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Infrared Sensors, Devices, and Applications II

Paul D. LeVan
Ashok K. Sood
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Editors

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Infrared Sensors, Devices, and Applications II

Conference Chairs

Paul D. LeVan, Air Force Research Lab. (United States)

Ashok K. Sood, Magnolia Optical Technologies, Inc. (United States)

Priyalal S. Wijewarnasuriya, U.S. Army Research Lab. (United States)

Arvind I. D'Souza, DRS Sensors & Targeting Systems, Inc. (United States)

SESSION 1: Graphene and Related Detectors

Session Chairs: Ashok K. Sood, Magnolia Optical Technologies, Inc. (United States);

Paul D. LeVan, Air Force Research Lab. (United States)

Graphene science and technology: a new frontier in multifunctional material and electronics (*Invited Paper*), Madan Dubey, U.S. Army Research Lab. (United States) [8512-01]

The presentation was given by Matt Chen, also of Army Research Laboratory. This research, involving lots of university collaboration, seeks to exploit the advantages of graphene in the areas of with higher carrier mobility, current density, and tensile strength. Many of these properties seem to be preserved, even after the material is flexed repeatedly. The recurring theme was wearable multi-purpose assets for soldiers, often with dual functionality (e.g., serving as an armament protection vest and acting as a source of electrical power). Other areas of interest include IR imaging bolometers, high frequency (THz) CMOS, and super-capacitors. The author also described some materials of interest even more exotic than graphene, including MoS₂.

Characterization of polymeric composite films with MWCNT and Ag nanoparticles, Matthew E. Edwards, Ashok K. Batra, Ashwith K. Chilvery, Padmaja Guggilla, Manmohan D. Aggarwal, Alabama A&M Univ. (United States) [8512-02]

The author described the pyroelectric detection properties of polymer films, incorporating carbon nanotubes and silver (lithium tantalate). This detector operates below the Curie temperature, where the pyroelectric coefficient measurements were conducted. Significantly, the theory to explain some of the prodigious values observed for pyroelectric coefficient appears to be lacking.

Graphene P-N junction devices: an overview (*Invited Paper*), Je Ung Lee, College of Nanoscale Science & Engineering (United States) [8512-03]

This invited talk graphene applications, including light focusing properties of p-n junctions and field effect transistors. The promised optical properties are

noteworthy: angles of refraction that deviate from the Snell's Law in the sense that they are negative relative to the normal, allowing p-n junctions to negative refractive index and provide improved resolution ("Veselago Lens"), and near-zero junction resistance in the transistor devices. Among the many observations shown was a current-voltage curve for single CNT showing near-perfect diode behavior, in both biasing polarities.

Design and development of CNT and graphene-based microbolometer for IR imaging applications, Ashok K. Sood, E. James Egerton, Yash R. Puri, Magnolia Optical Technologies, Inc. (United States); Akin Akturk, Neil Goldsman, Univ. of Maryland, College Park (United States); Nibir K. Dhar, Defense Advanced Research Projects Agency (United States); Priyalal Wijewarnasuriya, Madan Dubey, U.S. Army Research Lab. (United States) [8512-04]

The overarching objective of this effort emphasizes the potential of CNT micro-bolometer fabrication directly on the CMOS read-out integrated circuit. The advantages of the material include high absorption, fast photocarrier relaxation, and relatively low heat capacity. As part of this undertaking, values of pixel pitch, TCR, and noise-equivalent delta temperature have been assessed with CNT films currently available. The prodigious capabilities of the SUNY wafer growth and fabrication facility (Albany NanoTech Complex) have been brought to bear on this effort.

SESSION 2: EO-IR and Applications

Session Chairs: Priyalal S. Wijewarnasuriya, U.S. Army Research Lab. (United States); Ashok K. Sood, Magnolia Optical Technologies, Inc. (United States)

EO-IR material and device research at the Army Research Laboratory (*Invited Paper*), Parvez N. Uppal, U.S. Army Research Lab. (United States) [8512-05]

The presentation described a multitude of activities in the author's branch of ARL, including III-V LWIR detectors (C-QWIP, SLS, and InAsSb), with additional discussion on the properties of the SLS having no gallium. A highlight of the presentation was on homo- and hetero-junctions of InAsSb as a photovoltaic detector; these include long cutoff wavelengths, a capability for growth on a variety of substrates (and, if grown on InSb, an inherent two-waveband capability). Updates on C-QWIP include potential NASA applications for a mission to the Moon of Titan, benefiting from large FPA format, pixel uniformity, and relatively high responsivity. Finally, the doping of individual quantum dots (Q-BIC), offer the potential to suppress G-R currents. An increase in responsivity is projected for an increase in the density of dots that might eventually be realized.

