

Terahertz and Ultrashort Electromagnetic Pulses for Biomedical Applications

**Gerald J. Wilmink
Bennett L. Ibey**
Editors

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Contents

vii	<i>Conference Committee</i>
ix	<i>Introduction</i>

SESSION 1 TERAHERTZ TECHNOLOGIES

- 8585 06 **Development of terahertz (THz) microfluidic devices for “Lab-on-a-Chip” applications (Invited Paper)** [8585-5]
Q. Tang, M. Liang, Y. Lu, P. K. Wong, The Univ. of Arizona (United States); G. J. Wilmink, Air Force Research Lab. (United States); H. Xin, Univ. of Arizona (United States) and Air Force Research Lab. (United States)
- 8585 07 **Terahertz sensing with meta-surfaces and integrated circuits (Invited Paper)** [8585-6]
B. Reinhard, Univ. of Kaiserslautern (Germany); K. Schmitt, Univ. of Kaiserslautern (Germany) and Fraunhofer Institute for Physical Measurement Techniques IPM (Germany); T. Fip, Univ. of Kaiserslautern (Germany); M. Volk, Univ. of Kaiserslautern (Germany) and Fraunhofer Institute for Physical Measurement Techniques IPM (Germany); J. Neu, A.-K. Mahro, Univ. of Kaiserslautern (Germany); R. Beigang, Univ. of Kaiserslautern (Germany) and Fraunhofer Institute for Physical Measurement Techniques IPM (Germany); M. Rahm, Univ. of Kaiserslautern (Germany)
- 8585 08 **Terahertz quantum cascade laser based optical coherence tomography (Invited Paper)** [8585-7]
A. W. M. Lee, LongWave Photonics LLC (United States) and Massachusetts Institute of Technology (United States); T.-Y. Kao, Q. Hu, Massachusetts Institute of Technology (United States); J. L. Reno, Sandia National Labs. (United States)
- 8585 09 **Terahertz and mid-infrared photoexpansion nanospectroscopy (Invited Paper)** [8585-8]
F. Lu, M. Jin, Univ. of Texas at Austin (United States); M. Salih, P. Dean, S. P. Khanna, L. H. Li, G. Davies, E. H. Linfield, Univ. of Leeds (United Kingdom); M. A. Belkin, Univ. of Texas at Austin (United States)

SESSION 2 SPECTROSCOPY AND THEORY

- 8585 0D **Molecular modeling of membrane modifications after exposure to nanosecond, pulsed electric fields (Keynote Paper)** [8585-12]
P. T. Vernier, Univ. of Southern California (United States) and Old Dominion Univ. (United States)
- 8585 0E **Protein-water network dynamics during metalloenzyme hydrolysis observed by kinetic THz absorption (KITA) (Invited Paper)** [8585-13]
B. Born, Ruhr-Univ. Bochum (Germany) and Weizmann Institute of Science (Israel); M. Heyden, Univ. of California, Irvine (United States); M. Grossman, I. Sagi, Weizmann Institute of Science (Israel); M. Havenith, Ruhr-Univ. Bochum (Germany)

- 8585 OF **Determination of the optical properties of melanin-pigmented human skin equivalents using terahertz time-domain spectroscopy** [8585-14]
D. Lipscomb, Air Force Research Lab. (United States) and Univ. of California, Berkeley (United States); I. Echchgadda, National Academy of Sciences NRC Research Associateship (United States); X. G. Peralta, Univ. of Texas at San Antonio (United States); G. J. Wilmink, Air Force Research Lab. (United States)

SESSION 3 NSEP AND THZ BIOMEDICAL APPLICATIONS

- 8585 OG **Nanoelectroablation for human carcinoma therapy (Keynote Paper)** [8585-15]
R. Nuccitelli, M. Kreis, B. Athos, R. Wood, J. Huynh, K. Lui, P. Nuccitelli, BioElectroMed Corp. (United States); E. Epstein, Children's Hospital Oakland Research Institute (United States)
- 8585 OI **Hemorrhage control by microsecond electrical pulses** [8585-17]
Y. Mandel M.D., Hansen Experimental Physics Lab., Stanford Univ. (United States); R. Manivanh, R. Dalal, Stanford Univ. (United States); P. Huie, J. Wang, M. Brinton, D. Palanker, Hansen Experimental Physics Lab., Stanford Univ. (United States))
- 8585 OJ **Using a portable terahertz spectrometer to measure the optical properties of in vivo human skin** [8585-18]
I. Echchgadda, National Academy of Sciences NRC Research Associateship (United States); J. E. Grundt, Air Force Research Lab. (United States); M. Tarango, General Dynamics Information Technology (United States); B. L. Ibey, Air Force Research Lab. (United States); T. Tongue, Zomega Terahertz Corp. (United States); M. Liang, H. Xin, The Univ. of Arizona (United States); G. J. Wilmink, Air Force Research Lab. (United States)
- 8585 OK **Identification of tissue interaction of terahertz radiation toward functional tissue imaging** [8585-19]
H. Yokus, W. Baughman, S. Balci, M. Bolus, D. Wilbert, P. Kung, S. M. Kim, Univ. of Alabama (United States)

