07:00–17:00 Registration Open, *Baltimore Convention Center, Pratt Street, 300 Level Lobby*

08:00–09:45 JMA • Joint Symposium on Hybrid Quantum Nanoplasmonic Systems - Towards Active Nanoplasmonics I: Plasmon Nanolasers

Mikhail Noginov, Norfolk State Univ., USA, Presider

JMA1 • 08:00 Invited

Lasing and spontaneous emission in gap-plasmon mode Bragg grating waveguides, *Milan J. Marell[1], Martin Hill[1]; [1]Electrical Engineering, Technische Universiteit Eindhoven, Netherlands.* We show strong spontaneous emission modification in subwavelength gap-plasmon mode Bragg grating metal waveguides. The gratings are extremely broadband and have a coupling factor significantly higher than the strongest dielectric gratings.

JMA2 • 08:30 Invited

Lasers beyond the diffraction limit, *Rupert F. Oulton[1,2], Volker J. Sorger[2], Ren-Min Ma[2], Thomas Zentgraf[2], Guy Bartal[2], Xiang Zhang[2]; [1]Physics, Imperial College London, UK; [2]NSF Nanoscale Science and Engineering Centre, Univ. of California at Berkeley, USA.* We review recent progress on metal-based lasers with optical confinement approaching 1/20th of the wavelength at room temperature and discusses the broader impact of plasmonic light sources and their application.

08:00–09:45 JMB • Joint Symposium on Nano-Bio-Photonics I: Nanoscale Imaging and Sensing for Biomedical Applications

Jin Kang, Johns Hopkins Univ., USA, Presider

JMB1 • 08:00 Invited

Magnetomotive Molecular Nanoprobes for Optical Biomedical Imaging and Diagnostics, *Stephen A. Boppart[1]; [1]Beckman Inst., Univ. of Illinois at Urbana-Champaign, USA.* Magnetomotive molecularly-targeted iron oxide nanoparticles are demonstrated as in vivo contrast agents using magnetomotive OCT. These nanoprobes are also multifunctional as molecular agents in MRI, optical elastography, and therapeutic applications.

JMB2 • 08:30 Invited

Beyond Diffraction Limited Imaging and Sensing in Nanobiophotonics, *Ilko Ilev[1]; [1]CDRH, US FDA, USA.* Based on simple fiber-optic approaches, we present some advanced nanobiophotonic methods for ultrahigh-resolution imaging and sensing beyond the diffraction barrier in the subwavelength nanometric range at cellular, intracellular and tissue level.

08:00–09:45 CMA • Efficiency Enhancement by Patterning

Hao-chung Kuo, National Chiao Tung Univ., Taiwan, Presider

CMA1 • 08:00 Tutorial

Light Extraction Methods in Light-Emitting Diodes, *Jonathan J. Wierer[1]; [1]Sandia National Laboratories, USA.* This paper describes the basics of light extraction in light-emitting diodes covering the ways light is trapped, is lost, and escapes. Additionally, methods to maximize light extraction in various UV-visible emitting semiconductors are shown.

Jonathan J. Wierer, Jr. (M '95) received his M.S., B.S., and Ph.D. from the Univ. of Illinois at Urbana-Champaign in electrical engineering in 1994, 1995, and 1999 respectively. His Ph.D. research involved using tunnel junction contacts in InAlGaAs-based edge-emitting lasers, vertical-cavity surface-emitting lasers, and resonant-cavity light emitting diodes (LEDs). After his doctorate he joined the Hewlett-Packard Optoelectronic Division (later becoming Philips-Lumileds) working on novel III-nitride LED device designs until 2008. He worked with a team producing the world's first high-power (1 Watt) flip-chip III-nitride LED, and he also did research on incorporating photonic crystals into LEDs. He is currently a Principle Member of the Technical Staff at Sandia National Laboratories working on III-nitride intersubband devices, solar cells, and ultra-violet LEDs. He has authored or co-authored about 45 technical publications and also holds 20 patents, related to solid-state lighting and LEDs.

08:00–09:45 AMA • Fundamentals of Laser Processing for Adding, Modifying and Joining Materials

Alberto Pique, NRL, USA, Presider

AMA1 • 08:00 Invited

Paper Withdrawn

AMA2 • 08:30

Fabrication of transparent electrodes from AZO nanoparticles by pulsed laser annealing, *Kun-Tso Chen[1], Jeng-Rong Ho[1], Yu-Hsuan Lin[1]; [1]Mechanical Engineering, National Chung Cheng Univ., Taiwan.* We report on an approach for fabricating transparent electrodes on a plastic substrate by annealing AZO nanopartieles using a pulsed UV laser. For the resulting AZO film, the resistivity and transmittance is good.

07:00–17:00 Registration Open, *Baltimore Convention Center, Pratt Street, 300 Level Lobby*

08:00–09:45 CMB • Ytterbium and Praseodymium Lasers

Andy Bayramian, Lawrence Livermore Natl. Lab, USA, Presider

CMB1 • 08:00
A Highly Efficient Diode-Pumped Pulsed Laser Based on Room-Temperature Yb:YAG Ceramics, *Andrey V. Okishev[1]; [1]Lab for Laser Energetics, Univ. of Rochester, USA.* A pulsed room-temperature Yb:YAG ceramic laser with a slope efficiency of 78% and an optical-to-optical efficiency of 51% has been demonstrated. This is the highest slope efficiency for a room-temperature Yb:YAG ceramic laser reported to date.

CMB2 • 08:15
Direct amplification of ultrashort pulses in μ-pulling down Yb:YAG single crystal fibers, *Yoann Zaouter[1], Igor Martial[2,3], Xavier Délen[2], Nicolas Aubry[3], Sandrine Ricaud[1,2], Julien Didierjean[3], Frederic Druon[2], Clemens Hönninger[1], Eric Mottay[1], Patrick Georges[2], François Balembois[2]; [1]Amplitude Systemes, France; [2]Laboratoire Charles Fabry de l'Institut d'Optique, France; [3]Fibercryst SAS, France.* We demonstrate that Yb:YAG SCF have a strong potential for the amplification of femtosecond pulses. The gain in SCF reaches a value of 30 (12 W and 350 fs) in double pass configuration.

CMB3 • 08:30
High single-pass small signal gain in Femtosecond Solid State Yb:CaF_2 Amplifiers Pumped by a 976-nm YDFA, *Guillaume Machinet[1], Giedrius Andriukaitis[2], Jerome Lhermite[1], Dominique Descamps[1], Audrius Pugzlys[2], Daniel Adam[2], Andrius Baltuska[2], Eric Cormier[1]; [1]Laboratoire CELIA, France; [2]Photonics Inst., Austria.* We demonstrate an enhancement of the single-pass small signal gain up to 3.2 in a longitudinal pumping scheme by using a 10 mm-long Yb:CaF_2 crystal at room temperature. This result significantly outperforms any CW-diode pumped scheme.

08:00–09:45 QMA • Novel Phenomena in Optics

Demetrios Christodoulides, CREOL, Univ. of Central Florida, USA, Presider

QMA1 • 08:00 Invited
Electron Laguerre-Gaussian beams, *Benjamin McMorran[1], Amit Agrawal[1,3], Ian M. Anderson[2], Andrew A. Herzing[2], Henri Lezec[1], Jabez J. McClelland[1], John Unguris[1]; [1]Center for Nanoscale Science and Technology, National Inst. of Standards and Technology, USA; [2]Surface and Microanalysis Science Division, National Inst. of Standards and Technology, USA; [3]Maryland Nanocenter, Univ. of Maryland, USA.* We use nanofabricated diffraction holograms to demonstrate electron Laguerre-Gaussian beams. These beams are analogous to optical vortices but are composed of charged particle wavefunctions possessing mass.

QMA2 • 08:30
Accelerating Light Beams Along Arbitrary Trajectories, *Elad Greenfield[1], Mordechai Segev[1], Oren Raz[2]; [1]Physics and Solid State Inst., Technion Inst. of Technology, Israel; [2]Physics of Complex Systems, Weizmann Inst. of Science, Israel.* We demonstrate theoretically and experimentally non-broadening beams that propagate along any arbitrarily-chosen convex trajectory in space, present a general method to construct them, and explore their universal properties using catastrophe theory.

08:00–09:45 CMC • Advanced Nonlinear Configurations

Narasimha Prasad, NASA Langley Res. Ctr., USA, Presider

CMC1 • 08:00
Third Harmonic Generation Enhancement in Nematic Liquid Crystals via Nonlocal Solitons Propagation, *Marco Peccianti[1,2], Alessia Pasquazi[1], Gaetano Assanto[3], Roberto Morandotti[1]; [1]Énergie, Matériaux et Télécommunications, INRS, Canada; [2]UOS Roma, IPCF-CNR, Italy; [3]Nonlinear Optics and OptoElectronics Lab, Univ. Roma Tre, Italy.* We demonstrate type I third harmonic generation enhanced by the tight localization of fs laser light in nonlocal spatial solitons excited in nematic liquid crystals.

CMC2 • 08:15
Non-linear Optical Switch in Liquid Crystal Polymer Coated Microspheres, *Silvia Soria[1], Simone Berneschi[3,1], Gualtiero Nunzi Conti[1], Stefano Pelii[1], Giancarlo C. Righini[1], Ilya Razdolskiy[2], Tatyana V. Murzina[2]; [1]IFAC-CNR, Italy; [2]Department of Physics, Univ. of Moscow, Russian Federation; [3]Centro Studi e Ricerche "Enrico Fermi", Italy.* Kerr effect in a liquid crystal coated microsphere is used to switch reversibly and instantaneously a probe beam by a femtosecond pump. Shift magnitudes (2 GHz versus 250 MHz in CW) ruled out thermooptical effects.

CMC3 • 08:30
Single-Photon Detection in Near-Infrared Region Based on Frequency Upconversion in MgO-Doped Periodically-Poled Lithium Niobate Waveguide, *Da Li[1], Yi Jiang[1], Yujie J. Ding[1], Boon S. Ooi[1], Ioulia B. Zotova[2], Narasimha S. Prasad[3]; [1]Electrical & Computer Engineering, Lehigh Univ., USA; [2]ArkLight, USA; [3]NASA Langley Research Center, USA.* MgO-doped periodically-poled $LiNbO_3$ waveguide is used to up-convert photons at 1.535-1.568 μm to those at 598-603 nm, which can be detected by avalanche photodetector at single-photon counting level. Conversion efficiencies up to 45% are achieved.

07:00–17:00 Registration Open, *Baltimore Convention Center, Pratt Street, 300 Level Lobby*

08:00–09:45 CMD • Ultrafast Fiber Lasers

Almantas Galvanauskas, Univ. of Michigan, USA, Presider

CMD1 • 08:00
Tunable high-energy soliton pulse generation from a large-mode-area fiber pumped by a picosecond time-lens source, *Ke Wang[1], Yizhen Wei[1], Demirhan Kobat[1], Chris Xu[1]; [1]School of Applied and Engineering Physics, Cornell Univ., USA.* We demonstrate high-energy soliton pulse generation from a large mode area fiber, tunable from 1560 nm up to 1700 nm, pumped with a 10 MHz, 1.5-ps time lens source at 1544 nm.

CMD2 • 08:15
Femtosecond pulses from coherently combined parallel chirped pulse fiber amplifiers, *Leo Siiman[1], Tong Zhou[1], Wei-zung Chang[1], Almantas Galvanauskas[1]; [1]Center for Ultrafast Optical Science, Univ. of Michigan, USA.* Active coherent combining of femtosecond pulses from parallel chirped-pulse fiber amplifiers is demonstrated. This opens a new path for simultaneously increasing both energy and average power of ultrashort pulses from fiber based systems.

CMD3 • 08:30
Passively Mode Locked GHz Femtosecond Yb-Fiber Laser Using an Intra-Cavity Martinez Compressor, *Ingmar Hartl[1], Albert Romann[1], Martin E. Fermann[1]; [1]IMRA America, Inc., USA.* We demonstrate a 130fs, 3W, 1.3GHz fiber laser system based on a passively modelocked Yb fiber soliton oscillator using an intra-cavity Martinez compressor with adjustable dispersion and bandwidth and a linear Yb-fiber amplifier.

08:00–09:45 JMC • Environmental and Explosive Sensing by Quantum Cascade Lasers

Iain McKinnie, Lockheed Martin Coherent Technologies, USA, Presider

JMC1 • 08:00
Standoff chemical detection using quantum cascade lasers and photoacoustic sensing techniques, *Xing Chen[1], Douglas Janssen[2], Dan Kosov[3], Fow-Sen Choa[1]; [1]CSEE, UMBC, USA; [2]Greater Grace Christian Academy, USA; [3]CBE, UMBC, USA.* Standoff chemical detection using quantum-cascade-lasers as pump sources and photoacoustic techniques for sensing is demonstrated for the first time. With <40mW laser power, a chemical detection distance of more than one meter has been achieved.

JMC2 • 08:15
Open path water vapor measurements using a chirped pulse MIR QCL sensor system, *Barry Gross[1], Maung Lwin[2,1], Paulo Castillo[1], Paul Corrigan[1], Fred Moshary[1], Sam Ahmed[1]; [1]City College of New York, USA; [2]Energy Dynamics Lab, USA.* An open path chirped pulse Quantum Cascade Laser system operating from 1900cm^{-1} to 1902 cm^{-1} has been developed for water vapor measurements. QCL retrieval accuracies are shown to be significantly smaller than FTIR retrievals.

JMC3 • 08:30 Invited
IR Reflectance Detection of Explosives Using Pseudo Random Code Generator Driven QCLs, *John Haas, ARA, USA.* We present a new approach to multiplexed detection of reflected quantum cascade laser beams using pseudorandom code modulation and a single detector. The application for this work is a portable system for stand-off detection of explosive residues.