NIR reflectance spectroscopy for nondestructive moisture content determination of different varieties of in-shell peanuts, Chari V. Kandala, Jaya Sundaram, Agricultural Research Service (United States) [8512-06]

Cancellation; replacement presentation by Dr. Priyalal Wijewarnasuriya, U.S. Army Research Lab.

Overview of HgCdSe material research for IR applications at the Army Research Laboratory, Gregory N. Brill, Yuanping Chen, U.S. Army Research Lab. (United States) [8512-07]

This presentation was given by Kevin Doyle (VA Tech) Described growth of this somewhat exotic detector material on GaSb (with eventual option for 4" diameter wafers), as well as on Silicon substrates following deposition of a ZnTe buffer layer. An area of focus has been dislocation densities, given their potential to act as both recombination centers (shortening the minority carrier lifetime) and tunneling centers (for excess tunneling dark current). Currently the carrier mobility is considerably lower than for HgCdTe, but this is to be expected for such a new material. The nature of impurities is also under investigation.

Common-path interferometer for stimulated Raman scattering (SRS) and coherent anti-stokes Raman scattering applications (CARS), Gabriela Negrete-Gonzalez, Ctr. de Investigación e Innovación Tecnológica (Mexico); Herman L. Offerhaus, Univ. Twente (Netherlands); Fernando Martinez-Pinon, Jose A. Alvarez-Chavez, Ctr. de Investigación e Innovación Tecnológica (Mexico) [8512-08]

No presentation as author was not present.

SESSION 3: Advanced Concepts and Materials

Session Chairs: Arvind I. D'Souza, DRS Sensors & Targeting Systems, Inc. (United States); Paul D. LeVan, Air Force Research Lab. (United States)

Integrated EO/IR programs at DARPA /MTO (Invited Paper), Nibir K. Dhar, Defense Advanced Research Projects Agency (United States) [8512-09]

In an effort to realize high resolution imaging over very large fields-of-view, innovative approaches incorporating lenslet arrays on the back hemisphere of a rather large ball lens, which acts as the principal light collection aperture, with each lenslet array paired with a conventional sensor array. The resulting system demonstrates outstanding imagery as viewed over the entire field-of-view, and remarkable capabilities for zooming into very tiny subsections of the overall image. Additional efforts include very small-pitch LWIR pixels, 'pillarized' pixels of nBn (a barrier detector with a barrier surrounded by n-type detector material) that offers nearly-complete light absorption capability and reduced dark current generation area, as well as increased FPA well capacity with capacitors elongated in an innovative fashion along the z-direction below each pixel site. A

variety of applications were described, including eventual infrared camera in cell-phone-like package; the overarching theme is to better equip the soldier in the field with light-weight, low power surveillance devices.

Design and performance modeling of an HgCdTe-based SWIR micro-camera, Christopher Anton, Episensors, Inc. (United States); Silviu Velicu, Fikri Aqariden, EPIR Technologies, Inc. (United States) [8512-10]

After explaining the advantages of HgCdTe with cut-off wavelength near 2.5 microns with respect to extended InGaAs, this presentation described the product specifications (or design) for a SWIR camera that enjoys the sensitivity of HgCdTe at higher operating temperatures that are more attractive for product commercialization. Desired photodiode resistivity-area products were defined, at both the more desirable operating temperature of 300K, and a fallback temperature of 200 Kelvin. Either approach baselines growth of HgCdTe on large silicon wafers, with the appropriate buffer layer.

Study on fluorescence of Na₂KSb(Cs) multi-alkali photocathode film during growth process, Xiaofeng Li, Shenglin Lu, North Night Vision Technology Co., Ltd. (China); Fan Yu, Yunnan Univ. (China); Wenbo Yang, North Night Vision Technology Co., Ltd. (China) [8512-12]

The responsivity of the photocathodes was shown in excess of 0.9 milliamps per lumen, and it was found that as the antimony fraction increased, the longer wavelength response increased as well, but at a penalty of some drop in responsivity. A considerable amount of experimental data was described. The application is for improved night vision goggles.

SESSION 4: Miscellaneous Detector Applications

Session Chairs: Paul D. LeVan, Air Force Research Lab. (United States); Arvind I. D'Souza, DRS Sensors & Targeting Systems, Inc.

