



UEO

Ultrafast Electronics & Optoelectronics

Topical Meeting and Tabletop Exhibit

January 15-16, 2003
Wyndham City Center
Washington, DC

Technical Program Committee

Chairs:

- Young-Kai Chen, *Bell Laboratories, Lucent Technologies, USA*, Conference Chair
- Peter Delfyett, *University of Central Florida, USA*, Co-Chair
- Yohtaro Umeda, *NTT Photonics Laboratories, Japan*, Co-Chair

Electronics:

- Mark Rodwell, *University of California, Santa Barbara, USA*
- Ekmel Ozbay, *Bilkent University, Europe*
- Tado Ishibashi, *NTT Laboratories, Japan*
- Taiichi Otsuji, *Kyushu Institute of Technology, Japan*

Ultrafast Systems:

- David Cotter, *Corning Inc, Europe*
- Keren Bergmann, *Columbia University, USA*
- Wayne Knox, *University of Rochester, USA*
- M. Nakazawa, *Tohoku University, Japan*
- Ming Wu, *University of California, Los Angeles, USA*

Ultrafast optical physics:

- Ted Norris, *University of Michigan, USA*
- Lars Thylen, *KTH-Electrum, Europe*
- Jagdeep Shah, *DARPA, USA*
- Jim Allen, *University of California, Santa Barbara, USA*
- Takayoshi Kobayashi, *University of Tokyo, Japan*

About UEO

A revolution in communications is taking place. Optical fiber will carry terabits of data, while mm-wave radio links will carry gigabits. Signals are produced by ultrafast optical techniques, and ultrafast electronic and optoelectronic devices. Nonlinear optical processes and electronic and optoelectronic devices switch femtosecond pulses and generate THz signals. Electronics is progressing towards THz transistors and 100 GHz logic. Don't miss this opportunity to learn about leading results and critical applications in ultra-high-speed communications, science, and measurement.

Meeting Scope

January 15-16, 2003

- **Gigabit / terabit communications:** high capacity fiber links, time-division and wavelength-division multiplexing. mm-wave and THz radio communication
- **THz and fs measurements:** optoelectronic device and circuit probing, noninvasive testing, THz imaging and THz spectroscopy
- **Ultrafast optoelectronics:** photodetectors, GHz direct-modulated semiconductor lasers, electrooptic and electroabsorption modulators for 40 Gbit/s and above
- **Ultrafast optics:** new sources of high-speed or high-frequency optical signals and pulses, integrated fs sources, new wavelength regimes, measurement techniques
- **Ultrafast electronics:** transistors, logic, amplifiers, ICs for fiber and mm-waves
- **All-optical techniques:** all-optical switching and processing, fiber and semiconductor devices, multiplexing, and wavelength conversion
- **THz sources and detectors:** photomixers, hot-electron- and nano-bolometers, far-IR lasers, multipliers and mixers, resonant tunneling and superlattices, novel devices
- **Physics and materials:** Ultrafast spectroscopy, non-equilibrium processes in materials and devices, carrier dynamics, quantum confinement, transport effects; nonlinear pulse propagation, wave mixing, solitons, nonlinear optical materials

Speakers

The list of invited speakers for the UEO program follows:

Ultrafast physics and materials

- Diffraction transformation of ultra short pulses in sub-cycle regime, Oleg Mitrofanov, *Bell Labs, Lucent Tech., USA*
- Ultrafast spectroscopy of materials using ultrashort visible light pulses, Dr. Masakatsu Hirasawa, *Univ. of Tokyo, Japan*

Terahertz generation and detection

- All-electronic terahertz spectroscopy, Daniel Van Der Weide, *Univ. of Wisconsin, USA*
- Terahertz imaging, Professor Xi Cheng Zhang, *Rensselaer Polytechnic Inst., USA*