08:00–09:45 QMB • High Field THz and Strong Coupling

Alfred Leitenstorfer, Univ. of Konstanz, Germany, Presider

QMB1 • 08:00
Transmission Coefficient Enhancement in Undoped Indium Arsenide by High THz Field, *Gurpreet Kaur[1], Pengyu Han[1], Xi-Cheng Zhang[1]; [1]Physics, Rensselaer Polytechnic Inst., USA.* We demonstrate enhancement of transmission coefficient in InAs due to THz field induced competition where intervalley scattering overcomes impact ionization. The controllable delay of THz pulse due to sample's increased refractive index is observed.

QMB2 • 08:15
Interaction of Strong Terahertz Pulses with Exciton-Polaritons in Quantum-Well Microcavity, *Yun-Shik Lee[1], Joseph L. Tomaino[1], Andrew D. Jameson[1], Galina Khitrova[2], Hyatt M. Gibbs[2], Andrea Stroech[3], Mackillo Kira[3], Stephan Koch[3]; [1]Physics, Oregon State Univ., USA; [2]Optical Sciences Center, Univ. of Arizona, USA; [3]Fachbereich Physik and Material Sciences Center, Philips Univ., Germany.* Interaction of strong THz pulses with a QW microcavity reveals that exciton-polariton modes and 2p-exciton state form a Λ-type three-level system. THz pulses resonantly drive the transitions from the exciton-polariton states to the 2p-exciton state.

QMB3 • 08:30
THz Electro-absorption Effect in Quantum Dots, *Dmitry Turchinovich[1], Boris S. Monozon[2], Daniil A. Livshits[3], Edik U. Rafailov[4], Matthias C. Hoffmann[5]; [1]DTU Fotonik - Department of Photonics Engineering, Technical Univ. of Denmark, Denmark; [2]Department of Physics, State Marine Technical Univ., Russian Federation; [3]Innolume GmbH, Germany; [4]School of Engineering, Physics and Mathematics, Univ. of Dundee, UK; [5]Max Planck Research Department for Structural Dynamics, CFEL, Univ. of Hamburg, Germany.* Instantaneous electro-absorption effect in quantum dots, induced by electric field of THz pulse with 3 THz bandwidth is demonstrated in THz pump - optical probe experiment. This effect may be promising for Tbit/s wireless transmission systems.

08:00–09:45 QMC • High Harmonic Generation

David Villeneuve, National Res. Council, Canada, Presider

QMC1 • 08:00
Probing Collective Multi-Electron Dynamics with High Harmonic Spectroscopy - the Giant Resonance in Xenon, *Andrew D. Shiner[1], Bruno E. Schmidt[2,1], Carlos Trallero-Herrero[1], Hans Worner[1,3], Serguei Patchkovskii[1], Paul B. Corkum[1], Jean-Claude Kieffer[2], François Légaré[2], David M. Villeneuve[1]; [1]Joint Attosecond Science Lab, National Research Council of Canada, Canada; [2]Institut National de la Recherche Scientifique, Canada; [3]Labortorium fur physikalische Chemie, ETH Zurich, Switzerland.* We present high harmonic spectra of xenon obtained with a 1.8 μm, 2 cycle laser source. These spectra contain features due to collective multi-electron effects involving inner shell electrons, in particular the giant resonance at 100eV.

QMC2 • 08:15
Single attosecond pulse generation using GDOG without the need to stabilize Carrier-Envelope phase, *Yi Wu[1], Sabih D. Khan[2], Steve Gilbertson[2], Michael Chini[1,2], Zenghu Chang[1,2]; [1]CREOL and Department of Physics, Univ. of Central Florida, USA; [2]Department of Physics, Kansas State Univ., USA.* We demonstrate that CE phase stability is not required in GDOG method to generate single attosecond pulses when gate width is set smaller than optical cycle.

QMC3 • 08:30
Characterization of isolated 80 as XUV Pulses with PROOF, *Qi Zhang[1], Kun Zhao[2], Michael Chini[1], Steve Gilbertson[2], Sabih D. Khan[1], Zenghu Chang[1,2]; [1]Univ. of Central Florida, USA; [2]Physics, Kansas State Univ., USA.* Isolated 80 as XUV pulses are produced and characterized in a streak camera with a magnetic bottle electron spectrometer. The pulses were retrieved by PROOF algorithms for XUV pulses with different chirp.

CLEO: Science & Innovations

07:00–17:00 Registration Open, *Baltimore Convention Center, Pratt Street, 300 Level Lobby*

08:00–09:45
CME • Nanowires—Novel Material and Device Concepts
Claire Gmachl, Princeton Univ., USA, Presider

CME1 • 08:00
Characterization of DNA Optical Microfiber Devices Fabricated by Drawing, *Weihong Long[1], Weiwen Zou[1], Zehua Hong[1], Yikai Su[1], Liming Tong[2], Litao Yang[3], Linjie Zhou[1], Xinwan Li[1], Jianping Chen[1]; [1]State Key Lab of Advanced Optical Communication Systems and Networks, Department of Electronic Engineering, Shanghai Jiao Tong Univ., China; [2]State Key Lab of Modern Optical Instrumentation, Department of Optical Engineering, Zhejiang Univ., China; [3]GMO Detection Lab, SJTU-Bor Luh Food Safety Center, Key Lab of Microbial Metabolism, Shanghai Jiao Tong Univ., China.* We demonstrate the characterization of DNA optical microfiber devices fabricated by manually drawing. The strength, flexibility and optical loss are experimentally investigated. DNA optical microfiber devices are expected as novel optical biosensors.

CME2 • 08:15
Cross-Sectional Geometry Control of Low-Loss Biconical Fiber Tapers Using Hydrofluoric Acid Flow Etching, *Eric J. Zhang[1], Jared C. Mikkelsen[1], Joyce Poon[1]; [1]Electrical and Computer Engineering, Univ. of Toronto, Canada.* We present an etch method for fabricating low-loss biconical fiber tapers. Surface tension driven flows of hydrofluoric acid etch the fibers to sub-micron diameters. Varying the immersion depth controls the taper cross-section shape and ellipticity.

CME3 • 08:30
Color-Tunable Periodic Emission of Alloyed $CdS_{1-x}Se_x$/Sn: $CdS_{1-x}Se_x$ Superlattice Microwires, *Guozhang Dai[1]; [1]Beijing Inst. of Technology, China.* We demonstrate a color-tunable emission from the semiconductor superlattice alloyed microwire. Such unique microwire can modulate photons and/or excitons, like one-dimensional coupled optical microcavities, to produce multiple emission modes.

08:00–09:45
CMF • Terahertz Quantum Cascade Lasers
Benjamin Williams, Univ. of California at Los Angeles, USA, Presider

CMF1 • 08:00
3-4 THz InGaAs/InAlAs Quantum-Cascade Lasers based on the Indirect Pump Scheme, *Masamichi Yamanishi[1], Kazuue Fujita[1], Nafang Yu[2], Tadataka Edamura[1], Kazunori Tanaka[1], Federico Capasso[2]; [1]Central Research Labs.,, Hamamatsu Photonics KK, Japan; [2]School of Engineering and Applied Sciences, Harvard Univ., USA.* We present the operation of an indirectly pumped InGaAs/InAlAs THz quantum-cascade laser. The threshold-current-density is obtained to be low, ~470 A/cm^2 at 6-25 K, with recourse to the absence of lower level pumping.

CMF2 • 08:15
Terahertz Quantum Cascade Sources based on Intra-cavity Frequency Mixing in Passive Nonlinear Sections, *R. W. Adams[1], A. Vizbaras[2], C. Grasse[2], S. Katz[2], G. Boehm[2], K. Vijayraghavan[1], M. Jang[1], M. C. Amann[2], Y.-H. Cho[3], A.A. Belyanin[3], Mikhail A. Belkin[1]; [1]Electrical and Computer Engineering, The Univ. of Texas at Austin, USA; [2]Walter Schottky Inst., Technische Universität München, Germany; [3]Physics, Texas A&M Univ., USA.* We report terahertz quantum cascade laser sources based on intra-cavity difference-frequency generation in passive nonlinear sections. Current devices provide terahertz output up to a heat sink temperature of 210 K.

CMF3 • 08:30 Invited
Monolithically Integrated Solid-State Terahertz Transceivers, *Mike Wanke[1], Mark Lee[2], Chris Nordquist[1], Mike Cich[1], Albert D. Grine[3], Charles T. Fuller[1], John Reno[1]; [1]Sandia National Labs, USA; [2]Univ. of Texas at Dallas, USA; [3]LMATA Government Services, USA.* We monolithically integrated a Schottky diode and a THz quantum cascade laser to create a THz transceiver, capable of detecting incident THz radiation and/or characterizing the performance and dynamics of the QCL.

08:00–09:45
CMG • Remote Optical Sensing
Joseph Buck, Boulder Nonlinear Systems, USA, Presider

CMG1 • 08:00
A High Resolution, Chirped Pulse Lidar for Simultaneous Range and Velocity Measurements, *Mohammad Umar Piracha[1], Dat Nguyen[1], Ibrahim Ozdur[1], Peter J. Delfyett[1]; [1]CREOL, The College of Optics and Photonics, Univ. of Central Florida, USA.* A lidar based on the coherent detection of oppositely chirped optical pulses is used to perform range measurements with sub-millimeter resolution and simultaneous velocity measurements. A target moving at 212km/h is tracked with 20dB SNR.

CMG2 • 08:15
An Extended Spectral Angle Map for Hyperspectral and Multispectral Imaging, *Jack O'Sullivan[1], Paul R. Hoy[2], Harvey N. Rutt[1]; [1]Faculty of Physical and Applied Sciences, Univ. of Southampton, UK; [2]School of Medicine, Univ. of Southampton, UK.* We present an extension to the widely used spectral angle metric, calculating an azimuthal angle around a reference vector. We demonstrate that it provides additional information, thus improving the classification ability of the spectral angle.

CMG3 • 08:30
Compressive Sensing LIDAR for 3D Imaging, *Gregory Howland[1], Petros Zerom[2], Robert W. Boyd[2], John C. Howell[1]; [1]Physics and Astronomy, Univ. of Rochester, USA; [2]Inst. of Optics, Univ. of Rochester, USA.* We present a proof-of-principal 3D single pixel lidar based on compressive sensing. Our technique improves on pixel array based designs by requiring fewer measurements with better SNR, compact implementation, and scalable resolution without scanning.

JOINT

JMA • Joint Symposium on Hybrid Quantum Nanoplasmonic Systems - Towards Active Nanoplasmonics I: Plasmon Nanolasers—Continued

JMA3 • 09:00
Electrically Pumped Subwavelength Metallo-dielectric Laser with Low Threshold Gain, *Jin Hyoung Lee[1], Aleksandar Simic[1], Mercedeh Khajavikhan[1], Olesya Bondarenko[1], Qing Gu[1], Boris Slutsky[1], Maziar P. Nezhad[1], Yeshaiahu Fainman[1]; [1]Electrical and Computer Engineering, Univ. of California at San Diego, USA.* An electrically pumped subwavelength metallo-dielectric laser with a low threshold gain is demonstrated. InP electrical channel is selectively etched for low threshold gain. Lasing operation is observed for temperatures up to 180 K.

JMA4 • 09:15
Novel Metal-Cavity Nanolasers at Room Temperature, *Chien-Yao Lu[1], Shun L. Chuang[1], Tim D. Germann[2], Alex Mutig[2], Dieter Bimberg[2]; [1]ECE, Univ. of Illinois at Urbana-Champaign, USA; [2]Institut für Festkörperphysik, Technische Universität Berlin, Germany.* We propose and implement room-temperature metal-cavity surface-emitting nanolasers, which are platform-insensitive, with μ-watt CW output, of circular beam shape, better in thermal management, and capable of dense integration due to metal shielding.

JMA5 • 09:30
Demonstration of Metallic Nano-Cavity Light Emitters with Electrical Injection, *Akira Matsudaira[1], Chien-Yao Lu[1], Shun L. Chuang[1], Liming Zhang[2]; [1]Electrical and Computer Engineering, Univ. of Illinois, USA; [2]Bell Laboratories, Alcatel Lucent, USA.* Metallic nano-cavity light emitter with a cavity volume of 0.19 λ_0^3 and metal encapsulated active region is demonstrated with current injection at room temperature.

JMB • Joint Symposium on Nano-Bio-Photonics I: Nanoscale Imaging and Sensing for Biomedical Applications—Continued

JMB3 • 09:00 Invited
Combined OCT and Fluorescence Imaging for Cancer Detection and Therapeutic Monitoring, *Yu Chen[1], Jerry Wierwille[1], Celeste Roney[2], Biying Xu[3], Gary L. Griffiths[3], Ronald M. Summers[2]; [1]Bioengineering, Univ. of Maryland, USA; [2]Radiology and Imaging Sciences, National Inst.s of Health, USA; [3]Imaging Probe Development Center, National Inst.s of Health, USA.* We developed a co-registered OCT and fluorescence molecular imaging system for simultaneous morphological and molecular imaging. This system enables real-time imaging of fluorescence-labeled gold nanoparticles and monitoring photothermal therapy.

CLEO: Science & Innovations

CMA • Efficiency Enhancement by Patterning—Continued

CMA2 • 09:00
Extraction Efficiency Improvement of GaN Light-emitting Diode Using Sub-wavelength Nanoimprinted Patterns on Sapphire Substrate, *Hao Chen[1], Chao Wang[1], Stephen Y. Chou[1]; [1]Department of Electrical Engineering, Princeton Univ., USA.* Nano-patterned sapphire substrate with sub-wavelength pattern pitch (200nm) was fabricated to enhance the poor extraction efficiency of GaN LED. Such substrate can give 80% more light out, better than previously-reported micro-scale pattern.

CMA3 • 09:15
Impact of the Vertical Layer Structure on the Emission Directionality of Thin-Film InGaN Photonic Crystal LEDs, *Elizabeth Rangel[1], Elison Matioli[1], James S. Speck[1], Claude Weisbuch[1], Evelyn Hu[1]; [1]Univ. of California, Santa Barbara, USA.* This work explores the impact of cavity thickness, photonic crystal etch depth, and quantum well placement on the extraction efficiency and emission directionality of thin-film InGaN photonic crystal light-emitting diodes (LEDs).

