub-picosecond charge photogeneration and band-like charge transport in a variety of organic molecular crystals (pentacene, functionalized pentacene, tetracene and rubrene) and thin films (pentacene and functionalized pentacene) using time-resolved terahertz pulse spectroscopy.

12:00 p.m.–1:30 p.m.
Lunch Break (on your own)

Salon 4
1:30 p.m.–3:15 p.m.
TuC • Imaging and Microscopy
Philip Taday; Teraview Ltd., UK, Presider

TuC1 • 1:30 p.m.
THz Near-Field Microscopy

Paul C. Planken, Cathalijn E. van Rijmenam, Nick C. van der Valk; Delft Univ. of Technology, The Netherlands.
We present results on the spatial extent and origin of the near-field of a metal tip and the first measurement of a phonon resonance in THz apertureless scanning near-field optical microscopy.

TuC2 • 1:45 p.m.
THz Microscopy of Charge Carrier Distributions
Federico F. Buersgens[1], R. Kersting[1], H. T. Chen[2]; [1]Univ. of Munich, Germany, [2]Rensselaer Polytechnic Inst., USA.
We report on the application of apertureless THz microscopy for sensing charge carrier distributions in semiconductors on submicron scales. A spatial resolution of less than 1 micron allows for the detection of about 1000 electrons.

TuC3 • 2:00 p.m.
Near-field THz Probe Based on Electro-Optic Effect in an Unbalanced AlGaAs/GaAs Microresonator
Oleg Mitrofanov, Loren N. Pfeiffer, Ken W. West; Bell Labs, USA.
We discuss detection of terahertz transients using electro-optic effect in an unbalanced AlGaAs/GaAs optical resonator. The resonator significantly enhances electro-optic effect and allows THz detection by miniature probes. Application for THz near-field imaging is discussed.

TuC4 • 2:15 p.m.
Inspection of Semiconductor Devices without Bias Voltage Using a Laser-THz Emission Microscope
Masatsugu Yamashita[1], Kodo Kawase[1], Chiko Otani[1], Kiyoshi Nikawa[2], Masayoshi Tonouchi[3]; [1]RIKEN, Japan, [2]NEC Electronics Corp., Japan, [3]Inst. of Laser Engineering, Osaka Univ., Japan.
We measured normal and damaged MOSFETs without bias votage using LTEM. The polarity reversal of the THz emission waveform between normal MOSFET and damaged one indicates the possibillity of the LSI inspection without bias voltage.

TuC5 • 2:30 p.m.
High Resolution Co-Linear Stand-off Terahertz Reflection Imaging
David A. Zimdars, Jeffrey S. White, Greg Stuk, Steve Williamson; Picometrix Inc., USA.
We demonstrate terahertz reflection images of space shuttle sprayed on foam insulation and thermal protection system tiles from a true co-linear high resolution transceiver with 2 mm resolution at a 30 cm working distances.

TuC6 • 2:45 p.m.
Real-Time Two-Dimensional Spatiotemporal Imaging for THz Tomography of a Moving Object
Takashi Yasuda, Takeshi Yasui, Tsutomu Araki; Osaka Univ., Japan.
We proposed real-time two-dimensional spatiotemporal imaging for THz tomography of a moving object by combined use of non-collinear free-space electro-optic sampling and a line focus of THz pulse at a sample.

TuC7 • 3:00 p.m.
T-Ray Reflection Computed Tomography
Jeremy Pearce[1], Hyeokho Choi[1], Daniel Mittleman[1], Jeff White[2], Dave Zimdars[2]; [1]Rice Univ., USA, [2]Picometrix Inc., USA.
We describe a powerful new imaging modality for terahertz radiation, T-ray reflection computed tomography. Edge maps of an object's cross-section are reconstructed from a series of time-domain reflection measurements at different viewing angles.

Salon 8
3:15 p.m.–3:45 p.m.
Coffee Break

Salon 4
3:45 p.m.–5:30 p.m.
TuD • Techniques and Applications
Antoinette J. Taylor; Los Alamos Natl. Lab, USA, Presider

TuD1 • 3:45 p.m.
Dynamic Range and Numerical Error Propagation in Terahertz Time-Domain Spectroscopy
Bernd M. Fischer, Matthias Hoffmann, Peter U. Jepsen; Univ. of Freiburg, Germany.
We discuss the influence of electronic noise and laser fluctuations on the largest detectable absorption and data accuracy in terahertz time-domain spectroscopy. Error propagation from the time domain to the frequency domain is discussed.

TuD2 • 4:00 p.m.
The Role of Terahertz Technology in Security Applications and People Screening
Colin Baker, William R. Tribe, Bryan E. Cole, Mike C. Kemp; Teraview Ltd, [UK].
We discuss the role of pulsed terahertz systems for security screening applications. In particular, the use of terahertz systems in the detection of hidden objects and explosives by spectroscopy is investigated.