Ultrafast optical and electronic devices

- Pushing the frequency envelope using ultrafast SiGe HBTs with f_t/f_{max} above 200GHz, Joseph Alvin, *IBM Communications R&D Ctr., USA*
- Digital ICs at beyond 100 GHz, Mehran Mokhtari, *HRL, USA*

Ultrafast optoelectronic devices and systems

- Ultrafast optoelectronic functional circuits based on uni-traveling carrier photodiodes, Satoshi Kodama, *NTT Photonics Labs., Japan*
- Ultrafast all-optical switching using intersubband transition in InGaAs/AlAsSb double quantum-well structure, Osamu Wada, *Kobe Univ., Japan*

Ultrafast Lasers & Measurements

- Ultrashort pulse technology based on optical fibers, Roy Taylor, *Imperial College, U.K.*
- Femtosecond optical carrier-phase stabilization, Steve Cundiff, *NIST, USA*

- Ultrastable modelocked diode lasers, Tolga Yilmaz, *Univ. of Central Florida, USA*

Ultrafast applications (imaging, switching, communications, etc.)

- All-optical microwave vector modulator, Andreas Leven, *Bell Labs., Lucent Tech., USA*
- Broadband wireless access system using 120 GHz radio-on-fiber technology, Tadao Nagatsuma, *NTT Telecommunications Energy Labs., Japan*
- Photonically assisted burst and continuous arbitrary millimeter waveform generation via direct space-to-time pulse shaping, A. Weiner, *Purdue Univ., USA*

Publications

Advance Program

This Advance Program is only available via the website. A broadcast email will be sent to all previous registrants and authors notifying them of the availability of the online program.

Technical Digests

The UEO Technical Digest will be comprised of the camera-ready summaries of papers being presented during the meeting. At the meeting, each registrant will receive a copy of one Technical Digest. Extra copies can be purchased at the meeting for a special price of \$45 USD.

UEO Exhibitor List

2001 UEO Exhibitor List:

- IMRA America Inc.
- Inrad, Inc.
- Laser Focus World
- Onyx Optics
- Photonics Spectra

Agenda of Sessions

▼Tuesday January 14, 2003

Time	Event
4:00pm-6:00pm	Registration, City Center Ballroom Foyer

▼Wednesday January 15, 2003

Time	Event
7:30am-5:00pm	Registration, City Center Ballroom Foyer
8:30am-8:45am	OPENING REMARKS, City Center 1
8:45am-10:30am	WA, ULTRAFAST OPTICS, City Center 1
10:30am-4:00pm	Exhibits Open, City Center 2
10:30am-11:00am	Coffee Break, City Center 2
11:00am-12:00pm	WB, ULTRAFAST SWITCHING, City Center 1
12:00pm-1:30pm	Lunch Break
1:30pm-3:30pm	WC, ULTRAFAST PHYSICS AND SPECTROSCOPY, City Center 1
3:30pm-4:00pm	Coffee Break, City Center 2
4:00pm-5:00pm	WD, ULTRAFAST IMAGING, City Center 1
5:00pm-6:30pm	POSTDEADLINE PAPER SESSION, City Center 1
6:30pm-8:30pm	Conference Banquet, Potomac Room

▼Thursday January 16, 2003

Time	Event
7:30am-5:00pm	Registration, City Center Ballroom Foyer
8:30am-10:15am	ThA, ULTRAFAST LASERS, City Center 1
10:00am-4:00pm	Exhibits Open, City Center 2
10:15am-11:00am	Coffee Break, City Center 2
11:00am-12:00pm	ThB, ULTRAFAST OPTOELECTRONIC DEVICES, City Center 1
12:00pm-1:30pm	Lunch Break
1:30pm-3:15pm	ThC, ULTRAFAST OPTICAL/MILLIMETER-WAVE APPLICATIONS, City Center 1
3:15pm-3:45pm	Coffee Break, City Center 2
3:45pm-5:00pm	ThD, ULTRAFAST ELECTRONICS, City Center 1
5:00pm-5:15pm	CLOSING REMARKS, City Center 1