CMA4 • 09:30
White Emission from InGaN Multi-quantum Wells on c-Planes and Nano-pyramids Hybrid Structure, *Taek Kim[1], Jusung Kim[1], Moonseung Yang[1], Sangmoon Lee[1], Youngsoo Park[1], Youngho Ko[2], Yonghoon Cho[2]; [1]Samsung Advanced Inst. of Technology, Republic of Korea; [2]Department of Physics, Korea Advanced Inst. of Science and Technology, Republic of Korea.* We report a white emission from InGaN MQWs on c-plane and nano-pyramids hybrid structure. We achieve a spectrum close to that of a phosphor-converted white LED and pave the way for phosphor-free white LED.

CLEO: Applications & Technology

AMA • Fundamentals of Laser Processing for Adding, Modifying and Joining Materials—Continued

AMA3 • 08:45
Selective Tuning of Silicon Photonic Crystal Cavities via Laser-Assisted Local Oxidation, *Jiangjun Zheng[1], Charlton J. Chen[1], James F. McMillan[1], Mingbin Yu[2], Guo-Qiang Lo[2], Dim-Lee Kwong[2], Chee Wei Wong[1]; [1]Columbia Univ., USA; [2]The Inst. of Microelectronics, Singapore.* Ultra-high-Q nanocavity resonance tuning by laser-assisted thermal oxidation of silicon is demonstrated by using a 532 nm continuous wave laser. The resonance is blue-shifted by >2nm. The quality factor remains >200,000.

AMA4 • 09:00
Matrix Assisted Growth of Nanoparticles and Nanoporous Thin Films: An Emerging Approach, *Matthew A. Steiner[1], James M. Fitz-Gerald[1]; [1]Materials Science & Engineering, Univ. of Virginia, USA.* Complex inorganic nanoparticles and nanoporous films have been synthesized by ultraviolet decomposition of metal based acetate precursors. Unary, alloyed and oxide crystalline nanoparticles where characterized via transmission electron microscopy.

AMA5 • 09:15
Effects of Growth Temperature on Epitaxial Thin Films of Vanadium Dioxide Grown by Pulsed Laser Deposition, *Joyeeta Nag[1], Richard Haglund[1], Andrew Payzant[2]; [1]Physics and Astronomy, Vanderbilt Univ., USA; [2]Center for Nanophase Materials Science, Oak Ridge National Lab, USA.* Contrary to conventional wisdom, epitaxial thin films of vanadium dioxide can be grown at room temperature and then annealed. Such films exhibit smoother surfaces and higher optical quality than epitaxial films grown at high temperature.

AMA6 • 09:30
Thermodynamics of Resonant Infrared Matrix-Assisted Pulsed Laser Evaporation of Luminescent Dendrimers, *Richard Haglund[1], Stephen Johnson[1], Kenneth Schriver[1], Ricardo Torres-Pagan[2], Paul Holloway[2], Jungseek Hwang[2], Paul Burn[3]; [1]Physics and Astronomy, Vanderbilt Univ., USA; [2]Univ. of Florida, USA; [3]Univ. of Queensland, Australia.* The mechanism of resonant infrared matrix assisted pulsed laser evaporation of luminescent dendrimers depends on thermodynamic properties of cryogenic chloroform and toluene matrices and is correlated with film roughness and structural changes to the dendrimer.

09:45–10:15 Coffee Break, *300 Level Foyer*

Room 315

CLEO: Science & Innovations

CMB • Ytterbium and Praseodymium Lasers—Continued

CMB4 • 08:45
100-mJ diode-pumped, cryogenically-cooled Yb:YLF chirped-pulse regenerative amplifier, *Kanade Ogawa[1,2], Yutaka Akahane[1,2], Koichi Yamakawa[1,2]; [1]Japan Atomic Energy Agency, Japan; [2]CREST, Japan Science and Technology Agency, Japan.* A cryogenically-cooled, Yb-doped YLF chirped-pulse regenerative amplifier with an output pulse energy of 107 mJ was obtained at a 10-Hz repetition rate. To our knowledge, this is the highest energy Yb-doped solid-state regenerative amplifier.

CMB5 • 09:00
Diode pumped efficient continuous-wave Yb:YGG laser, *Yongdong Zhang[1], Zhiyi Wei[1], Qing Wang[1], Liang Lv[2], Xin Zhong[1], Zhiguo Zhang[1], Dehua Li[1], Haohai Yu[3], Huaijin Zhang[3], Jiyang Wang[3]; [1]Lab of Optical Physics, Inst. of Physics, China; [2]School of Technical Physics, Xidian Univ., China; [3]State Key Lab of Crystal Material and Inst. of Crystal Material, Shandong Univ., China.* We demonstrated a continuous-wave Yb:YGG laser up to 2.65 W under absorbed pump power of 4.23 W at 971 nm, corresponding to optical-to-optical efficiency of 62.6 nd maximum slope efficiency of 90.2%.

CMB6 • 09:15
Continuous-wave Diode-pumped Pr^{3+} :BaY_2F_8 Orange Laser, *David Pabœuf[1,2], Oussama Mhibik[1], Fabien Bretenaker[1], Philippe Goldner[2], Daniela Parisi[3], Mauro Tonelli[3]; [1]Laboratoire Aimé Cotton, CNRS, France; [2]Laboratoire de Chimie de la Matière Condensée de Paris, France; [3]NEST, Nanoscience Inst. -CNR,, Italy.* We describe a continuous wave orange Pr^{3+}:BaY_2F_8 laser pumped by a blue GaN laser diode. A maximal output power of 78 mW at 607 nm is obtained in a quasi single transverse mode beam.

CMB7 • 09:30
Passively Q-switched Pr:YLF laser, *Vasili Savitski[1], Izilda M. Ranieri[2], Andrey B. Krysa[3], Stephane Calvez[1]; [1]Inst. of Photonics, Univ. of Strathclyde, UK; [2]Centre for lasers and applications, IPEN-CNEN, Brazil; [3]EPSRC National Centre for III-V Semiconductors, Univ. of Sheffield, UK.* We report passively Q-switched operation of a diode-pumped Pr:YLF laser using an AlInGaP on GaAs SEmiconductor Saturable Absorber Mirror. Q-switched pulses with 145ns duration and 23mW average output power at 639.5nm are obtained.

Room 316

CLEO: QELS-Fundamental Science

QMA • Novel Phenomena in Optics—Continued

QMA3 • 08:45
Broad Band Unidirectional Invisibility using PT-Symmetry, *Hamidreza Ramezani[1], Zin Lin[1], Toni Eichelkraut[2], Tsampikos Kottos[1], Hui Cao[3], Demetrios Christodoulides[2]; [1]Department of Physics, Wesleyan Univ., USA; [2]College of Optics & Photonics-CREOL, Univ. of Central Florida, USA; [3]Department of Applied Physics, Yale Univ., USA.* We show that parity-time symmetric Bragg grating structures, at the spontaneous PT-symmetry point, can act as unidirectional transparent media where the reflection from one side is suppressed while it is enhanced from the other.

QMA4 • 09:00
Scale-free optics and diffractionless waves in nano-disordered ferroelectrics, *Eugenio DelRe[1], Elisa Spinozzi[1], Aharon J. Agranat[2], Claudio Conti[3]; [1]Electrical and Information Engineering, Univ. of L'Aquila, Italy; [2]Applied Physics, Hebrew Univ., Israel; [3]Inst. for Complex Systems, ISC-CNR, Italy.* In supercooled KLTN we report light propagation where wavelength is cancelled by nonlinearity. Diffraction is not compensated, but ceases: beams form solitons of any size and intensity, even arbitrarily low, allowing ultraresolved imaging.

QMA5 • 09:15
Optical-Parametric-Amplification Imaging of Complex Objects, *Peter Vaughan[1], Rick Trebino[1]; [1]Georgia Inst. of Technology, USA.* We used ultrafast Fourier-plane OPA imaging to image, wavelength-shift, and amplify complex two-dimensional objects with spatial features from 1.1 to 11.3 line-pairs/mm, corresponding to a 2D space-bandwidth product (SBP) of 13,790.

QMA6 • 09:30
Scattering phenomena in PT-symmetric optical systems, *Yidong Chong[1], Li Ge[1,2], A. Douglas Stone[1]; [1]Yale Univ., USA; [2]Electrical Engineering, Princeton Univ., USA.* We study the scattering properties of balanced gain/loss (PT-symmetric) structures, without restriction to the paraxial approximation. The scattering eigenstates exhibit a symmetry breaking transition with experimentally accessible consequences.

Room 317

CLEO: Science & Innovations

CMC • Advanced Nonlinear Configurations—Continued

CMC4 • 08:45
Single-Photon Detection at 1550 nm via Up-conversion Using a Tunable Long-Wavelength Pump Source, *Jason Pelc[1], Christopher Phillips[1], Carsten Langrock[1], Qiang Zhang[1], Lijun Ma[2], Oliver Slattery[2], Xiao Tang[2], Martin M. Fejer[1]; [1]Stanford Univ., USA; [2]NIST, USA.* We demonstrate 37% single-photon detection efficiency at 1550 nm via sum-frequency generation in a periodically poled lithium niobate waveguide, by pumping with a monolithic optical parametric oscillator tunable near 1800 nm.

CMC5 • 09:00
2nd and 4th Harmonic Generations of a Diode-Oscillator Fiber-Amplifier for Atomic Spectroscopy, *Kwang-Hoon Ko[1], Kyung-Hyun Lee[1], Hyunmin Park[1], Jaemin Han[1], Yong Ho Cha[1], Gwon Lim[1], Taek-Soo Kim[1], Do-Young Jeong[1]; [1]Quantum Optics Division, Korea Atomic Energy Research Inst., Republic of Korea.* 2nd and 4th harmonic generations of a single-frequency continuous-wave infrared beam at 1089 nm are demonstrated for calcium spectroscopy. The optical pumping of the calcium atom is also demonstrated.

CMC6 • 09:15
Enhancement on Surface-Emitting Second-Harmonic Generation by Counter-Propagating Fundamental Beams in $LiNbO_3$ Channel Waveguide by Seven Orders of Magnitude, *Yi Jiang[1], Da Li[1], Xiaomu Lin[1], Yujie J. Ding[1], Lei Wang[2], Ioulia B. Zotova[3], Narasimha S. Prasad[4]; [1]Electrical & Computer Engineering, Lehigh Univ., USA; [2]School of Physics, Shandong Univ., China; [3]ArkLight, USA; [4]Laser Remote Sensing Branch, NASA Langley Research Center, USA.* By coupling two counter-propagating fundamental beams into a $LiNbO_3$ channel waveguide, we have generated a strong surface-emitting second-harmonic beam, with normalized conversion efficiency being enhanced by seven orders of magnitude.

CMC7 • 09:30
Efficient broad-band harmonic generation for UV picosecond temporal pulse shaping, *Carlo Vicario[1], Alexandre Trisorio[1], Christoph P. Hauri[1,2]; [1]Paul Scherrer Inst., Switzerland; [2]Ecole Polytechniques de Lousanne, Switzerland.* We present efficient and broadband sum frequency generation tenfold beyond nonlinear crystal's acceptance bandwidth. Versatile shapes, up to 4nm bandwidth and 15% efficiency have been achieved for ps flattop UV pulse generation.

09:45–10:15 Coffee Break, *300 Level Foyer*

Room 327 — CLEO: Science & Innovations

CMD • Ultrafast Fiber Lasers—Continued

CMD4 • 08:45
Femtosecond Fiber Oscillator at 976 nm, *Jerome Lhermite[1], Guillaume Machinet[1], Caroline Lecaplain[2], Johan Boullet[1,3], Ammar Hideur[2], Nicholas Traynor[3,4], Eric Cormier[1]; [1]CELIA, France; [2]CORIA, France; [3]Aphanov, France; [4]Azur Light Systems, France.* We report on a passively mode-locked fiber laser emitting around 976 nm. The laser emits chirped pulses with a duration of 1.02 ps and 12 nJ at 40,7 MHz. External compression leads to pulses as short as 286 fs.

CMD5 • 09:00 Invited
Sub-40 fs Er:fiber laser, *Zhigang Zhang[1], Weijian Zong[1], Chen Li[1], Ding Ma[1], Chun Zhou[1], Aimin Wang[1]; [1]Inst. of Quantum Electronics, Peking Univ., China.* Simulation and experiment results are presented for sub-40 fs pulse generation in Er:fiber ring lasers.

CMD6 • 09:30
Carrier envelope phase locked modelocking in fiber lasers at ultra-high repetition rates, *Mark Shtaif[1], Curtis Menyuk[2]; [1]School of Electrical Engineering, Tel Aviv Univ., Israel; [2]Computer Science and Electrical Engineering, Univ. of Maryland Baltimore County, USA.* We propose a method for high repetition-rate carrier-envelope-phase-locked passive modelocking of a fiber-laser. This method uses an intra-cavity Mach-Zehnder interferometer and a feedback servo loop to control the pulse spacing and phase-slip.

Room 336 — JOINT

JMC • Environmental and Explosive Sensing by Quantum Cascade Lasers—Continued

JMC4 • 09:00
Quantum Cascade Lasers for Sensing CO2 Isotopic Fingerprints, *Matthew Escarra[1], Loan Le[1], Richard Cendejas[1], Igor Trofimov[1,2], Xiaojun Wang[3], Jen-Yu Fan[3], Claire F. Gmachl[1]; [1]Department of Electrical Engineering, Princeton Univ., USA; [2]PTAC, Inc., USA; [3]AdTech Optics, Inc., USA.* We demonstrate a quantum cascade laser for detecting $^{12}CO_2$ and $^{13}CO_2$ isotopes for fingerprinting CO_2 emissions from sources such as power plants and carbon storage reservoirs. The lasers emit a single mode at 4.32 μm in continuous wave operation.