TuD3 • 4:15 p.m.
Coherent Detection of Tunable Narrowband Far-Infrared Radiation
Ajay Nahata; Univ. of Utah, USA.
We demonstrate the coherent detection of tunable narrowband far-infrared radiation. This radiation is produced using conventional difference frequency mixing and detected using the linear electro-optic effect. The technique can be straightforwardly extended to the mid-infrared.

TuD4 • 4:30 p.m.
Enhanced Emission and Detection Techniques for Terahertz Time-Domain Spectroscopy
Josef Kroell, Juraj Darmo, Karl Unterrainer, Werner Schrenk, Gottfried Strasser; Vienna Univ. of Technology, Austria.
By combining the advantages of cavity enhanced photoconductive emitters and electro-optic sensors with a new type of broadband anti-reflection coating the system performance is increased in terms of bandwidth and frequency resolution.

TuD5 • 4:45 p.m.
Spiral Optical Delay Line
Mohammed Salhi[1], Frank Rutz[1], Thomas Kleine-Ostmann[1], Vladimir Petukhov[1], Carsten Metz[2], Martin Koch[1]; [1]Inst. für Hochfrequenztechnik, Germany, [2]Bell Labs, Lucent Technologies, USA.
We present a spiral-shaped optical delay line which supports high data acquisition rates. Its working principle is demonstrated using a terahertz time-domain spectrometer. Our design proves to be superior to a shaking optical delay line.

TuD6 • 5:00 p.m.
Tunable and Fast THz Detectors Based on Quantum Hall Devices with Various Geometries
Nikolai Kalugin[1], C. Stellmach[2], A. Hirsch[2], G. Nachtwei[2], G. Hein[3], B. E. Sağol[3], Y. Vasilyev[4]; [1]Texas A&M Univ., USA, [2]Inst. für Technische Physik, Germany, [3]Physikalisch-Technische Bundesanstalt, Germany, [4]A. F. Ioffe Physical Technical Inst., Russian Federation.
In this work we separate different parts of the THz photoresponse of quantum Hall systems. In Corbino shaped detectors we realized the devices with response times from 20 ns to 150 ns.

TuD7 • 5:15 p.m.
Terahertz Emission from Catalytic-Metal/Semiconductor Interface of Hydrogen Sensors
Toshihiko Kiwa[1], Keiji Tsukada1, Masato Suzuki[2], Masayoshi Tonouchi[2], Sonoko Migitaka[3], Koichi Yokosawa[3]; [1]Okayama Univ., Japan, [2]Inst. of Laser Engineering, Osaka Univ., Japan, [3]Advanced Res. Lab, Hitachi Ltd., Japan.
Terahertz emission properties of catalytic-metal/semiconductor structures under hydrogen gas were investigated for non-contact and non-destructive test of hydrogen sensors. The peak amplitude of terahertz from the samples decreases with increasing the hydrogen concentration.

Poolside
5:30 p.m.–7:00 p.m.
Conference Reception

Wednesday, March 16, 2005

Salon 4
8:00 a.m.–9:45 a.m.
WA • Sources II
Mark Allen; Physical Sciences Inc., USA, Presider

WA1 • 8:00 a.m. (Invited)
Intense Coherent THz Pulses from the NSLS/SDL Linac and Applications in Material Sciences
G. Lawrence Carr; Brookhaven Natl. Lab, USA.
No abstract provided.

WA2 • 8:30 a.m.
The Jefferson Lab High Power THz User Facility
Amelia Greer[1], Joe F. Gubeli[1], George R. Neil[1], Michelle D. Shinn[1], Tim L. Siggins[1], David Waldman[1],,[2], Gwyn P. Williams[1], Alan Todd[2], Vincent Christina[2],,[3], Oleg Chubar[3]; [1]Jefferson Lab, USA, [2]Advanced Energy Systems, USA, [3]Synchrotron Soleil, France.
We describe a high power (100 Watt average, 10 MW peak) broadband THz facility based on emission from sub-picosecond bunches of relativistic electrons, and the system that transports this beam into a user laboratory.

WA3 • 8:45 a.m.
Application of a Compact FEL on THz Imaging
Young Uk Jeong[1], Hyuk Jin Cha[1], Seong Hee Park[1], Byung Cheol Lee[1], Grigori M. Kazakevitch[2]; [1]Lab for Quantum Optics, Korea Atomic Energy Res. Inst., Republic of Korea, [2]Budker Inst. of Nuclear Physics, Russian Federation.
We have developed a compact terahertz free electron laser operating in the 100-1200 μm range. In this paper we will show and discuss the main results of THz imaging by using the KAERI compact FEL.