Ultrafast Electronics & Optoelectronics Abstracts



■ Tuesday
■ January 14, 2003

Room: City Center Ballroom Foyer
4:00pm – 6:00pm
■ Registration

■ Wednesday
■ January 15, 2003

Room: City Center Ballroom Foyer
7:30am – 5:00pm
■ Registration

Room: City Center 1
8:30am – 8:45am
■ Opening Remarks

Room: City Center 1
8:45am - 10:30am
WA ■ Ultrafast Optics
W. Knox, Univ. of Rochester, Rochester, NY,
USA, Presider

WA1 8:45am Invited
Carrier-envelope phase stabilization of ultrashort optical pulses, S. Cundiff, T. Fortier, D. Jones, J. Ye, JILA/NIST and Univ. of Colorado, Boulder, CO, USA.
The recent melding of ultrafast technology with laser stabilization techniques has enabled the stabilization of the carrier-envelope phase. This has impacted optical frequency metrology and optical clocks and promises advances in ultrafast sciences.

WA2 9:15am Invited
Diffraction transformation of ultrashort pulses in subcycle regime, O. Mitrofanov, Lucent/Bell Labs., Murray Hill, NJ, USA.
Diffraction of ultrashort electromagnetic pulses results in deformation of the temporal waveform. The deformation is significant if the pulse duration is comparable to the period of the carrier wave. Effects of diffraction transformation in the sub-cycle regime will be presented.

WA3 9:45am
Mode-locking stability observation of a kerr-lens mode-locked Ti:sapphire laser analyzed by a recently developed real-time spectrum analyzer, H. Takahashi, Y. Suzuki, Graduate Univ. for Advanced Studies, Hayama, Japan; S. Ono, N. Sarukura, Inst. for Molecular Science, Okazaki, Japan; T. Nakamura, Tektronix Japan, Ltd., Nagoya, Japan.

The mode-locking stability of a Kerr-lens mode-locked Ti:sapphire is investigated by a newly developed real-time spectrum analyzer, which can seamlessly acquire the time-domain signals and provide time-varying power spectrum.

WA4 10:00am
Ultrafast lattice-bonding dynamics in tellurium, C. Roeser, A. Kim, E. Mazur, Harvard Univ. Cambridge, MA, USA.

A pump-probe technique measuring the dielectric function is presented and applied to the ultrafast dynamics of coherent phonons in Te. Oscillations in the bonding-antibonding splitting are revealed, allowing for THz modulation of a semiconductor-semimetal transition.

WA5 10:15am
Use of single-crystal DAST as electro-optic transducer in electro-optic sampling systems, X. Zheng, S. Wu, R. Sobolewski, Univ. of Rochester, Rochester, NY, USA; R. Adam, M. Mikulics, A. Förster, J. Schelten, P. Kordos, M. Siegel, Res. Ctr. Juelich, Juelich, Germany.

We present an organic 4-dimethylamino-N-methyl-4-stilbazolium tosylate (DAST) material, as a transducer in our electro-optic-sampling system. Compared to LiTaO₃, DAST has the lower dielectric constant and significantly higher electro-optic coefficient, resulting in much improved performance of the system.

Room: City Center 2
10:30am – 11:00am
Coffee Break

Room: City Center 1

11:00am - 12:00pm

WB ■ Ultrafast Switching

P. Delfyett, Univ. of Central Florida, Orlando, FL, USA, Presider

WB1 11:00am Invited

Ultrafast all-optical switching using intersubband transition in InGaAs/AlAsSb double quantum-well structure, *O. Wada, Kobe Univ., Nada, Kobe, Japan.*

Abstract not available.

WB2 11:30am

THz-radiation from InAs with various surface orientations in a magnetic field, *H. Takahashi, Y. Suzuki, Dept. of Photo Science, Graduate Univ. for Advanced Studies, Hayama, Japan; M. Sakai, S. Ono, N. Sarukura, Inst. for Molecular Science, Okazaki, Japan; T. Sugiura, T. Hirosumi, M. Yoshida, Aisin Seiki Co., Ltd., Kariya, Japan.*

Magnetic-field dependence of THz-radiation power from InAs with various surface orientations is investigated. Significant difference of the saturation peak is clearly observed for (111) surface, in comparison with (100) or (110) surfaces.