JMC5 • 09:15
Compact Quantum Cascade Laser Based Atmospheric CO_2 Sensor, *Wen Wang[1], Stephen So[1], Feng Xie[2], Catherine Caneau[2], Chung-en Zah[2], Gerard Wysocki[1]; [1]Electrical Engineering, Princeton Univ., USA; [2]Corning Inc., USA.* We have developed a compact sensor system for environmental CO_2 studies based on quantum cascade laser. The sensor targets the strongest fundamental CO_2 rovibrational band at 4.24μm and requires only 8mm optical path to provide sensitivity of 2 ppm.

JMC6 • 09:30
Deployment of a Quantum Cascade Laser Open- Path Gas Sensor for Water Vapor and Wood Smoke Analysis, *Ekua N. Bentil[1], Charles Amuah[2,1], Anna P. Michel[3], Moses Eghan[2], James A. Smith[4], Claire F. Gmachl[1]; [1]Electrical Engineering, Princeton Univ., USA; [2]School of Physical Sciences, Physics Dept., Univ. of Cape Coast, Ghana; [3]Princeton Inst. of Science and Technology of Materials, Princeton Univ., USA; [4]Civil amd Environmental Engineering, Princeton Univ., USA.* We present results from a widely tunable (296 cm^{-1}) Quantum Cascade laser based-sensor used in sensing water vapor and target gases found in wood smoke in the rural fishing village of Elmina, Ghana.

Room 337 — CLEO: QELS-Fundamental Science

QMB • High Field THz and Strong Coupling—Continued

QMB4 • 08:45
Ultrafast Dynamics of Semiconductor Interband Transitions in THz Fields up to 4 MV/cm, *Friederike Junginger[1], Olaf Schubert[1,2], Christian Schmidt[1], Sebastian Mährlein[1], Bernhard Mayer[1], Alexander Sell[1], Rupert Huber[1,2], Alfred Leitenstorfer[1]; [1]Department of Physics and Center for Applied Photonics, Univ. of Konstanz, Germany; [2]Department of Physics, Univ. of Regensburg, Germany.* Phase-locked multi-THz transients bias semiconductors far above the usual threshold for dielectric breakdown. Few-cycle NIR pulses synchronized to the THz transients on an attimescale, probe interband transitions under electric fields of 4 MV/cm.

QMB5 • 09:00
High field transport of photo-injected electrons in GaAs: Transition from ballistic to drift motion, *Pamela Bowlan[1], Wilhelm Kuehn[1], Klaus Reimann[1], Michael Woerner[1], Thomas Elsaesser[1], Rudolf Hey[2], Christos Flytzanis[3]; [1]Max-Born-Institut für nichtlineare Optik und Kurzzeitspektroskopie, Germany; [2]Paul-Drude-Institut für Festkörperelektronik, Germany; [3]Laboratoire Pierre Aigrain, École Normale Supérieure, France.* Using visible/NIR pump and strong THz probe pulses, we observe the THz field emitted by accelerated photoelectrons in n-type GaAs. A transition from ballistic to drift motion is observed.

QMB6 • 09:15
Light-matter strong coupling in the mid-infrared region with metallic microcavities, *Pierre Jouy[1], Yanko Todorov[1], Angela Vasanelli[1], Giorgio Biasiol[2], Raffaele Colombelli[3], Carlo Sirtori[1]; [1]Laboratoire Materiaux et Phenomenes Quantiques, France; [2]Laboratorio TASC, CNR-IOM, Italy; [3]Institut d'electronique fondamentale, France.* We demonstrate a very strong coupling between a mid-infrared intersubband excitation of a two-dimensional electron gas and a microcavity mode, obtained thanks to a sub-wavelength confinement of the light between two metal layers.

QMB7 • 09:30
Strong coupling between intersubband transitions and surface plasmons sustained by a metallic grating, *Zanotto Simone[1], Riccardo Degl'Innocenti[1], Giorgio Biasiol[2], Lucia Sorba[1], Alessandro Tredicucci[1]; [1]Scuola Normale Superiore and NEST, Istituto Nanoscienze - CNR, Italy; [2]CNR-IOM, Laboratorio TASC, AREA Science Park, Italy.* We observed strong coupling between an intersubband transition and photonic modes sustained by a grating. Research on this system is motivated as good candidate for studying cavity quantum electrodynamics in the non-adiabatic regime.

QMC • High Harmonic Generation—Continued

QMC4 • 08:45
Isotope Effect in the High Harmonics of Water, *Joe Farrell[1,2], Brian K. McFarland[1,2], Limor S. Spector[1,2], Philip H. Bucksbaum[1,2], Markus Guehr[1,2]; [1]Stanford Univ., USA; [2]PULSE Inst., USA.* We show that the high harmonics of water are affected by sub-femtosecond nuclear motion launched via ionization of the inner valence $3a_1$ orbital. This introduces a new method to find multi-orbital contributions to high harmonics.

QMC5 • 09:00
Tunability in High Harmonic Enhancement by a Binary Quasi-Static Electric Field, *Jens Biegert[1,2], Carles Serrat[1,3]; [1]Attoscience and Ultrafast Optics, ICFO - The Inst. of Photonic Sciences, Spain; [2]ICREA Institucio Catalana de Recerca i Estudis Avancats, Spain; [3]DFEN Universitat Politecnica de Catalunya, Spain.* An alternating quasi-static field allows for controlling and enhancing the yield in high harmonic generation. Simulations predict increase of more than two orders of magnitude for harmonics in the water window spectral range.

QMC6 • 09:15
Complete Control of High-Harmonic Generation for High Average Power Applications, *Arik Willner[1,2], Mark Yeung[3], Tom Dzelzainis[3], Christos Kamperidis[4], Makis Bakarezos[4], Darryl Adams[3], Vladislav Yakovlev[5], Franz Tavella[2], Brendan Dromey[3], Bart Faatz[1], Nektarios Papadogiannis[4], Michael Tatarakis[4], Joerg Rossbach[6], Matthew Zepf[3]; [1]DESY Hamburg, Germany; [2]Helmholtz-Inst. Jena,, Germany; [3]Queens Univ., UK; [4]Centre for Plasma Physics & Lasers, Greece; [5]Max-Planck-Inst. for Quantum Optics, Germany; [6]Univ. of Hamburg, Germany.* We present a new dual-gas multi-jet HHG source which can be perfectly controlled via phasematching of the long and short trajectory contributions and is applicable for high average power driver laser systems.

QMC7 • 09:30
Order-dependent wavefront structure of high harmonic radiation, *Eugene Frumker[1,2], Gerhard G. Paulus[2,3], David M. Villeneuve[1], Paul B. Corkum[1]; [1]Joint Lab for Attosecond Science, NRC and Univ. of Ottawa, Canada; [2]Department of Physics, Texas A&M Univ., USA; [3]Inst. of Optics and Quantum Electronics, Germany.* We discover that different high harmonics have a significantly different wavefront curvature. This results in spatial and temporal chirp of attosecond pulses. We consider an implications of these findings on attosecond science and technology.

09:45–10:15 Coffee Break, *300 Level Foyer*

CLEO: Science & Innovations

CME • Nanowires—Novel Material and Device Concepts—Continued

CME4 • 08:45
High-Q Monolithic Distributed Bragg Reflector Cavities in Al_2O_3 Channel Waveguides, *Edward H. Bernhardi[1], Henk van Wolferen[2], Kerstin Worhoff[1], Rene M. de Ridder[1], Markus Pollnau[1]; [1]Integrated Optical MicroSystems Group, Univ. of Twente, Netherlands; [2]Transducers Science and Technology Group, Univ. of Twente, Netherlands.* Monolithic distributed Bragg reflector cavities have been realized in aluminum oxide channel waveguides and exhibit grating reflectivities exceeding 99%, finesse of up to 147 and quality factors of more than one million.

CME5 • 09:00
Tellurite Nanostructured Fiber, *Meisong Liao[1], Xin Yan[1], Zhongchao Duan[1], Takenobu Suzuki[1], Yasutake Ohishi[1]; [1]Optical Functional Materials Lab., Toyota Technological Inst., Japan.* We propose a distortion factor which indicates the distortion degree of the geometry of fiber compared with the geometry of preform. Hexagonal core, and triangular core nanostructured fibers with the smallest size are demonstrated.

CME6 • 09:15
Single-Crystal Erbium Chloride Silicate Nanowires for Novel Si-Compatible Sources at 1.53 μm, *Anlian Pan[1,2], Leijun Yin[1], Zhicheng Liu[1], Minghua Sun[1], Patricia L. Nicholas[1], Cun-Zheng Ning[1]; [1]Arizona State Univ., USA; [2]Hunan Univ., China.* We report on synthesis of single crystal erbium chloride silicate nanowires, which exhibit superior optical property than erbium silicate, providing a new Si-compatible material for light emission and amplification at 1.53 μm wavelength.

CME7 • 09:30
Strain-Induced Self-rolling of Semiconductor Membranes: Effect of Geometry, Energetics, and Kinetics, *Ik Su Chun[1], A. Challa[1], B. Derickson[1], K. J. Hsia[1], Xiuling Li[1]; [1]Univ. of Illinois, USA.* Semiconductor micro- and nanotubes can be formed by strain-induced self-rolling of membranes. The geometry effect on the final rolling direction of $In_xGa_{1-x}As$-GaAs membranes is reported.

CMF • Terahertz Quantum Cascade Lasers—Continued

CMF4 • 09:00
Ultra-broadband THz semiconductor laser based on heterogeneous quantum cascade gain medium, *Dana Turcinkova[1], Giacomo Scalari[1], Fabrizio Castellano[1], Maria I. Amanti[1], Mattias Beck[1], Jérôme Faist[1]; [1]Inst. of Quantum Electronics, ETH Zurich, Switzerland.* We report broadband laser emission from a quantum cascade laser based on heterogeneous gain medium. Laser emission exceeding 1 THz bandwidth is reported around 2.66 THz (40% of the central frequency).

CMF5 • 09:15
InGaAs/GaAsSb Terahertz Quantum Cascade Lasers, *Hermann Detz[1], Christoph Deutsch[2], Michele Nobile[1], Pavel Klang[1], Aaron M. Andrews[1], Clemens Schwarzer[1], Werner Schrenk[1], Karl Unterrainer[2], Gottfried Strasser[1]; [1]Center for Micro- and Nanostructures and Inst. for Solid-State Electronics, Vienna Univ. of Technology, Austria; [2]Photonics Inst., Vienna Univ. of Technology, Austria.* We present THz QCLs based on the InGaAs/GaAsSb material system, which benefits from the low effective masses. The devices are emitting between 3.6¬ 4.2 THz up to a temperature of 135 K.

CMF6 • 09:30
Phase seeding of a terahertz quantum cascade laser, *Julien Madéo[1], Nathan Jukam[1], Dimitri Oustinov[1], Rakchanok Rungsawang[1], Jean Maysonnave[1], Pierrick Cavalié[1], Stefano Barbieri[2], Pascal Filloux[2], Carlo Sirtori[2], Xavier Marcadet[3], Jérôme Tignon[1], Sukhdeep S. Dhillon[1]; [1]Laboratoire Pierre Aigrain, Ecole Normale Supérieure, France; [2]Matériaux et Phénomènes Quantiques, Université Paris 7, France; [3]Alcatel-Thales 3-5 Lab, France.* The QCL carrier phase is set by coherent injection seeding with a THz pulse. This enables the phase-resolved laser emission to be measured in the time-domain and the QCL to be used directly for time-domain-spectroscopy.

CMG • Remote Optical Sensing—Continued

CMG4 • 08:45
Incident Field Image Reconstruction Using Speckle Intensity Correlations Over Position, *Jason Newman[1], Kevin J. Webb[1]; [1]Electrical and Comp. Engineering, Purdue Univ., USA.* Speckle images are used to form speckle intensity spatial correlations over incident light position. These correlations allow the reconstruction of the field incident on and transmitted through a heavily scattering medium.

CMG5 • 09:00 Invited
Hyperspectral Imaging Technology and Systems, Exemplified by Airborne Real-time Target Detection, *Torbjorn Skauli[1], Trym V. Haavardsholm[1], Ingebjørg Kåsen[1], Thomas O. Opsahl[1], Atle Skaugen[1], Amela Kavara[1]; [1]Norwegian defence research establishment (FFI), Norway.* Hyperspectral imaging exploits the information contained in the spectrum of light, and has many applications. Systems require specialized cameras and image processing. We describe an airborne system with real-time image processing.

CMG6 • 09:30
TOF-Range Image Sensor in 0.18μm CMOS technology based on Current Assisted Photonic Demodulators, *Silvano Donati[2], Gian-Franco Dalla Betta[1], Quazi D. Hossain[1], Giuseppe Martini[2], Lucio Pancheri[3], David Stoppa[3], Giovanni Verzellesi[4]; [1]Dipartimento di Ingegneria e Scienza dell'Informazione, Università di Trento, Italy; [2]Dipartimento di Elettronica, Università di Pavia, Italy; [3]Centro per i Materiali e i Microsistemi, Fondazione Bruno Kessler, Italy; [4]Dipartimento di Scienze e Metodi dell'Ingegneria, Università di Modena e Reggio Emilia, Italy.* We report on a 0.18μm CMOS range image sensor with 120x160 array of $10x10\mu m^2$ photonic demodulation pixels allowing for real-time 3D imaging with a worst-case accuracy of 3.3% in the distance interval [1.2-3.7]m.

09:45–10:15 Coffee Break, *300 Level Foyer*

Room 318-320 | Room 321-323 | Room 324-326 | Room 314

JOINT

10:15–12:00
JMD • Joint Symposium on Hybrid Quantum Nanoplasmonic Systems - Towards Active Nanoplasmonics II: Nanoplasmonic Systems with Gain
Presider to Be Announced

JMD1 • 10:15 Invited

Active and Passive Composite Metal-Dielectric Nanophotonic Devices, *Yeshaiahu Fainman[1]; [1]Univ. of California at San Diego, USA.* We explore metallo-dielectric composite nanostructures for localization and resonant excitation of optical fields and investigate design, fabrication and testing of nanolasers. Integration with silicon photonics material platform is demonstrated.