WA4 • 9:00 a.m.
Enhanced Terahertz Emission from Porous InP
Matthew E. Reid[1], Igor Cravetchi[1], Robert Fedosejevs[1], Ion Tiginyanu[2], L. Sirbu[2], Robert W. Boyd[3]; [1]Univ. of Alberta, Canada, [2]Inst. of Applied Physics, Acad. of Sciences and Technical Univ. of Moldova, Republic of Moldova, [3]Inst. of Optics, Univ. of Rochester, USA.
Terahertz and second-harmonic emission from bulk and porous InP samples is investigated under irradation with femtosecond Ti:Sapphire laser pulses. The emission from the porous samples is enhanced relative to the bulk samples.

WA5 • 9:15 a.m.
Compact Tunable p-Ge Laser
T. W. Du Bosq[1], A. V. Muravjov[1], Kijun Park[1], C. Mathis[1], T. J. Mahaney[1], M. V. Dolguikh[1], R. E. Peale[1], C. J. Fredricksen[2]; [1]Univ. of Central Florida, USA, [2]Zaubertek, USA.
Innovations in intracavity wavelength selection in the range 1.5 to 4.2 THz and compact control electronics enable a commercial application for a far-infrared p-Ge laser.

WA6 • 9:30 a.m.
Terahertz Gain in Multilayer Delta-Doped p-Ge Film
M. V. Dolguikh[1], A. Muravjov[1], R. Peale[1], O. Kuznetsov[2], E. Uskova[2]; [1]Univ. of Central Florida, USA, [2]Univ. of Nizhny Novgorod, Russian Federation.
A proposed multi-layer planar intersubband THz laser in p-type germanium is tested by numerical simulation and preliminary experiments. Population inversion and gain sufficient for laser operation are expected up to 77 K.

Pre-function Area
9:45 a.m.–10:15 a.m.
Coffee Break

Salon 4
10:15 a.m.–12:00 p.m.
WB • Biological Applications
Charles Schmuttenmaer; Yale Univ., USA, Presider

WB1 • 10:15 a.m. (Invited)
Biomolecular Sensing with Integrated THz Systems
Peter G. Haring Bolivar; Inst. für Halbleitertechnik, Germany.
No abstract provided.

WB2 • 10:45 a.m.
Terahertz Spectroscopy of RNA and DNA and Spot Array Imaging
Matthias Hoffmann, Bernd M. Fischer, Peter U. Jepsen; Univ. of Freiburg, Germany.
We characterize the dielectric properties of RNA and DNA polymers, and perform THz imaging of biopolymer spot arrays. We discuss the design of a THz spectroscopy system for characterization of microscopic quantities of sample material.

WB3 • 11:00 a.m.
High-Speed Characterization of Integrated Resonant THz Biosensors Using Asynchronous Optical Sampling
Christof Janke[1], Michael Nagel[1], Michael Först[1], Heinrich Kurz[1], Albrecht Bartels[2]; [1]Inst. für Halbleitertechnik, RWTH Aachen Univ., Germany, [2]GigaOptics GmbH, Germany.
Asynchronous optical sampling using two slightly detuned GHz-repetition rate femtosecond lasers is employed to spectrally characterize integrated THz resonators for biomolecular sensing. Temporal delay scanning at kilohertz frequencies paves the way for high-throughput analytics.

WB4 • 11:15 a.m.
Biochemical Sensing of Picoliter Volumes of Analyte Using Photonic Crystals Based Sensors in the Terahertz Region
Hamza Kurt, David S. Citrin; Georgia Tech, USA.
Photonic crystals open up the applicability of them for biosensing purposes. We proposed and carried out the detailed study of photonic crystal based sensors with different configurations using finite-difference time-domain method with recursive convolution.

WB5 • 11:30 a.m.
Highly Sensitive Detection of the Onset of Solid-State Phase Transition in an Endocrine-Disrupting Estrogen-Like Chemical Using Terahertz Radiation
Alex Quema[1], Gilbert Diwa[1], Hidetoshi Murakami[1], Shingo Ono[1], Nobuhiko Sarukura[1], Gerardo Janairo[2]; [1]Inst. for Molecular Science, Japan, [2]De La Salle Univ., Philippines.
Using terahertz transmission spectroscopy, solid-state phase transition onset in an estrogen-like chemical is detected. This is indicated by the observation of two broad absorption peaks and sudden upsurge of terahertz-radiation power at 210 K.

WB6 • 11:45 a.m.
Complex Dielectric Constant of Amino-Acid Solution Revealed by THz Time-Domain Attenuated Total-Reflection Technique
Takashi Arikawa, Kumiko Yamashita, Hideki Hirori, Masaya Nagai, Koichiro Tanaka; Kyoto Univ., Japan.
We measure complex dielectric constants of amino-acid solution with THz Time-domain attenuated total-reflection technique. The analysis with considering local field reveals intermolecular interaction between amino-acid molecules and water molecules.