WB3 11:45am

100 GHz pulse sequence generation from a 1.5 μ direct space-to-time pulse shaper, *J. McKinney, A. Weiner, Purdue Univ., West Lafayette, IN, USA; D. Seo, Myongji Univ., Seoul, Republic of Korea.*

We demonstrate optical pulse sequence generation at rates of 100 Gb/s using a novel direct space-to-time pulse shaping technique. The pulse sequences are generated by parallel-to-serial conversion of the spatial profile of the short input pulse to the pulse shaper.

12:00pm – 1:30pm

Lunch on Your Own

Room: City Center 1

1:30pm - 3:30pm

WC ■ Ultrafast Physics and Spectroscopy

T. Norris, Univ. of Michigan, Ann Arbor, MI, USA, Presider

WC1 1:30pm Invited

Sub-5-fs pulse generation from a noncollinear optical parametric amplifier and its application to real-time spectroscopy, *M. Hirasawa, T. Kobayashi, Univ. of Tokyo, Tokyo, Japan.*

Transform-limited (TL) visible pulses with as short as sub-5-fs duration have been generated from a noncollinear optical parametric amplifier and applied to the study of polyacetylene, polydiacetylene, azobenzene, and J-aggregates of porphyrin for optical devices.

WC2 2:00pm Invited

All electronic terahertz spectroscopy, *D. van der Weide, Univ. of Wisconsin, Madison, WI, USA.*

Ultrafast electronic circuits coupled to broadband antennas can be employed for coherent spectroscopy in the GHz-THz regime. Reflection and transmission signatures of biological and energetic materials highlight the potential of this technology for sensing.

WC3 2:30pm

Ultrafast inter-subband hole relaxation in an InGaN multiple-quantum-well laser diodeantum-well (MQW) laser diode, *K. Gan, J. Bowers, S. DenBaars, Univ. of California, Santa Barbara, Santa Barbara, CA, USA; C. Sun, Natl. Taiwan Univ., Taipei, Taiwan.*

The femtosecond carrier dynamics in InGaN MQW laser diodes were investigated using a time-resolved bias-lead monitoring technique. Ultrafast inter-subband hole relaxation processes were found to dominated the observed carrier dynamics.

WC4 2:45pm

Temperature-dependent transparency conditions and spatial degeneracy in self-organized quantum dots,

K. Kim, T. Norris, J. Singh, P. Bhattacharya, Univ. of Michigan, Ann Arbor, MI, USA.

We have used ultrafast spectroscopic measurements of gain spectra in self-organized quantum dots to measure directly the transparency condition at different temperatures and wavelengths. The results provide insight into the energy-dependent density-of-states and carrier thermalization in high-speed quantum-dot lasers.

WC5 3:00pm

Significant enhancement of THz-radiation from InSb by use of a communication-wavelength laser,

H. Takahashi, Y. Suzuki, Graduate Univ. for Advanced Studies, Hayama, Japan; M. Sakai, S. Ono, N. Sarukura, Inst. for Molecular, Okazaki, Japan; T. Sugiura, T. Hirosumi, M. Yoshida, Aisin Seiki Co., Ltd., Kariya, Japan.

Magnetic-field dependence of THz-radiation power from InSb (100) surface is investigated. Significant enhancement of THz-radiation power is successfully achieved by using a 1560 nm excitation and an external magnetic field.