JMD2 • 10:45 Invited

Amplification of Surface Plasmons: Theory and Experiment, *Pierre Berini[1,2], Israel De Leon[1]; [1]SITE, Univ. of Ottawa, Canada; [2]Physics, Univ. of Ottawa, Canada.* Amplification of single-interface and long-range surface plasmons by dipolar gain media is reviewed. Of interest are plasmons on thin metal stripes propagating through dye, where amplification and reduced spontaneous emission were observed.

10:15–12:00
JME • Joint Symposium on Nano-Bio-Photonics II: Nanoparticles for Biomedical Diagnosis and Treatment
Chang-Seok Kim, Pusan National Univ., Republic of Korea, Presider

JME1 • 10:15 Invited

Functional Fluorescent Nanocapsules for Molecular Imaging and Potential Targeted Therapy, *Yongping Chen[1], Toufic Jabbour[1], Xingde Li[1]; [1]Biomedical Engineering, Johns Hopkins Univ., USA.* Dual-functional nanocapsules are developed using FDA approved materials for translational optical molecular imaging and potential targeted therapy. *In intro* and *in vivo* experiments were conducted to test the performance of the nanocapsules.

JME2 • 10:45 Invited

Nanoshells for Two-Photon-Induced Photoluminescence Imaging of Tumors, *James Tunnell[1]; [1]Biomedical Engineering, Univ. of Texas at Austin, USA.* Gold-silica nanoshells exhibit intrinsic, bright two-photon-induced photoluminescence (TPIP) that is ideal for biological imaging applications. We demonstrate 3D, microscopic imaging of nanoparticle distribution in solid tumors.

CLEO: QELS-Fundamental Science

10:15–12:00
QMD • Spatiotemporal Dynamics and Discrete Systems
Mikael Rechtsman, Technion, Israel, Presider

QMD1 • 10:15

Spatio-Temporal Nonlinear Optics in Arrays of Subwavelength Waveguides, *Wei Ding[1], Andrey Gorbach[1], Owain Staines[1], Charles Nobriga[1], Gareth Hobbs[1], William Wadsworth[1], Jonathan Knight[1], Dmitry Skryabin[1], Antonio Samarelli[2], Marc Sorel[2], Richard De La Rue[2]; [1]Univ. of Bath, UK; [2]Univ. of Glasgow, UK.* Spectral broadening in an array of subwavelength silicon waveguides pumped with fs pulses is studied. Adjusting input pulse position, different spectral patterns are observed and explained with the resonant emission from temporal supermode solitons.

QMD2 • 10:30

Nonlinear self-trapping of broad beams in defocusing lithium niobate waveguide arrays, *Francis H. Bennet[1], Tristram J. Alexander[1], Franz Haslinger[1], Arnan Mitchell[2], Dragomir N. Neshev[1], Yuri S. Kivshar[1]; [1]Nonlinear Physics Centre, Australian National Univ., Australia; [2]School of Electrical and Computer Engineering, RMIT Univ., Australia.* We demonstrate experimentally the localization of broad beams in defocusing waveguide arrays. Unlike gap solitons, these novel localized states have an arbitrary width defined by the size of the input beam while independent on nonlinearity.

QMD3 • 10:45

Bandstructure measurements of lithium niobate waveguide arrays, *Frank Setzpfandt[1], Matthias Falkner[1], Roland Schiek[2], Falk Eilenberger[1], Ekaterina Pshenay-Severin[1], Thomas Pertsch[1]; [1]Friedrich-Schiller-Univ. Jena, Germany; [2]Univ. of Applied Sciences Regensburg, Germany.* We experimentally determined the bandstructure of lithium niobate waveguide arrays by means of angle dependent tuning curve measurements. We used these results to calculate linear coupling constants of various higher order second harmonic modes.

QMD4 • 11:00

Light localization and Shockley surface states in honeycomb photonic lattices, *Daohong Song[1,2], Cibo Lou[2], Natalia Malkova[1], Zhuoyi Ye[2], Yi Hu[2], Jingjun Xu[2], Zhigang Chen[1,2]; [1]Phys & Astro, San Francisco State Univ, USA; [2]TEDA Applied Physical School, Nankai Univ, China.* We demonstrate an induction technique to generate honeycomb photonic lattices with equal and unequal sites in each unit-cell. We show light localization as nonlinear solitons and linear Shockley surface states in lattices with unequal sites.

CLEO: Applications & Technology

10:15–12:00
AMB • Laser Systems Development for Industrial Applications
Craig Arnold, Princeton Univ., USA, Presider

AMB1 • 10:15 Tutorial

Industrial Applications of Laser Materials Processing, *Marshall Jones, GE Global Res. Ctr., USA.* This tutorial presentation will address some of the past, present, and potential uses of laser for material processing with emphasis of manufacturing. The U.S. was the hot bed for initial uses of lasers for material processing in the past with Europe, especially Germany, presently leading the way. The future laser-processing leader may still be Germany. Selected uses, past and present, of lasers within GE will also be highlighted as seen in such businesses units as Aviation, Lighting, Energy, Healthcare, and Transportation.

Dr. Marshall G. Jones joined GE Global Research (GR) in 1974 as a mechanical engineer after receiving his M.S. and Ph.D. from University of Massachusetts. He received his B.S. in the same field from University of Michigan (U of M). He worked four years as development engineer at Brookhaven National Lab after in his undergrad studies at U of M. Dr. Jones, a Principal Engineer, has performed research and development work for most all the industrial business segments of GE. He has spent most of his GE career addressing laser material processing, laser device development and fiber optics which has afforded him 50 U.S. patents, 31 foreign patents, and over 45 publications. Dr. Jones is a GE-GR Coolidge Fellow and is member of the National Academy of Engineering (NAE), a fellow of the American Society of Mechanical Engineering (ASME) and the Laser Institute of America (LIA). He serves or has served on both community and national boards including the Engineering Directorate for the National Science Foundation (NSF) and LIA. Dr. Jones has received many community and technical awards including the GE Phillippe Award (community service) in 1992 and the 2007 Arthur Schawlow Award (LIA's highest achievement award).

CLEO: Science & Innovations

10:15–12:00
CMH • Advanced Laser Techniques
Dennis Harris, MIT Lincoln Lab, USA, Presider

CMH1 • 10:15 Tutorial

Laser beam quality control with nonlinear interactions and adaptive optics, *Arnaud Brignon[1]; [1]Thales Research & Technology, France.* This lecture will review nonlinear interactions and adaptive optics techniques which permit a dynamic correction of beam distortions in solid-state lasers. Applications of these techniques including beam combining to fiber lasers will be also presented.

Arnaud Brignon received his PhD in 1996 from the Paris Univ. During his thesis work, he studied nonlinear wave-mixing in laser media for the application of high beam quality solid-state lasers. From 1996 to 2007 he was working on laser beam control including phase conjugation, beam cleanup, beam shaping, beam steering and beam combining, and high-power diode-pumped solid-state lasers. Since 2007, he is head of the Micro and Nano-Physics Lab in Thales Research & Technology, Palaiseau, France. He has authored and coauthored more than 150 papers (including some 30 invited and tutorials) on laser beam control in scientific journals and conference proceedings, two books, and 30 patents. In 1996 he received the Fabry-de-Gramont prize from the French Optical Society, in 2000 the Fresnel prize from the European Physical Society, and in 2001 the Technology Review's Young Innovators Award from the Massachusetts Inst. of Technology.

10:15–12:00
CMI • Semiconductor Laser Resonators
Peter Smowton, Cardiff Univ., UK, Presider

CMI1 • 10:15

Highly unidirectional whispering gallery mode lasers, *Qijie Wang[1], Changling Yan[2], Nanfang Yu[3], Christian Pflugl[3], Laurent Diehl[3], Federico Capasso[3], Julia Unterhinninghofen[4], Jan Wiersig[4], Tadataka Edamura[5], Masamichi Yamanishi[5], Hirofumi Kan[5]; [1]School of Electrical and Electronic Engineering, Nanyang Technological Univ., Singapore; [2]Changchun Univ. of Science and Technology, China; [3]School of Engineering and Applied Sciences, Harvard Univ., USA; [4]Insititut fur theoretische physik, Universitat Magdeburg, Germany; [5]Central research laboratories, Hamamatsu Photonics K. K., Japan.* We report elliptical resonators with a wavelength-size notch at the boundary, which supports highly unidirectional emission from whispering gallery modes. Using quantum cascade lasers, a unidirectional beam divergence of 6 degrees is demonstrated.

CMI2 • 10:30

The Smallest Deformed Disk with Unidirectional Output, *Qinghai Song[1]; [1]Harbin Inst. of Technology, China.* We demonstrate the smallest deformed microdisk laser with unidirectional output. The radius of disk over emission wavelength is as small as 0.7.

CMI3 • 10:45

Single-mode Quantum Cascade Lasers Employing a Candy-cane Shaped Fabry-Perot Cavity, *Peter Q. Liu[1], Kamil Sladek[1,2], Xiaojun Wang[3], Jen-Yu Fan[3], Claire F. Gmachl[1]; [1]Electrical Engineering, Princeton Univ., USA; [2]Inst. for Bio- and Nanosystems, Forschungszentrum Jülich, Germany; [3]AdTech Optics, USA.* Single-mode Quantum Cascade lasers employing a candy-cane shaped Fabry-Perot cavity are demonstrated. Single-mode emission with ~25 dB side mode suppression is achieved up to ~500 mA above threshold current in pulsed operation.

CMI4 • 11:00

Wavelength Tuning and Athermal Operations of Micro-machined VCSELs for Uncooled WDM Applications, *Hayato Sano[1], Norihiko Nakata[1], Masanori Nakahama[1], Akihiro Matsutani[1], Fumio Koyama[1]; [1]Photonics Integration System Research Center, Tokyo Inst. of Technology, Japan.* We successfully demonstrated the wavelength tuning and athermal operation of micro-machined VCSELs at the same time. A small temperature dependence of below 0.002 nm/K is realized with precise continuous wavelength tuning of 1.1 nm.

10:15–12:00
CMJ • Nonlinear Mixing in Optical Fibers
Presider to Be Announced

CMJ1 • 10:15

High Average Power Temporal Pulse Compression in a Xenon-Filled Kagome-Type Hollow-Core Photonic Crystal Fiber, *Oliver Heckl[1], Clara Saraceno[1], Cyrill Baer[1], Thomas Südmeyer[1], Yu Cheng[2], Yingying Y. Wang[2], Fetah Benabid[2], Ursula Keller[1]; [1]Inst. for Quantum Electronics, ETH Zurich, Switzerland; [2]Department of Physics, Univ. of Bath, UK.* We spectrally broaden 1-ps pulses from a 14.3-W, 10.6-MHz thin-disk laser in a 30-cm long Xe-filled HC-PCF. After compression, we achieve 9.1-W in 470-fs pulses (63% overall efficiency). No depolarization or damage is observed.

CMJ2 • 10:30

Few-Photon Switching via Two-Photon Absorption in Rb-Filled Photonic Bandgap Fibers, *Kasturi Saha[1], Vivek Venkataraman[1], Pablo Londero[1], Alexander L. Gaeta[1]; [1]School of Applied and Engineering Physics, Cornell Univ., USA.* We show 40% all-optical modulation with 1 nW total power via non-degenerate two-photon absorption in Rb vapor confined to a photonic bandgap fiber. This corresponds to 12 photons of switching energy.

CMJ3 • 10:45

Nonlinear Optics in Gas-Filled HC-PCF in the Plasma Regime, *Philipp Hoelzer[1], Wonkeun Chang[1], Johannes Nold[1], John C. Travers[1], Alexander Nazarkin[1], Nicolas Y. Joly[2,1], Philip Russell[1,2]; [1]Russell Division, Max Planck Inst. for the Science of Light, Germany; [2]Department of Physics, Univ. of Erlangen-Nuremberg, Germany.* Laser-driven ionization in Ar-filled HC-PCF is accessed through self-compression of few-microjoule pulses. Modeling confirms that the observed blue-shifted spectral bands are caused by light-plasma interactions over an extended length in the fiber.

CMJ4 • 11:00

Coherent Quasi-cw 153 nm Light Generated at 33 MHz Repetition Rate, *Yutaka Nomura[1], Yoshiaki Ito[1], Akira Ozawa[1,2], Xiaoyang Wang[3], Changtian Chen[3], Shik Shin[1,2], Shuntaro Watanabe[2,4], Yohei Kobayashi[1,2]; [1]Inst. for Solid State Physics, Univ. of Tokyo, Japan; [2]Core Research for Evolutional Science and Technology (CREST), Japan Science and Technology Agency (JST), Japan; [3]Technical Inst. of Physics and Chemistry, Chinese Academy of Sciences, China; [4]Tokyo Univ. of Science, Japan.* Coherent quasi-cw radiation at 153 nm is generated at 33 MHz repetition rate by successive frequency conversion of the output from Yb-fiber-based laser system using two LBO crystals and two KBBF crystals.

Room 327

CLEO: Science & Innovations

10:15–12:00
CMK • Mode-Locked Fiber Lasers I
Emmanuel Hugonnot, CEA, France, Presider

CMK1 • 10:15
Tm Fiber Laser Mode-Locked At Large Normal Dispersion, *Hui Liu[1]; [1]Cornell Univ., USA.* We demonstrate a mode-locked Tm fiber laser at large normal dispersion, generating 0.4 nJ pulses dechirping to 470 fs. The dispersion is controlled in an all fiber format.

CMK2 • 10:30
Mode-locked Tm-Ho Fiber Laser with a Sb-based SESAM, *Qing Wang[1], Jihong Geng[1], Zhuo Jiang[1], Tao Luo[1], Shibin Jiang[1]; [1]AdValue Photonics Inc., USA.* A mode-locked Tm-Ho-codoped silicate fiber laser with a Sb-based SESAM is reported. The fiber laser generates mode-locked solitons at 2.06 um with pulse energy of 0.41 nJ and pulse duration of 1.1 ps.