SESSION 4 NERVE STIMULATION

- 8585 OM **Neurostimulation using subnanosecond electric pulses (Invited Paper)** [8585-21]
S. Xiao, A. Pakhomov, F. Guo, Frank Reidy Research Ctr. for Bioelectrics, Old Dominion Univ. (United States); S. Polissety, Old Dominion Univ. (United States); K. H. Schoenbach, Frank Reidy Research Ctr. for Bioelectrics, Old Dominion Univ. (United States)
- 8585 ON **Comparison of the effects of millimeter wave irradiation, general bath heating, and localized heating on neuronal activity in the leech ganglion (Invited Paper)** [8585-22]
S. Romanenko, P. H. Siegel, D. A. Wagenaar, California Institute of Technology (United States); V. Pikov, Huntington Medical Research Institutes (United States)
- 8585 OO **Effects of nano-second electrical pulses (nsPEFs) on cell cycle progression and susceptibility at various phases** [8585-37]
M. A. Mahlke, Air Force Research Lab. (United States) and Univ. of Texas at San Antonio (United States); G. Thompson, National Research Council (United States); L. Estlack, General Dynamics Information Technology (United States); C. Navara, Univ. of Texas at San Antonio (United States); B. L. Ibey, Air Force Research Lab. (United States)

SESSION 5 BIOLOGICAL EFFECTS

- 8585 0Q **Intense picosecond THz pulses alter gene expression in human skin tissue *in vivo*** [8585-26]
L. V. Titova, A. K. Ayesheshim, Univ. of Alberta (Canada); A. Golubov, R. Rodriguez-Juarez,
A. Kovalchuk, Univ. of Lethbridge (Canada); F. A. Hegmann, Univ. of Alberta (Canada);
O. Kovalchuk, Univ. of Lethbridge (Canada)
- 8585 0R **Changes in protein expression of U937 and Jurkat cells exposed to nanosecond pulsed
electric fields** [8585-27]
E. K. Moen, Univ. of Southern California (United States); C. C. Roth, General Dynamics
Information Technology (United States); C. Cerna, L. Estalck, G. Wilmink, B. L. Ibey, Air Force
Research Lab. (United States)
- 8585 0S **Measurement of changes in plasma membrane phospholipid polarization following
nanosecond pulsed electric field exposure** [8585-28]
S. Franklin, Univ. of Texas at San Antonio (United States); B. L. Ibey, Air Force Research Lab.
(United States); K. Nash, Univ. of Texas at San Antonio (United States); H. T. Beier, Air Force
Research Lab. (United States)
- 8585 0T **Role of cytoskeleton and elastic moduli in cellular response to nanosecond pulsed electric
fields** [8585-29]
G. L. Thompson, National Research Council (United States); C. Roth, Univ. of Texas Health
Science Ctr. at San Antonio (United States); G. Tolstykh, National Research Council (United
States); M. Kuipers, B. L. Ibey, Air Force Research Lab. (United States)

SESSION 6 ENHANCEMENT OF APPLICATIONS

- 8585 0X **Reflectivity measurements of water and dioxane mixtures using a 100 GHz Gunn diode
source** [8585-33]
A. Maccabi, D. B. Bennett, N. Bajwa, P. Tewari, S. Sung, W. S. Grundfest, Z. D. Taylor, Univ. of
California, Los Angeles (United States)
- 8585 0Y **Terahertz metamaterials perfect absorbers for sensing and imaging** [8585-34]
D. S. Wilbert, M. P. Hokmabadi, J. Martinez, P. Kung, S. M. Kim, Univ. of Alabama (United
States)
- 8585 10 **Aperture-less terahertz near-field imaging** [8585-38]
W. E. Baughman, Z. Smithson, M. Baker, D. S. Wilbert, P. Kung, S. M. Kim, Univ. of Alabama
(United States)

Author Index

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- 1 Terahertz Technologies
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- 2 Spectroscopy and Theory
Richard Nuccitelli, BioElectroMed Corporation (United States)
- 3 nsEP and THz Biomedical Applications
M. Hassan Arbab, University of Washington (United States)
- 4 Nerve Stimulation
Peter Uhd Jepsen, Technical University of Denmark (Denmark)
- 5 Biological Effects
Elliott R. Brown, Wright State University (United States)
- 6 Enhancement of Applications
Paul Thomas Vernier, The University of Southern California (United States)

Introduction

The terahertz (THz) region of the electromagnetic (EM) spectrum is defined as frequencies ranging from 0.1 to 10 THz (1 THz = 10^{12} Hz = 1 ps). Historically, few sources have been available to efficiently generate THz radiation; however, several recent technological advances have resulted in the unprecedented development of many new types of THz sources and components. These technologies are now being used as tools for a plethora of novel basic science investigations, and they are increasingly being integrated into innovative sensing and imaging operational schemes, which are finding widespread use in a host of medical, military, and defense applications.

Ultrashort electromagnetic pulses (USEP) are defined as pulses with duration below one microsecond and a rise time at or below a nanosecond. Direct application of USEP on tissue has been shown to elicit an array of biological effects including plasma membrane breakdown, cellular swelling, nuclear granulation, and initiation of apoptotic death. These observed phenomena have spawned quick advancement of USEP-based techniques into clinical devices to treat both superficial and deep cancers. USEP-based technologies have a distinct advantage of causing desired effects only within the profile of the electric field with little to no thermal footprint. Future technology is pushing beyond direct application into shorter pulse regimes (picoseconds) to enable free field propagation of USEP into deep tissue. These efforts have required advancements in pulse generators and antenna construction. The drive to shorter pulse duration bridges the gap between electrical pulses and those commonly generated by THz sources.

Fundamental knowledge gaps exist regarding how electric fields with frequency components from the MHz to the THz interact with biological structures. This conference aims to highlight USEP and THz source development, biological applications, and fundamental interactions with tissues, cells, and biomolecules.