WC6 3:15pm

Ultrafast transient photoconductivity of bisbenzocyclobutene (BCB) polymer films,

W. Cao, M. Du, Y. Kim, W. Herman, C. Lee, Univ. of Maryland, College Park, MD, USA.

Ultrafast photoconductive switching was observed for the first time for BCB in a metal-polymer-metal (MPM) device. Transient photoconductivity vs. laser fluence and bias voltage were investigated. Carrier mobility of $1.1 \times 10^{-3} \text{ cm}^2/\text{Vs}$ at a electrical field of $5 \times 10^5 \text{ V/cm}$ was estimated.

Room: City Center 2

3:30pm – 4:00pm

Coffee Break

Room: City Center 1

4:00pm - 5:00pm

WD ■ Ultrafast Imaging

T. Kobayashi, Univ. of Tokyo, Tokyo, Japan, President

WD1 4:00pm Invited

Terahertz imaging, *X. Zhang, Rensselaer Polytechnic Inst., Troy, NY, USA.*

Abstract not available.

WD2 4:30pm

Identification of metal surface features with THz dark-field imaging techniques,

N. Hasegawa, Physikalisches Inst. der Johann Wolfgang Goethe-Univ., Frankfurt am Main, Germany and Nippon Steel Corp., Chiba, Japan; M. Thomson, T. Löffler, H. Roskos, Physikalisches Inst. der Johann Wolfgang Goethe-Univ., Frankfurt am Main, Germany.

We demonstrate that diffraction and scattering of coherent terahertz (THz) radiation by texture variations on surfaces allows characterization of sub-millimeter-sized surface topographical features of metals and other technical materials.

WD3 4:45pm

The application of ultrafast photonic technique on polarization switching dynamics study of thin film ferroelectric PZT capacitors,

J. Li, H. Liang, B. Nagaraj, W. Cao, C. Lee, R. Ramesh, Univ. of Maryland, College Park, MD, USA.

We demonstrate the use of jitter-free, ultrafast rise-time electrical pulses generated by a semiconductor photoconductive switch with femtosecond laser illumination to study the fast polarization switching process in fully integrated, ferroelectric PZT thin film capacitors.

Room: City Center 1

5:00pm – 6:30pm

■ Postdeadline Paper Session

Room: Potomac Room

6:30pm – 8:30pm

■ Conference Banquet

Speaker: Robert Leheny, Director of DARPA, Microsystems Tech. Office, Arlington, VA, USA.

■ Thursday
■ January 16, 2003

Room: City Center Ballroom Foyer

7:30am – 5:00pm

■ Registration

Room: City Center 1

8:30am - 10:15am

ThA ■ Ultrafast Lasers

K. Bergmann, Columbia Univ., New York, NY, USA,
Presider

ThA1 8:30am Invited

Ultrastable modelocked diode lasers, T. Yilmaz, C. DePriest, P. Delfyett, Univ. of Central Florida, Orlando, FL; A. Braun, J. Abeles, Sarnoff Corp., Princeton, NJ, USA.

Pulsetrain RF noise characteristics of a modelocked external cavity semiconductor laser is examined and photonic RF synthesis and potential for arbitrary waveform generation is demonstrated.

ThA2 9:00am Invited

Ultrashort pulse technology based on optical fibers, J. Taylor, Imperial College, London, United Kingdom.

Various fibre-based ultrashort pulse sources are described with emphasis placed on simple integrated single-pass, master-oscillator power-fibre amplifier schemes combining non-linear manipulation that allows pulse width as well as wavelength tunability at moderate (~W) average power levels.

ThA3 9:30am

Dispersion managed semiconductor mode-locked ring laser, B. Resan, L. Archundia, P. Delfyett, CREOL/School of Optics, Univ. of Central Florida, Orlando, FL, USA; G. Alphonse, Sarnoff Corp., Princeton, NJ, USA.

A novel type of external σ -ring cavity semiconductor mode-locked laser is characterized, employing both intracavity pulse compression and stretching. Resulting generated pulses have asymmetric exponential pulse shapes with linear chirp, which can be compensated to 274 fs.