CMK3 • 10:45
Mode-locked Fiber Laser with Few-Layer Epitaxial Graphene Grown on 6H-SiC Substrates, *Jiang Liu[1], Rusheng Wei[2], Xiangang Xu[2], Pu Wang[1]; [1]Beijing Univ. of Technology, China; [2]State Key Lab of Crystal Materials and Inst. of Crystal Materials, Shandong Univ., China.* Few-layer epitaxial graphene grown on 6H silicon carbide wafers by thermal decomposition was used as novel saturable absorbers for mode-locking of ytterbium-doped fiber lasers, which generated 19nJ single pulse energy at 1.05MHz repetition rate.

CMK4 • 11:00
4 GHz Hybrid Mode-Locked Fiber Laser Using PDMS/SWCNT Thin Film Composite, *Ivan Hernandez-Romano[2], Josue Davila-Rodriguez[3], Dimitrios Mandridis[3], Jose J. Sanchez-Mondragon[2], Peter J. Delfyett[3], Daniel A. May-Arrioja[1]; [1]Ingenieria Electrica, Universidad Autonoma de Tamaulipas, Mexico; [2]Optics Department, INAOE, Mexico; [3]CREOL, The College of Optics and Photonics, Univ. of Central Florida, USA.* A hybrid mode-locked fiber laser was built by using a PDMS/SWCNTs film as a saturable absorber. The system allows for a high repetition rate of 4 GHz, while achieving pulse widths of 730 fs.

Room 336

CLEO: Applications & Technology

10:15–12:00
AMC • Paths to High Efficiency Photovoltaics
Christian Wetzel, Rensselaer Polytechnic Inst., USA, Presider

AMC1 • 10:15 Invited
High efficiency photovoltaics: recent progress and long term goals, *Nicholas J. Ekins-Daukes[1]; [1]Physics, Imperial College, UK.* Photovoltaic solar cells based on III-V semiconductors can now reach efficiencies in excess of 42%. This technology is reviewed and discussed with reference to the fundamental efficiency limit which sits at 87%.

AMC2 • 10:45
Silicon Nanowire/Poly(3,4-ethylenedioxythiophene): Poly(styrenesulfonate) Core-Sheath Heterojunction Solar Cells, *Hong-Jhang Syu[1], Shu-Chia Shiu[1], Chih-Fu Lin[1]; [1]National Taiwan Univ., Taiwan.* Silicon nanowire/Poly(3,4-ethylenedioxythiophene):poly(styrenesulfonate) solar cells were fabricated. The nanowires of 370 nm were coated with PEDOT:PSS. The short circuit current density and power conversion efficiency are 27.46 mA/cm^2 and 8.05%.

AMC3 • 11:00
Application of Hybrid Dielectric - Metallic Back Reflectors to Thin Film Amorphous Silicon Solar Cells, *James G. Mutitu[1], Shouyuan Shi[1], Dennis Prather[1], Allen Barnett[1]; [1]Electrical Engineering, Univ. of Delaware, USA.* The application of photonic engineering design concepts to photovoltaic devices is not entirely trivial; it introduces formidable complexity. This paper investigates some of the opportunities afforded by the amalgamation of the two sciences.

Room 337

CLEO: QELS-Fundamental Science

10:15–12:00
QME • Ultrafast Magnetism
Joe Orenstein, MIT, USA, Presider

QME1 • 10:15 Tutorial
Coherent Processes in the Ultrafast Magnetization Dynamics, *Jean-Yves Bigot[1]; [1]Univ. of Strasbourg - CNRS, France.* The ultrafast magnetization dynamics induced by femtosecond laser pulses involves several coherent mechanisms described in this tutorial. They include the spin-photon, the spin-orbit and the spin-lattice interactions occurring from a few femtoseconds to several picoseconds.

Jean-Yves BIGOT is a Research Director at CNRS-France which he joined in 1984 after his PhD. He then spent two years at AT&T Bell Laboratories (1988) and Lawrence Berkeley Lab (1989). Back to Strasbourg in 1990, he investigated the dynamical processes in conjugated polymers (wave packet dynamics of polymer backbones) and metallic nanostructures (Surface Plasmon dynamics) developing and using femtosecond spectroscopy techniques. He pioneered the field of Ultrafast Magnetization Dynamics, or Femtomagnetism, which he has been developing since 1995. He won two prizes from the French Physical Society in 1987 for his "Doctorat d'Etat" and 2000 for his works on Ultrafast Processes in Condensed Matter Physics. In 2008 he was awarded the silver medal of CNRS for his work on Femtomagnetism. In 2009 he received the prestigious senior advanced "AdG-ERC" grant from the European Research Council to develop the new project "ATOMAG" on magnetic systems interacting with X-ray pulses.

10:15–12:00
QMF • Atoms and Molecules in Strong Fields
Sergei Tochitsky, Univ. of California at Los Angeles, USA, Presider

QMF1 • 10:15
Measurement of Laser-induced Alignment of Jet-cooled Molecules using Femtosecond Degenerate Four Wave Mixing, *Varun Makhija[1], Xiaoming Ren[1], Vinod Kumarappan[1]; [1]Physics, Kansas State Univ., USA.* A degenerate four wave mixing setup for characterizing the alignment of jet-cooled molecules is described. This scheme allows characterization of asymmetric top alignment using arbitrary pump pulses, and is easily incorporated into an optimization loop.

QMF2 • 10:30
Breakdown of the Independent Electron Approximation in Sequential Double Ionization, *Adrian N. Pfeiffer[1], Claudio Cirelli[1], Mathias Smolarski[1], Xu Wang[2], Joseph H. Eberly[2], Reinhard Dörner[3], Ursula Keller[1]; [1]Department of Physics, ETH Zurich, Switzerland; [2]Rochester Theory Center and the Department of Physics & Astronomy, Univ. of Rochester, USA; [3]Institut für Kernphysik, Johann Wolfgang Goethe Universität, Germany.* We present coincidence momentum measurements that contradict the independent electron assumption for elliptically polarized laser pulses. This shows that recollision is not the only reason for electron correlation in strong field double ionization.

QMF3 • 10:45 Invited
Ultraintense X-Ray Induced Multiple Ionization and Double Core-Hole Production in Molecules, *Nora Berrah[1]; [1]Physics, Western Michigan Univ., USA.* We used the world first hard x-ray FEL to investigate the response of molecular systems to the ultraintense, femtosecond x-ray radiation. We report sequential multiphoton ionization, frustrated absorption and double core hole production mechanisms.

Thank you for attending CLEO: 2011. Look for your post-conference survey via email and let us know your thoughts on the program.

CLEO: Science & Innovations

10:15–12:00
CML • 3D Nano Fabrication
Anders Kristensen, Technical Univ. of Denmark, Denmark, Presider

CML1 • 10:15
Three-Dimensional Laser Lithography with Conceptually Diffraction-Unlimited Lateral and Axial Resolution, *Joachim Fischer[1], Tolga Ergin[1], Georg von Freymann[1,2], Martin Wegener[1,2]; [1]Institut für Angewandte Physik and DFG-Center for Functional Nanostructures, Karlsruhe Inst. of Technology, Germany; [2]Institut für Nanotechnologie, Karlsruhe Inst. of Technology, Germany.* By transferring concepts from stimulated-emission-depletion microscopy to Direct Laser Writing, we improved its lateral and axial resolution significantly. Thus, woodpile photonic crystals with 300-nm lateral rod spacing can be fabricated routinely.

CML2 • 10:30
Fabrication of Stepped and Reflowed 3-D Profiles for Optical Applications by Dose-modulated Electron Beam Lithography and Selective Thermal Reflow, *Helmut Schift[1], Arne Schleunitz[1]; [1]Lab for Micro- and Nanotechnology, Paul Scherrer Institut, Switzerland.* Microlens and prism arrays were fabricated using multi-level electron beam patterning combined with thermal reflow. The molecular weight dependent processing allows selective transfer of stepped into sloped resist structures with smooth surfaces.

CML3 • 10:45
One step non-contact fabrication of polymer microlens arrays by thermocapillary lithography, *Euan McLeod[1], Sandra M. Troian[1]; [1]Applied Physics, California Inst. of Technology, USA.* Thermocapillary lithography, a continuous-relief patterning technique, is used to fabricate polymer microlens arrays with variable pitch and focal length. Pattern definition results from sculpting by thermocapillary forces imposed by a cooled mask.

CML4 • 11:00
Fabrication of Self-Assembled Silica / Polystyrene Microlens Arrays for Light Extraction Enhancement in Nitride Light-Emitting Diodes, *Xiao-Hang Li[1], Yik-Khoon Ee[1], Renbo Song[1], Nelson Tansu[1]; [1]Department of Electrical and Computer Engineering, Lehigh Univ., USA.* The fabrications of SiO_2 / polystyrene (PS) microlens arrays with various PS thicknesses were performed, and this approach resulted in 2.2-2.8 times increase in output power for nitride light-emitting diodes.

10:15–12:00
CMM • THz Sources I
Tsuneyuki Ozaki, INRS, Canada, Presider

CMM1 • 10:15
Power-Scalable Narrowband Terahertz Pulses Generated by Periodically-Poled LiTaO3 based on Backward Rectification, *Guibao Xu[1], Yujie J. Ding[1], Ioulia B. Zotova[2]; [1]Electrical & Computer Engineering, Lehigh Univ., USA; [2]ArkLight, USA.* Narrowband terahertz pulses are generated by periodically-poled stoichiometric lithium tantalate with average output powers of 100 μW based on backward optical rectification, which is scalable to at least 10 mW.

CMM2 • 10:30
Two Photon Absorption Effect of Terahertz Radiation from Low-Temperature-Grown GaAs Photoconductive Antennas, *Chan-Shan Yang[1], Ci-Ling Pan[1], Chao-Kuei Lee[2], Sung-Hui Lin[3]; [1]NTHU, Department of Physics, Taiwan; [2]Department of Photonics, NSYSU, Taiwan; [3]Taiwan Semiconductor Manufacturing Company, Taiwan.* We investigate the possibility of enhancing terahertz radiation power though two-photon absorption in photoconductive antenna. Competition between single photon absorption and two photon absorption for terahertz radiation are discussed as well.

CMM3 • 10:45 Invited
Amplified Stimulated Terahertz Emission from Optically Pumped Graphene, *Taiichi Otsuji[1], Stephane Boubanga Tombet[1], Akira Satou[1], Victor Ryzhii[2]; [1]RIEC, Tohoku Univ., Japan; [2]CNEL, Univ. of Aizu, Japan.* This paper reviews the recent advances in theoretical and experimental study on terahertz light amplification by stimulated emission of radiation in optically pumped graphene.

10:15–12:00
CMN • Biomedical and Nanoparticle Optical Sensing
Johannes Kiefer, Univ. of Aberdeen, UK, Presider

CMN1 • 10:15
Measurements of Blood Flow and Hemoglobin Concentration Change in Anesthetized Rat Using Two-Wavelength Laser Speckle Imaging, *Naomichi Yokoi[1], Yuichi Shimatani[2], Yoshihisa Aizu[3]; [1]Asahikawa National College of Technology, Japan; [2]Tokyo City Univ., Japan; [3]Muroran Inst. of Technology, Japan.* We measured simultaneously blood flow and hemoglobin concentration change in an area of anesthetized rat using laser speckle patterns at two wavelengths. Blood flow and concentration were successfully analyzed with respect to their interrelation.

CMN2 • 10:30
Metallized Ultrathin Nanocrystalline Si Membranes as Biochemical SPR Sensors, *Krishanu Shome[1], David Z. Fang[2], Maryna N. Kavalenka[2], Philippe M. Fauchet[2,1]; [1]Inst. of Optics, Univ. of Rochester, USA; [2]Department of Electrical and Computer Engineering, Univ. of Rochester, USA.* Metal-coated ultrathin nanocrystalline Si membranes provides a novel substrate for biochemical sensing. FDTD simulations show SPR formation. The SPR peak is polarization dependent. Sensing experiments are performed with IPA and methanol.

CMN3 • 10:45
Material-specific detection and classification of single nanoparticles, *Steven Person[1], Bradley Deutsch[1], Anirban Mitra[1], Lukas Novotny[1]; [1]Inst. of Optics, Univ. of Rochester, USA.* A material-specific dual-color common-path interferometric detection system for real time discrimination between nanoparticles in solution is described. The detection technique is applicable where both particle size and material are of interest.

CMN4 • 11:00 Tutorial
Nonlinear Microspectroscopy for Biomedical Applications, *Jürgen Popp[1,2], Michael Schmitt[1], Benjamin Dietzek[1,2], Robert Möller[2], Christoph Krafft[2], Petra Rösch[1]; [1]Inst. of Physical Chemistry, Friedrich-Schiller Univ. Jena, Germany; [2]Inst. of Photonic Technology, Germany.* We will present modern trends in nonlinear microscopy spanning a multitude of different technologies from e.g. multi-photon fluorescence microscopy towards label free methods e.g. generation of second harmonic as well as nonlinear Raman microscopy (CARS).

(continued on pg. 71)

Room 318-320 | Room 321-323 | Room 324-326 | Room 314

JOINT

JMD • Joint Symposium on Hybrid Quantum Nanoplasmonic Systems - Towards Active Nanoplasmonics II: Nanoplasmonic Systems with Gain—Continued

JMD3 • 11:15
Integrated Hybrid Nanophotonics, *Volker J. Sorger[1], Rupert F. Oulton[1], Thomas Zentgraf[1], Ren-Min Ma[1], Ziliang Ye[1], Nitipat Pholchai[1], Xiaobo Yin[1], Xiang Zhang[1,2]; [1]NSF Nanoscale Science and Engineering Center, UC Berkeley, USA; [2]Materials Sciences Division, Lawrence Berkeley National Lab, USA.* Based on a hybrid-plasmon (HPP) platform, we report the first demonstrations of low-loss, deep-subwavelength waveguiding and plasmon semiconductor Nanolaser with room temperature operating, towards wavelength-scale photonic integrated circuits.