Fast scan-fail device for class 1 operation of scanning micromirrors at a high-laser power in the near-infrared region, Siegwart Bogatscher, Christian Giesel, Thorsten Beuth, Harsha Umesh Babu, Leilei Shinohara, Karlsruher Institut für Technologie (Germany); Nico Heussner, Forschungszentrum Informatik (FZI) (Germany); Andreas Streck, ELOVIS GmbH (Germany); Wilhelm Stork, Karlsruher Institut für Technologie (Germany) and Forschungszentrum Informatik (FZI) (Germany) [8512-13]

On the basis of Laser Class 1 safety guidelines, it was shown how the safety of a laser scanning device relies on proper operation of the scan mechanism; i.e., a failure in the scan mechanism would lead to an unsafe dwell time of the laser at a fixed location. The objective was to achieve a low-cost, low latency (microsec or less), low power unit to both detect and mitigate failure of a micro-mirror-based pointing approach. Applications include collision avoidance

in the automotive context.

Silver halide integrated waveguides for the mid-infrared, Tomer Lewi, Abraham Katzir, Tel Aviv Univ. (Israel) [8512-14]

With an application of spectral analysis of atmospheres of planets found to orbit stars, a nulling interferometric (Mach Zehnder) approach becomes tractable with Silver-halide fibers acting as waveguides in the thermal infrared (and specifically over wavelengths from 6 to 17 microns). Discussion topics included evanescent wave sensing. Propagation losses were measured, with both linear attenuation ("sidewall losses") and coupling losses accounted for.

A NiTiNOL membrane controlled by an external heat source, Margarita Tecpoyotl-Torres, Ramon Cabello-Ruiz, Jose Gerardo Vera-Dimas, Univ. Autónoma del Estado de Morelos (Mexico); Jorge Varona, Univ. Panamericana (Mexico); Miguel Torres-Cisneros, Universidad de Guanajuato (Mexico) [8512-15]

This presentation was given by Ramon Cabello-Ruiz, who described the displacement of diaphragms with large deflections, for the purposes of actuation (and specifically "thermal membrane actuation"). The class of materials is "shape memory alloys". Studies were conducted with and without isolation layers, and displacement capability was reported both for NiTiNOL and for Cu-Al-Ni approaches. Applications include concepts in external health monitoring.

Study of atmospheric effects on infrared polarization imaging system based on polarized Monte Carlo method,

Zhenyue Chen, Xia Wang, Beijing Institute of Technology (China) Mingyang Zhang, Runqiu Xia, Weiqi Jin, Beijing Institute of Technology (China) [8512-16]

This presentation first reviewed the existing literature, and then considered the complex contributions of path radiance, and absorption and scattering, to the polarization effects of an infrared beam propagating through the atmosphere. The results of simulation (via Monte Carlo) were compared with each other, and the transmitted degree of linear polarization as a function of distance and as parameterized with infrared wavelength. Conclusions were drawn on the degree of linear polarization, and the angle of polarization in reflection off a surface and in transmission through a medium, and increased persistence of the polarized signal was found to result at longer wavelengths.

SESSION 5: III-V and SL Detectors

Session Chairs: Arvind I. D'Souza, DRS Sensors & Targeting Systems, Inc.; Paul D. LeVan, Air Force Research Lab. (United States)

Growth and device performance of superlattice-based infrared detectors, Arezou Khoshakhlagh, David Z. Ting, Alexander Soibel, Linda Höglund, Sam A. Keo, Sarath D. Gunapala, Jet Propulsion Lab. (United States) [8512-17]

The speaker described recent progress in the characterization of superlattice detectors and arrays, with an emphasis on both atomic force microscopy AFM and XRD characterization. A capability for early characterization of material growth by means of X-rays (XRD) verifies adequate quality before committing material to additional processing steps. Current-voltage curves of recent detector test structures were found to exhibit the nice property of turn-on near zero bias, and exhibit low values of dark current density. The fabricated FPAs showed respectable values of NEDT (F/2 optics), when operated at 77 Kelvin. In response to a question, the numbers of monolayers in alternating superlattice layers was provided for the device.

Type-II InAs/GaSb superlattices grown by molecular beam epitaxy for infrared detector applications, Amin Torfi, Cheng Yun Chou, Wen I. Wang, Columbia Univ. (United States) [8512-18]

The author described efforts at his university on the design and growth of superlattice detectors, reporting on the values of cut-off wavelength obtained for various superlattice geometries. Both MWIR and LWIR cut-off wavelengths were achieved. Subsequent characterization of pixel dark current, at a given operating temperature, revealed both GR and diffusion contributions. In response to a question, the author mentioned that the values of D^* were calculated on the basis of the measured dark current, rather than from measured noise values.