ThA4 9:45am

High bit rate and reduced noise multiwavelength modelocked semiconductor lasers, M. Mielke, P. Delfyett, CREOL/School of Optics, Orlando, FL, USA; G. Alphonse, Sarnoff Corp., Princeton, NJ, USA.

A gain-flattened multiwavelength modelocked semiconductor laser transmitter generates 6 Gb/s pulses into 168 discrete wavelength channels. Hybrid modelocking suppresses mode partition noise and produces error-free (pulse Q > 13) pulses simultaneously in each channel of a multiwavelength semiconductor laser.

ThA5 10:00am

Reduction of excess laser noise in electro-optic sampling of high-speed circuits for eye-diagram measurements, O. Mitrofanov, Bell Labs., Lucent Tech., Murray Hill, NJ, USA.

A new optical detection scheme for measurements of small optical phase shifts is proposed and demonstrated. The scheme allows broadband reduction of excess laser noise. ~20 dB noise reduction is achieved in electro-optic sampling system for testing high-speed integrated circuits.

Room: City Center 2

10:15am – 11:00am

Coffee Break

Room: City Center 1

11:00am - 12:00pm

ThB ■ Ultrafast Optoelectronic Devices

*M. Wu, Univ. of California, Los Angeles, CA, USA,
Presider*

ThB1 11:00am Invited

Ultrafast monolithic optoelectronic devices based on uni-traveling-carrier photodiodes, *S. Kodama, Hiroshi Ito, NTT Photonics Labs., NTT Corp., Atsugi-shi, Japan.*

This paper describes the basic features of the uni-traveling-carrier photodiode (UTC-PD) and its applications to ultrafast monolithic optoelectronic devices.

ThB2 11:30am

Very fast metal-semiconductor-metal ultraviolet photodectors on GaN with submicron finger width, *J. Li, W. Donaldson, T. Hsiang, Univ. of Rochester, Rochester, NY, USA.*

We measured in time domain fast metal-semiconductor-metal ultraviolet photodetectors on GaN with sub-micrometer pitches. Results indicate a fixture-limited response of 26 ps at low illuminations. At higher illumination, space-charge screening is observed.

ThB3 11:45am

Ultrafast and sensitive photodetectors based on GaAs implanted by high-energy nitrogen ions, *S. Wu, X. Zheng, R. Sobolewski, Univ. of Rochester, Rochester, NY, USA; M. Mikulics, M. Marso, P. Kordos, Res. Ctr. Juelich, Juelich, Germany; S. Stancek, P. Kovac, Slovak Univ. of Tech., Bratislava, Slovakia.*

We present novel photodetectors based on nitrogen-implanted GaAs. Compared to low-temperature-grown GaAs devices, our ion-implanted GaAs detectors exhibit better sensitivity without sacrificing the ultrafast photoresponse time.

12:00pm – 1:30pm

Lunch on Your Own

Room: City Center 1

1:30pm - 3:15pm

ThC ■ Ultrafast Optical/Millimeter-Wave Applications

*T. Otsuji, Kyushu Inst. of Tech., Fukuoka, Japan,
Presider*

ThC1 1:30pm Invited

120-GHz millimeter-wave photonics for broadband wireless systems, *T. Nagatsuma, A. Hirata, T. Minotani, NTT Microsystem Integration Labs., Atsugi, Kanagawa, Japan.*

Photonic techniques can provide 10-Gb/s wireless links using >100-GHz millimeter waves. We describe key technologies for realizing broadband link systems.

ThC2 2:00pm Invited

All-optical microwave vector modulator, *A. Leven, Lucent Tech., Murray Hill, NJ.*
Abstract not available.

ThC3 2:30pm Invited

Photonic assisted burst and continuous arbitrary millimeter waveform generation via direct space-to-time pulse shaping, *J. McKinney, A. Weiner, Purdue Univ., West Lafayette, IN, USA; D. Seo, Myongji Univ., Seoul, Republic of Korea.*
Tailored optical pulse sequences from a novel direct space-to-time pulse shaper driving a high-speed photodiode allow generation of electromagnetic waveforms at center frequencies approaching 50 GHz. Through direct modulation of the optical pulse sequence, arbitrarily phase-and frequency-modulated waveforms are created.