JMD4 • 11:30
An Epitaxial Metal/Semiconductor System for Active Plasmonic Devices, *Hari P. Nair[1], Adam M. Crook[1], Seth R. Bank[1]; [1]Electrical and Computer Engineering, The Univ. of Texas at Austin, USA.* We present an epitaxial metal/semiconductor system for integrating plasmonic functionality into the heart of active III-V nanophotonic devices. We describe the optical properties, growth, and prototype application to plasmonic light emitting diodes.

JMD5 • 11:45
Plasmonic waveguides for active semiconductor devices at telecom wavelengths using transverse-magnetic-polarized diode lasers, *Daniele Costantini[1], Adel Bousseksou[1], Arthur Babuty[2], Leo Greusard[2], Yannick De Wilde[2], Carlo Sirtori[3], Alain Accard[3], G. Duan[3], Raffaele Colombelli[1]; [1]Univ. Paris 11, France; [2]Laboratoire d'Optique Physique, ESPCI, CNRS - UPRA0005, France; [3]Alcatel-Thales III-V Lab, France; [4]Laboratoire MPQ, Université Paris Diderot and CNRS, France.* We present a basic building block for the realization of integrated active plasmonic devices: a distributed-feedback semiconductor laser working at room temperature and λ=1.3μm obtained with metal patterning on a thinned top cladding.

JME • Joint Symposium on Nano-Bio-Photonics II: Nanoparticles for Biomedical Diagnosis and Treatment—Continued

JME3 • 11:15 Invited
Magnetic Nanoparticles for Contrast Enhanced Infrared Thermal Imaging, *Israel Gannot, Tel-Aviv Univ., Israel.* We demonstrate the use of superparamagnetic nanoparticles with specific antibodies as contrast agents for tumor detection. Using the same nanoparticles, three different approaches for detection are shown: thermal imaging, acoustic imaging and fluorescence lifetime imaging.

CLEO: QELS-Fundamental Science

QMD • Spatiotemporal Dynamics and Discrete Systems—Continued

QMD5 • 11:15 Invited
Observation of nonlinear Light Bullets in waveguide arrays, *Falk Eilenberger[1], Stefano Minardi[1], Ekaterina Pshenay-Severin[1], Yarsolav Kartashov[2], Alexander Szameit[3], Ulrich Roepke[4], Jena Kobelke[4], Kay Schuster[4], Lluis Torner[2], Stefan Nolte[1], Falk Lederer[5], Andreas Tünnermann[1], Thomas Pertsch[1]; [1]Inst. of Applied Physics, Friedrich Schiller Univ., Germany; [2]ICFO - Institut de Ciences Fotoniques, and Universitat Politecnica de Catalunya, Mediterrean Technology Park, Spain; [3]Solid State Inst. and Physics Department, Technion, Israel; [4]Inst. of Photonic Technology, Germany; [5]Inst. of Condensed Matter Theory and Solid State Optics, Friedrich Schiller Univ., Germany.* We investigate femtosecond spatiotemporal dynamics in waveguide arrays. Experiments use an ultrafast cross-correlator tracing the Light Bullet evolution. Simulations with higher-order effects underline the solitary nature of the observed wavepackets.

QMD6 • 11:45
Seeded Femtosecond Supercontinuum in Kr Gas, *Trenton R. Ensley[1], Dmitry Fishman[1], Scott Webster[1], Lazaro Padilha[1,2], David J. Hagan[1], Eric Van Stryland[1]; [1]CREOL, The College of Optics and Photonics, The Univ. of Central Florida, USA; [2]Los Alamos National Lab, USA.* We observe spectral enhancement of femtosecond supercontinua in krypton gas using weak, nJ to μJ, seed pulses with the order of ~mJ pump pulses resulting in > 3× total energy enhancement and spectral broadening.

CLEO: Applications & Technology

AMB • Laser Systems Development for Industrial Applications—Continued

AMB2 • 11:15
1-ps thin disk amplifier for advanced materials processing, *Martin Delaigue[1], Sandrine Ricaud[1], Robert Braunschweig[1], Clemens Hoenninger[1], Eric Mottay[1]; [1]R&D, Amplitude Systemes, Franee.* We demonstrate high energy ultrafast Yb:YAG thin disk laser amplifiers. Pulse durations of 1 ps in a chirped pulse amplification scheme and of about 30 ps in a CPA-free amplifier configuration are obtained.

AMB3 • 11:30
Phased locking of two lasers with self-adjusted minimal coupling, *Eitan Ronen[1]; [1]Weizmann Inst., Israel.* We present systems of two coupled lasers and show experimentally and theoretically that they self-adjust their exchanged power to the minimal power required to phase-lock them, even when loss is inserted between them.

AMB4 • 11:45
Interferometric measurement of refractive index difference applied to composite waveguide lasers, *Huai-Chuan Lee[1], Xiaodong Mu[1], Helmuth Meissner[1]; [1]Onyx Optics, USA.* A sensitive technique has been implemented to measure the differences in refractive indices between rare-earth doped YAG and un-doped YAG. Theoretically, a refractive index difference of less than 10^{-6} can be identified.

12:00–13:30 Lunch Break

NOTES

CLEO: Science & Innovations

CMH • Advanced Laser Techniques—Continued

CMH2 • 11:15
Nd:YVO_4 Laser Mode-Locking at 1.34 μm by Negative $\chi^{(2)}$-Lens Formation in an Intracavity BIBO Crystal, *Hristo L. Iliev[1], Ivan C. Buchvarov[1], Valentin Petrov[2]; [1]Physics, Sofia Univ., Bulgaria; [2]Max-Born-Inst. for Nonlinear Optics and Ultrafast Spectroscopy, Germany.* Self-starting χ(2)-lens mode-locking of a 1.34-μm Nd:YVO_4 laser using second harmonic generation in BiB_3O_6 is demonstrated. Pulses as short as 3.7 ps and average powers reaching 1.3 W at 120 MHz are achieved.

CMH3 • 11:30
Observing the Continuous Transformation of a Four Level Laser into a Two Level System, *John D. Hewitt[1], Jason D. Readle[2], James G. Eden[1]; [1]Department of Electrical and Computer Engineering, Univ. of Illinois at Urbana-Champaign, USA; [2]Oak Ridge National Lab, USA.* Pumping the Cs 852.1nm laser by photoassociating Cs-rare gas atomic pairs allows one to observe a four-level system morph into a two-level system. This occurs when the state 3-state 2 energy defect falls below ~2kT/3.

CMH4 • 11:45
Demonstration and Analysis of a High Power Radiation Balanced Laser, *Steven Bowman[1], Shawn O'Connor[1], Subrat Biswal[1], Nicholas Condon[1]; [1]Naval Research Lab, USA.* Detrimental heating in a high power Yb:YAG laser was eliminated by incorporating anti-Stokes optical cooling.

CMI • Semiconductor Laser Resonators—Continued

CMI5 • 11:15
Ultra-Compact Angular Reflector based InGaAsP/InP Micro-Lasers, *Fang Ou[1], Fei Yi[1], Xiangyu Li[1], Boyang Liu[2], Yingyan Huang[2], Seng-Tiong Ho[1]; [1]EECS, Northwestern Univ., USA; [2]OptoNet Inc, USA.* We demonstrate a linear cavity micro-laser design utilizing the ultra-compact angular reflector as end mirrors. Laser fabricated on InGaAsP/InP quantum well wafer has a threshold of 22.4mA and can give mW output power.

CMI6 • 11:30
Athermal Hollow Waveguide Distributed Bragg Reflector Laser, *Hideaki Yamakawa[1], Naomi Tadokoro[1], Takahiro Sakaguchi[1], Yoshihisa Tokunaga[1], Fumio Koyama[1]; [1]Precision & Intelligence Lab., Tokyo Instituite of technology, Japan.* We demonstrate athermal hollow-waveguide DBR lasers using hybrid-integration approach. The lasing wavelength can be locked within a longitudinal mode spacing (0.3nm) over temperature range of 15K. A design of mode-hop-free athermal operations is presented.

CMI7 • 11:45
Giant Wavelength-Temperature Dependence of VCSEL with Thermally Actuated Cantilever Structure, *Masanori Nakahama[1], Hayato Sano[1], Norihiko Nakata[1], Akihiro Matsutani[1], Fumio Koyama[1]; [1]P&I Lab., Tokyo Inst. of Technology, Japan.* Modeling and experimental result of a micromachined VCSEL is proposed. Calculated result shows a giant wavelength-temperature-dependence of over 3.5 nm/K. Measured one is 0.79 nm/K, which is 10 times larger than that of conventional VCSELs.

CMJ • Nonlinear Mixing in Optical Fibers—Continued

CMJ5 • 11:15
Remote Instantaneous Frequency Measurement System using Optical Mixing in Highly Nonlinear Fiber, *Lam A. Bui[1], Arnan Mitchell[1]; [1]Electrical and Computer Engineering, RMIT Univ., Australia.* Instantaneous frequency measurement using all optical mixing is demonstrated. This system requires no high speed electronic components and remotes all components of the measurement system to the receiver.

CMJ6 • 11:30
Solitonic Transistor in the Optical Event Horizon, *Jens Bethge[1], Carsten Brée[1,2], Shalva Amiranashvili[2], Frank Noack[1], Günter Steinmeyer[1], Ayhan Demircan[2]; [1]Max-Born-Institut, Germany; [2]Weierstrass Inst., Germany.* We report experimental demonstration of an optical transistor and present numerical simulations explaining the observed switching effect by solitonic pulse dynamics in the presence of a optical event horizon.

CMJ7 • 11:45
Parametric Tunable Dispersion Compensation for Sub-picosecond Optical Pulses, *Takayuki Kurosu[1], Ken Tanizawa[1], Stephane Petit[1], Shu Namiki[1]; [1]Network Photonics Research Center, Natioanal Inst. of Advanced Industrial Science and Technology, Japan.* We show that the parametric tunable dispersion compensation can be applied to 400 fs pulses. After transmission through a 500 m DSF, 430 fs-width pulse could be restored.

12:00–13:30 Lunch Break

NOTES

Room 327 | Room 336 | Room 337 | Room 338

CLEO: Science & Innovations

CMK • Mode-Locked Fiber Lasers I—Continued

CMK5 • 11:15
Stability enhancement of carbon-nanotube-based mode-locked fiber laser by Nitrogen sealing, *Kazuyuki Fuse[1], Amos Martinez[1], Shinji Yamashita[1]; [1]The Univ. of Tokyo, Japan.* We achieved stable mode locking of high-power fiber laser by sealing the carbon nanotube in Nitrogen gas. Little optical damage was observed in the sealed sample for 12 hours at 20dBm intravacity power.

CMK6 • 11:30
Sub-100fs pulse generation from a fiber oscillator mode-locked by nanotubes, *Daniel Popa[1], Zhipei Sun[1], Tawfique Hasan[1], Felice Torrisi[1], Fengqiu Wang[1], Andrea Ferrari[1]; [1]Univ. of Cambridge, UK.* We report an ultrafast fiber laser based on carbon nanotube saturable absorber. 84 fs pulses are generated directly from the fiber oscillator with 61.2 nm spectral width.

CMK7 • 11:45
Nanotube-based passively mode-locked Raman laser, *Carlos E. Schmidt Castellani[1], Edmund J. Kelleher[1], John C. Travers[1], Daniel Popa[2], Zhipei Sun[2], Tawfique Hasan[2], Andrea C. Ferrari[2], Sergei Popov[1], J. R. Taylor[1]; [1]Physics, Imperial College London, UK; [2]Engineering, Univ. of Cambridge, UK.* We demonstrate passive mode-locking of a Raman fiber laser using a nanotube-based saturable absorber. The normal dispersion cavity generates highly-chirped 500 ps pulses that are compressed down to 2 ps, with 1.4 kW peak power.

CLEO: Applications & Technology

AMC • Paths to High Efficiency Photovoltaics—Continued

AMC4 • 11:15 Invited
New Concepts and Materials for Solar Power Conversion Devices, *Wladek Walukiewicz, Lawrence Berkeley Natl. Lab, USA.* The presentation will discuss recent progress on applications of group III-nitride alloys for multijunction, hybrid solar cells and report first demonstration of intermediate band photovoltaic device using highly mismatched semiconductor alloys.

AMC5 • 11:45
Shunt Detection and Performance Characterization of Silicon Solar Cells Using Thermoreflectance Imaging, *Qiaoer Zhou[2,3], Xiaolin Hu[1], Kadhair Al-hemyari[1], Kevin McCarthy[1,2], Lawrence Domash[2], Janice A. Hudgings[1,2]; [1]Physics, Mount Holyoke College, USA; [2]Alenas Imaging, Inc, USA; [3]Electrical Engineering Department, Univ. of California, USA.* Thermoreflectance is quantitatively compared with lock-in IR thermography for NDE of solar cells. The order of magnitude enhancement in spatial resolution enables shunt detection as well as extraction of local IV curves, diode parameters, and thermal diffusivity and conductivity.

CLEO: QELS-Fundamental Science

QME • Ultrafast Magnetism—Continued

QME2 • 11:15
Ultrafast Non-thermal Switching of the Magnetization in (III,Mn)V Ferromagnets, *Ilias E. Perakis[1], Myron D. Kapetanakis[1], Jigang Wang[2]; [1]IESL/FORTH, Foundation for Research and Technology-Hellas, Greece; [2]Department of Physics & Astronomy and Ames Lab-USDOE, Iowa State Univ., USA.* Using density matrix equations of motion and a tightbinding bandstructure calculation, we demonstrate nonthermal ultrafast spin switching in (Ga,Mn)As triggered by coherent photoexcitation and controlled by pump fluence and external magnetic field.