Post growth annealing study on LWIR InAs/GaSb superlattices, Heather J. Haugan, Gail J. Brown, Air Force Research Lab. (United States); Said Elhamri, Univ. of Dayton Research Institute (United States); Benjamin V. Olson, Thomas F. Boggess, The Univ. of Iowa (United States); Larry Grazulis, Shantee Pacley, Air Force Research Lab. (United States) [8512-19]

The presenter began with a review of theoretical advantages of superlattice photodiodes, with emphasis on dark current estimates as a function of temperature. Following this, comparisons with measured device performance segued into an emphasis on SRH defects as a possible performance limiting mechanism. The suite of characterization assets is impressive and includes a new capability for “pump probe”. Both wafer surface quality issues and MBE machine-to-machine variations in cut-off wavelength (for a fixed recipe) were described. The strong potential for a future VLWIR capability with superlattice detectors was emphasized.

Study of the minority carrier lifetime in mid-wavelength infrared InAs/InAs_{1-x}Sb_x type-II superlattices, Elizabeth H. Steenbergen, Arizona State Univ. (United States); Blair Connelly, Grace D. Metcalfe, Paul H. Shen, Michael Wraback, US Army Research Lab. (United States); Dmitri Lubyshev, Yueming Qiu, Joel Fastenau, Amy W. K. Liu, IQE Inc. (United States); Said Elhamri, Univ. of Dayton (United States); Oray O. Celtek, Yong-Hang Zhang, Arizona State Univ. (United States) [8512-20]
This presentation on the “gallium-free” superlattices that have been recently

shown to result in longer minority carrier lifetimes described an effort to further characterize this mechanism on the basis of spectral PL studies. By breaking test diodes into two groups of differing amounts of antimony concentration, a clear distinction in the shapes of lifetime vs. operating temperature curves was apparent. This was interpreted as strongly suggesting different relative amounts of Auger, radiative, and perhaps SRH lifetime contributions (with each have very different theoretical variations with temperature).

Infrared photodetectors based on MWIR and LWIR InAs/InAsSb superlattices, Ha Sul Kim, Oray O. Cellek, Hua Li, Shi Liu, Zhiyuan Lin, Elizabeth H. Steenbergen, Yong-Hang Zhang, Arizona State Univ. (United States) [8512-21]

Devices were designed, fabrication, and measured, thereby enabling a comparison between in performance between the design and fabricated devices. Designs for photodiodes with cut-off wavelengths spanning the range from MWIR to LWIR indicated good agreement of the predicted and realized wavelengths, and a general decrease in PL response with increasing wavelength was noted. The measured diode sensitivities, as quantified with D^* , were however found to fall short of the predicted values.

Design and development of low dark current SLS detectors for IRFPA applications, Ashok K. Sood, Roger E. Welser, Magnolia Optical Technologies, Inc. (United States); Nutan Gautam, Sanjay Krishna, Ctr. for High Technology Materials (United States); Eric A. DeCuir, Jr., Priyalal Wijewarnasuriya, U.S. Army Research Lab. (United States); Nibir K. Dhar, Defense Advanced Research Projects Agency (United States) [8512-22]

This paper, presented by Dr Nutan Gautam, begins by reviewing current status of superlattice and barrier photodetectors, including areas of surface passivation and SRH center characterization. Innovative barrier structures, cutting off near 8.5 microns, were fabricated and characterized for dark current performance, and a transition temperature from SRH- to diffusion-limited dark current behavior was obtained.

SESSION 6: Si-based Detectors

Session Chairs: Arvind I. D'Souza, DRS Sensors & Targeting Systems, Inc.; Paul D. LeVan, Air Force Research Lab. (United States)

Antimony-doped silicon blocked impurity band (BIB) arrays for low-flux applications, Vaikunth Khalap, Henry H. Hogue, DRS Sensors & Targeting Systems, Inc. (United States) [8512-23]

The presenter began by discussing arsenic-doped silicon (Si:As), where it was shown that increased doping in the absorbing layer lead to an increase in cut-off wavelength. He then described a similar situation for Si:Sb, with an even longer cut-off wavelength than Si:As and for which doping level also affect cut-off

wavelength. Certain material improvements were described, including greater control over doping level. As part of questions and answers, it was pointed out that, in a certain sense, blocked-impurity band detectors (which date from the 1980s) were perhaps the first “barrier” infrared detectors.