ThC4 3:00pm

A voltage-controlled phase shifter that uses gate electrode lines of traveling-wave field effect transistors, *K. Narahara, T. Suemitsu, NTT Photonics Lab., NTT Corp., Kanagawa, Japan.*
This paper describes a suitable design criterion and theoretical and experimental investigations of the TW-FET as a phase shifter.

Room: City Center 2
3:15pm – 3:45pm
Coffee Break

Room: City Center 1
ThD ■ Ultrafast Electronics
3:45pm - 5:00pm

Y. Umeda, NTT, Atsugi, Japan, Presider

ThD1 3:45pm Invited
Digital ICs at beyond 100 GHz, M. Mohktari,
HRL, CA, USA.
Abstract not available.

ThD2 4:15pm Invited
Pushing the frequency envelope using ultra-fast
SiGe HBTs with f_T / f_{max} above 200 GHz, A.
Joseph, A. Stricker, J. Dunn, J. Johnson, D.
Harame, IBM, Essex Junction, VT, USA; G.
Freeman, J. Rieh, B. Jagannathan, IBM, Hopewell
Junction, NY, USA.

High-speed optical network applications require high performance bipolar transistors that provide jitter-free operation. Over the last several years, SiGe HBTs have made significant strides in performance, surpassing that of the GaAs or InP HBT based technologies that are currently in production. In addition, the ability to seamlessly integrate these SiGe HBTs with high-performance CMOS and passives provides a power-performance advantage at a much reduced cost and higher yields, making SiGe BiCMOS as the technology of choice for a wide range of communication IC applications. In this paper we present the status, challenges, and future directions for the development and integration of ultra-fast SiGe HBTs with f_T / f_{max} surpassing 200GHz.

ThD3 4:45pm
Submicron AlGaIn/GaN HEMTs for wireless
applications, M. Manfra, N. Weimann, Bell Labs.,
Lucent Tech. Inc., Murray Hill, NJ, USA.

We report on recent progress in AlGaIn/GaN HEMT devices grown by plasma-assisted Molecular Beam Epitaxy. While most reports of high power AlGaIn/GaN HEMTs have used

MOCVD-grown material, recent advances in the growth of AlGaIn/GaN HEMT structures by plasma-assisted MBE has enabled devices with performance rivaling the MOCVD-grown HEMTs. In our laboratory, we fabricated submicron HEMTs with f_t and f_{max} of 52 and 109 GHz, respectively, from layers grown by plasma-assisted MBE on semi-insulating 6H-SiC substrates. These cutoff frequencies were obtained with gate lengths of 200 nm. The HEMTs were optimized for maximum power output as measured on-wafer using an ATN load-pull setup. At 7 GHz, we recorded a saturated output power density of 6.1 W/mm with 40% PAE and 4.6 dB gain compression. In saturation, a gain of 10.8 dB was still available. The device with a gate periphery of 200 μ m was biased at $V_{DS} = 25$ V and $V_{GS} = -5$ V. At 2 GHz with 1 μ m gate length, we recorded a saturated output power density of 8.2 W/mm, with 41% efficiency and 11.2 dB gain. These high power densities are useful for power amplifiers targeted at frequency bands spanning from S- to Ka-band, taking advantage of the high output impedance given by the high breakdown voltage, and the high efficiency of AlGaIn/GaN HEMTs. MBE growth has distinct advantages in control of background impurities, uniformity, and interface sharpness. Our devices are unpassivated; we observe minimal drain dispersion or RF drain current compression even without passivation on HEMTs fabricated from optimized layers. We expect to raise f_t towards 100 GHz with scaled T-gate length and barrier thickness, enabling high-power amplifiers (few watts) operating up to 50 GHz.

Room: City Center 1
5:00pm – 5:15pm
■ Closing Remarks