Studies on transmittance of silicon with AR coating films for IR transparent window, Myeongho Song, National Nanofab Ctr. (Korea, Republic of) and Chungnam National Univ. (Korea, Republic of); Eunmi Park, Moon Seop Hyun, Tae Hyun Kim, Hee Yeoun Kim, National Nanofab Ctr. (Korea, Republic of); Gawon Lee, Chungnam National Univ. (Korea, Republic of) [8512-24]

As part of background information on the economic prospects of uncooled infrared detectors, the author showed a graph for which cost was plotted against the total number of pixels in an FPA, for the pyroelectric, thermopile, and bolometer technologies, with bolometers appearing in the upper right-hand side. This approach seems to suggest that a hermetically-sealed detector package enabled with a silicon window has additional economic advantages. Compared with alternative materials, the anti-reflection coated silicon, in a thickness of 0.4 mm, was found to have transmission approaching 90% and lower cost than the alternatives.

Silicon PIN diodes for remote sensing, Ernest W. Robinson, Arvind I. D'Souza, DRS Sensors & Targeting Systems, Inc. (United States) [8512-25]

The PIN (p-type, insulator, n-type) operates over the range from 0.4 to 0.9 microns, with bias voltages approaching 10 volts found to lead to noteworthy, low values of crosstalk among the pixels. Both surface and bulk dark current contributions were assessed with variable-area test detectors. The contribution to system MTF by the FPA is shown to approach the theoretical limit.

Development of large area nanostructured antireflection coatings for EO/IR sensor applications, Ashok K. Sood, Roger E. Welser, Adam W. Sood, Yash R. Puri, Magnolia Optical Technologies, Inc. (United States); Jaehee Cho, Samsung Advanced Institute of Technology (Korea, Republic of); E. Fred Schubert, Rensselaer Polytechnic Institute (United States); Nibir K. Dhar, Defense Advanced Research Projects Agency (United States); Priyalal Wijewarnasuriya, U.S. Army Research Lab. (United States); Martin B. Soprano, U.S. Army Research, Development and Engineering Command (United States) [8512-26]

The ambitious goal of 1% reflection loss at high angles of incidence, and over a broad range of wavelengths (UV through MWIR) for a novel optical coating approaches. Layers of nano-structures, one fabricated atop the other to implement orientations, were found to allow tailoring of the index of refraction and exhibit low reflection out to angles of +/-60 degrees. Substrate flexibility further extends the range of applications of the technology, with relatively large substrates available for larger diameter optical applications.

SESSION 7: Medical Applications

Session Chairs: Paul D. LeVan, Air Force Research Lab. (United States); Ashok K. Sood, Magnolia Optical Technologies, Inc. (United States)

Research on application of spectral imaging technology in determining on thermal burn degree, Yongquan Luo, Li Xian Huang, China Academy of Engineering Physics (China); Junjie Yang, Jun Wu, Third Military Medical Univ. (China); Dayong Zhang, China Academy of Engineering Physics (China) [8512-27]

Reflectance spectroscopy in the visible, near-infrared and SWIR were investigated for capability to distinguish the degree of burned skin, in a hospital triage scenario. In particular, distinguishing between second and third degree burns is critical to provide the proper care (in the case of a third degree burn) and to not provide costly overtreatment (in the case of a second degree burn) – for this case 0.9 to 2.1 microns appeared very promising.

Er³⁺-doped fibre laser sensor for structural health monitoring applications, María Guadalupe Pulido-Navarro, Grethell Perez-Sanchez, Ctr. de Investigación e Innovación Tecnológica (Mexico) Daniel Ceballos-Herrera, Universidad Autónoma de Nuevo León Centro de Investigaciones en Ciencias Físico- Matemáticas (Mexico) Jose A. Alvarez-Chavez, Ctr. de Investigación e Innovación Tecnológica (Mexico) [8512-28]

Structural health monitoring (SHM) in the context of road bridges and other public infrastructure was shown possible with embedded fibers, for which levels of stress can be sensitively measured through the variations in light propagation modes. The author described the various cases of Rayleigh, Brillouin, and Raman spectra. Doping the fiber was shown to enable transmission over the longer lengths that could be required by an application.

A fiber loop ringdown urine glucose sensor, Malik Kaya, Chuji Wang, Mississippi State Univ. (United States); Charlotte Wang, The Mississippi School for Mathematics and Science (United States) [8512-29]

This concept is made compelling by its relatively quick determination of glucose level in a urine sample (timescale of minutes) relative to the slower performance of currently-available hospital tests. Experimental data showed good linearity in the 0.1 to 1% range providing excellent assessment of lower levels of concentration.

Microbolometer SU-8 photoresist microstructure with cytochrome c protein as a sensing pixel for microbolometer,

Jian-Lun Lai, Guo-Dung Su, National Taiwan Univ. (Taiwan) [8512-30]

The presentation identified truly remarkable fabrication approach rendering the delicate details of a biped-supported bolometer structure (requisite thermal isolation and electrical contacts) made possible with a protein having high thermal coefficient of resistance, and SU8 photoresist acting as the insulation structure. Relevant bolometer figures of merit, including attractively short thermal time constants, result from the thermal conductivity and heat capacity of the proposed structure.

SESSION 8: Lasers and THz

Session Chairs: Ashok K. Sood, Magnolia Optical Technologies, Inc. (United States); Priyalal S. Wijewarnasuriya, U.S. Army Research Lab. (United States)

Lidar range profile reconstruction by using chaotic signals and compressive sensing, Berenice Verdin, Ricardo von Borries, The Univ. of Texas at El Paso (United States) [8512-31]

Efforts were described in the area of modeling an urban scene in Digital Imaging and Remote Sensing Image Generation (DIRSIG) and use of a lidar that is chaotic in amplitude in a deterministic way, permits measurement of angles-angles range profile following a compressive sensing approach. This presentation extends previous work along these lines, by including additive white Gaussian noise. Experiments have been conducted to verify the proposed approach. Altitude maps seem to be an obvious application.

Active imaging models and systems to see through adverse conditions: application to the surveillance of an aircraft environment, Nicolas Riviere, Laurent Hespel, Erwan Bernard, Romain Ceolato, ONERA (France) Bernard Tanguy, ONERA (France) [8512-32]

The presenter began with television news video of one aircraft striking another while taxiing under snowy conditions recently at JFK international airport. Airport collision avoidance radar could perhaps be supplemented with an aircraft-based capability to determine proximity of threatening obstacles. He described details on the basis of line-of-sight transmission modeling (including scintillation and turbulence effects) and 3-D laser imaging technology to enable such a capability.

First observation of a plasmon-mediated tunable photoresponse in a grating-gated InGaAs/InP HEMT for millimeter-wave detection, Nima Nader Esfahani, Solid State Scientific Corp. (United States); Robert E. Peale, Univ. of Central Florida (United States); Walter R. Buchwald, Solid State Scientific Corp. (United States); Justin W. Cleary, Joshua R. Hendrickson, Air Force Research Lab. (United States) [8512-33]

This presentation described the generation of Terahertz and millimeter-wave plasmons with coupled incident EM-fields. The photoresponse of graphene and InP-based HEMT devices was measured in the THz frequency range. Tests conducted to date at 4 Kelvin temperature. Potential applications include chip-scale frequency-agile THz imaging spectrometers and also include man-portable or space-based spectral-sensing applications.

Single-cycle pulse generation in the course of four-wave mixing in the filament, Vera Andreeva, Nicolay Panov, Olga G. Kosareva, Lomonosov Moscow State Univ. (Russian Federation); See Leang Chin, Ctr. d'optique, photonique et laser (Canada) [8512-34]

The presenter showed that the generation of signal pulses with tunable central wavelength is possible by doubling the fundamental laser frequency emitted by a Ti:Sa laser system. She described the mixing of the powerful pump radiation with the relatively weak seed radiation, of shorter wavelength than the pump. Further, the generation of single-cycle infrared pulses is possible. Modeling of this approach is based on four-wave mixing in the filament, for which the full electric field is analyzed.

Enhanced directionality of terahertz emission from a cluster of femtosecond filaments in gases, Vera Andreeva, Olga G. Kosareva, Nicolay Panov, Lomonosov Moscow State Univ. (Russian Federation); T. J. Wang, S. Yuan, See Leang Chin, Ctr. d'optique, photonique et laser (Canada) [8512-35]

This presentation described the generation of Terahertz (THz) radiation with the filament of a powerful femtosecond laser pulse. The problem of divergence of THz radiation after emission by the filament poses challenges to achieving a narrow and forwardly directed stream of THz emission. The author then showed how THz directionality could be enhanced in this case by using the phenomenon of multiple filamentation, achieved with amplitude or phase masks.