QME3 • 11:30
Ultrafast ferromagnetic-paramagnetic phase transition in MnAs observed by second-harmonic generation, *Christoph Lange[1], Jesse J. Dean[1], Kenneth S. Burch[1], David Rench[2], Nitin Samarth[2], Henry M. van Driel[1]; [1]Department of Physics and Inst. for Optical Sciences, Univ. of Toronto, Toronto, Canada; [2]Department of Physics, The Pennsylvania State Univ., USA.* We use second harmonic generation to observe an ultrafast magnetic phase transition in MnAs near room temperature following excitation by a 300 fs optical pulse; transition times are on the order of 10 ps.

QME4 • 11:45
Measuring the terahertz radiation from optically induced spins in diluted magnetic semiconductors, *Rakchanok Rungsawang[1], Florent Perez[2], Dimitri Oustinov[1], Julien Madéo[1], Javier Gomez[2], Nathan Jukam[1], Jean Maysonnave[1], Pierrick Cavalié[1], Tomasz Wojtowicz[3], Sukhdeep S. Dhillon[1], Jérôme Tignon[1]; [1]Laboratoire Pierre Aigrain, Ecole Normale Supérieure, France; [2]Institut des Nanosciences de Paris, CNRS, Université Paris 6, France; [3]Inst. of Physics, Polish Academy of Sciences, Poland.* The terahertz radiation induced by optically excited spins in CdMnTe two-dimensional electron gases is directly measured in the time domain using electro-optic sampling. The spin radiation decays in a few ps at high magnetic fields.

QMF • Atoms and Molecules in Strong Fields—Continued

QMF4 • 11:15
Influence of Phase Matching of the Cooper Minimum in Argon High Harmonic Spectra, *Limor S. Spector[1,2], Joseph P. Farrell[1,2], Brian K. McFarland[1,2], Philip H. Bucksbaum[1,2], Mette B. Gaarde[3], Kenneth J. Schafer[3], Markus Guehr[1,2]; [1]PULSE Inst., Stanford Univ., USA; [2]Chemical Sciences Division, SLAC National Accelerator Lab, USA; [3]Department of Physics and Astronomy, Louisiana State Univ., USA.* We systematically study interference minima in high harmonic spectra using the Cooper minimum in argon, emphasizing that phase matching must be taken into account to fully understand spectral features relevant for harmonic spectroscopy.

QMF5 • 11:30
Neutral dissociation of simple molecules in strong laser field, *Ali Azarm[1], D. Song[2], Y. Teranishi[3,4], Sima Hosseini[1], S. L. Chin[1], F. Kong[2], S. H. Lin[3,4]; [1]Department of Physics, Engineering Physics and Optics & Center for Optics, Photonics and Laser (COPL),, Laval Univ., Canada; [2]Inst. of Chemistry, Chinese Academy of Science, China; [3]Inst. of Atomic and Molecular Science, Academia Sinica, Taiwan; [4]Inst. of Applied Chemistry, Inst. of Molecular Science, Chiao-Tung Univ., Taiwan.* We report neutral dissociation of simple molecules in strong laser field, experimentally. Moreover, theoretical calculations of potential energy curves justify neutral dissociation through super excited states in all of the investigated gases.

QMF6 • 11:45
Strong-field Induced Optical Absorption in ZnO Crystal, *Shambhu Ghimire[1], David Reis[1], Anthony DiChiara[2], Emily Sistrunk[2], Louis F. DimMauro[2], Pierre Agostini[2]; [1]PULSE Inst., Stanford Univ., USA; [2]Physics Department, Ohio State Univ., USA.* We report the observation of intensity dependent red shift on the absorption-edge of zinc-oxide driven by a mid-infrared laser pulse. A new regime is identified where the shift is no longer linear to the intensity.

12:00–13:30 Lunch Break

NOTES

CLEO: Science & Innovations

CML • 3D Nano Fabrication—Continued

CML5 • 11:15
Toward Flexible Wafer-Size 3D Photonic Crystal Templates Fabricated by Scanning Holographic Lithography, *Liang (Leon) Yuan[1], Peter R. Herman[1]; [1]Electrical and Computer Engineering, Univ. of Toronto, Canada.* Parallel linear scanning laser exposure of diffractive optical elements is engineered to produce seamless stitching of thick 3D photonic crystal templates over large area and offer bandgap tuning, chirping, apodization and optofluidic integration.

CML6 • 11:30
Low-threshold whispering-gallery dye lasers by planar and 3D lithography on silicon, *Tobias Grossmann[1,2], Simone Schleede[1], Mario Hauser[1], Torsten Beck[1], Michael Thiel[1], Georg von Freymann[3,1], Timo Mappes[2], Heinz Kalt[1]; [1]Inst. for Applied Physics, Karlsruhe Inst. of Technology, Germany; [2]Inst. for Microstructure Technology, Karlsruhe Inst. of Technology, Germany; [3]Inst. for Nanotechnology, Karlsruhe Inst. of Technology, Germany.* We report on the planar and three-dimensional (3D) lithographic fabrication and optical characterization of microcavity lasers made of dye doped polymers with laser thresholds as low as 3 nJ per pulse at visible wavelengths.

CML7 • 11:45
Optofluidic Waveguides with Ta_2O_5 Cladding Layers and Low Photoluminescence, *Yue Zhao[1], Micah Jenkins[1], Kaelyn D. Leake[2], Shuo Liu[2], Philip Measor[2], Holger Schmidt[2], Aaron R. Hawkins[1]; [1]Electrical Engineering Department, Brigham Young Univ., USA; [2]School of Engineering, Univ. of California Santa Cruz, USA.* A new type of hollow core waveguide fabricated with Ta_2O_5 and SiO_2 films is demonstrated. The photoluminescence background of ARROW waveguides is decreased significantly by replacing Si_3N_4 with Ta_2O_5 films, while maintaining low optical losses.

CMM • THz Sources I—Continued

CMM4 • 11:15
High-Power Terahertz Generation due to Dipole Radiation within InGaN/GaN Multiple Quantum Wells, *Guan Sun[1], Guibao Xu[1], Yujie J. Ding[1], Hongping Zhao[1], Guangyu Liu[1], Jing Zhang[1], Nelson Tansu[1]; [1]Electrical & Computer Engineering, Lehigh Univ., USA.* We have generated broadband THz pulses within eight periods of InGaN/GaN quantum wells due to dipole radiation following generation of spatially-separated electrons and holes. Output powers as high as 1 μW have been obtained.

CMM5 • 11:30
Efficient Photoconductive Terahertz Generation Using a Radio Frequency Bias, *Haipeng Zhang[1,2], Jared Wahlstrand[1], SooBong Choi[1], Steven Cundiff[1,2]; [1]JILA, National Inst. of Standards and Technology, Univ. of Colorado Boulder, USA; [2]Department of Electrical, Computer, & Energy Engineering, Univ. of Colorado, Boulder, USA.* An efficient photoconductive THz source is described that uses a rapidly oscillating, high voltage bias across electrodes insulated from the GaAs sample. The resulting uniform field enables excitation with a large laser spot.

CMM6 • 11:45
Plasmonic Complementary Fractal Photoconductive Emitter, *Pouya Maraghechi[1], Abdulhakem Y. Elezzabi[1]; [1]Electrical Engineering, Univ. of Alberta, Canada.* A new class of photoconductive THz emitters based on a complementary Sierpinski fractal is presented. The self-similarity of plasmonic current present on the antenna surface results in superior performance compared to conventional bow-tie emitters.

CMN • Biomedical and Nanoparticle Optical Sensing—Continued

Jürgen Popp, received his Ph.D. in chemistry from the Univ. Würzburg, Germany, 1995. After his PhD in Physical Chemistry he joined Yale Univ. for postdoctoral work. He subsequently returned to Würzburg Univ. where he finished his habilitation in 2002. Since 2002 he holds a chair for Physical Chemistry at the Friedrich-Schiller Univ. Jena. Since 2006 he is also the scientific director of the Inst. of Photonic Technology, Jena. His research interests are concerned Biophotonics and material sciences. He is the coordinator of the EU excellence network Photonics4Life, Editor-in-Chief Journal of Biophotonics and fellow of the Society for Applied Spectroscopy.

12:00–13:30 Lunch Break

NOTES

Room 318-320

JOINT

13:30–15:15
JMF • Joint Symposium on Hybrid Quantum Nanoplasmonic Systems - Towards Active Nanoplasmonics III: Single Photons and Plasmonic Antennas
Vladimir Shalaev, Purdue Univ., USA, Presider

JMF1 • 13:30 Invited
Launching Single Photons into Plasmonic structure, *Joerg Wrachtrup[1], Fedor Jelezko[1], Bernhard Grotz[1], Ilja Gerhardt[1], Merle Becker[1], Helmut Fedder[1]; [1]Univ. of Stuttgart, Germany.* Interaction of defect centers in diamond and molecules with thin metal wires, bow tie, and other antenna structures: By studying the coupling efficiency and mechanism we acheive an improved insight into the quantum plasmon interaction.

JMF2 • 14:00
Controlling the Coupling of a Single Nitrogen Vacancy Center to a Silver Nanowire, *Alexander Huck[1], Shailesh Kumar[1], Ulrik L. Andersen[1]; [1]DTU Physics, Technical Univ. of Denmark, Denmark.* We demonstrate the controlled coupling of a nitrogen vacancy center in diamond to a silver nanowire by nano-positioning with an atomic force microscope. A decrease in emitter lifetime by a factor of 3.5 is demonstrated.

JMF3 • 14:15
Plasmonic Metamaterials Coupled to Single InGaAs-Quantum-Well Gain, *Nina Meinzer[1,2], Matthias Ruther[1,2], Stefan Linden[1,2], Costas M. Soukoulis[3,4], Galina Khitrova[5], Joshua Hendrickson[5], Joshua D. Olitzky[5], Hyatt M. Gibbs[5], Martin Wegener[1,2]; [1]Institut für Nanotechnologie, Karlsruhe Inst. of Technology (KIT), Germany; [2]Institut für Angewandte Physik and DFG-Center for Functional Nanostructures (CFN), Karlsruhe Inst. of Technology (KIT), Germany; [3]Ames Lab and Department of Physics and Astronomy, Iowa State Univ., USA; [4]Research Center of Crete, and Department of Materials Science and Technology, Greece; [5]College of Optical Sciences, The Univ. of Arizona, USA.* We present low-temperature femtosecond-pump-probe measurements on arrays of split-ring resonators above a single InGaAs-quantum well in which we study the coupling mechanism between the metamaterial and gain medium upon variation of their separation.

Room 321-323

CLEO: Science & Innovations

13:30–15:15
CMO • Nanophotonic Integration
Armand Rosenberg, NRL, USA, Presider

CMO1 • 13:30 Tutorial
Nanophotonics for Information Systems Integration, *Yeshaiahu Fainman[1]; [1]Univ. of California at San Diego, USA.* This paper explores the role of nanotechnology with focus on nanophotonics in dielectric, metal, and semiconductor inhomogeneous composition materials, devices and subsystems for optical communications, information and signal processing, and sensing.

Y. Fainman received the Ph. D. from Technion in 1983. He is a Cymer Professor of Advanced Optical Technologies and Professor of ECE at the Univ. of California, San Diego. His current research involves near field optical science and technology, nanophotonics, nanolasers and ultrafast optics. He is a Fellow of OSA, IEEE, and SPIE. He Chaired, co-Chaired and served on numerous program committees for various conferences for OSA, IEEE/LEOS, and SPIE. He is a recipient of the Miriam and Aharon Gutvirt Prize, Technion, Haifa, Israel (1982), Lady Davis Fellowship (2006), and Brown award (2006). He was a General Chair for Inaugural OSA Topical Meeting on Nanophotonics for Information Systems in 2005 and served as a topical editor and board member for various journals. He contributed over 200 manuscripts in peer review journals and over 350 conference presentations and conference proceedings.

Room 324-326

CLEO: QELS-Fundamental Science

13:30–15:15
QMG • Attosecond Science
Markus Drescher, Univ. of Hamburg, Germany, Presider

QMG1 • 13:30 Tutorial
Resolving attosecond processes via high harmonic generation, *Nirit Dudovich[1]; [1]Weizmann Inst. of Science, Israel.* The interaction of intense light with atoms or molecules can lead to the generation of XUV pulses and energetic electron pulses with attosecond duration. The interaction can encode the spatial properties of the electronic wavefunctions that contribute to the process and provide spatial resolution on the Angstrom scale. This unique combination opens new possibilities of spatio-temporal resolved measurements and allows probing an electronic wavefunction as it evolves over time.

Nirit Dudovich received her BSc from Tel Aviv Univ., Israel in 1996. She received her MSc and PhD from the Weizmann Inst. of Science, Israel in 1999 and 2004 in the field of quantum coherent control. Nirit Dudovich went to the National Recerch Council, Ottawa, Canada to perform her postdoc studies with Paul Corkum in the field of attosecond science. She joined the Physics faculty at the Weizmann Inst. as a senior scientist in 2007. Nirit Dudovich's field of research focuses basic phenomena in strong field light-matter interactions, focusing in particular on the generation and measurement of attosecond processes.

Room 314

CLEO: Applications & Technology

13:30–15:15
AMD • Laser Micro and Nano Structuring
Craig Arnold, Princeton Univ., USA, Presider

AMD1 • 13:30 Invited
Ultrafast laser processing of semiconductor devices, *James Carey[1], Martin Pralle[1], Christopher Vineis[1], Jeff McKee[1], Susan Alie[1], Jason Sickler[1], Xia Li[1], Jutao Jiang[1], Drake Miller[1], Chintamani Palsule[1], Homayoon Haddad[1]; [1]SiOnyx Inc., USA.* SiOnyx is developing ultrafast laser processing techniques that improve the performance of semiconductor based solar cells and image sensors. We will review the advantages of using lasers in these applications and recent device results.

AMD2 • 14:00
Speed Investigations toward an Industrial Application of Optical Trap Assisted Nanopatterning, *Romain Fardel[1], Yu-Cheng Tsai[1], Craig B. Arnold[1]; [1]Mechanical and Aerospace Engineering, Princeton Univ., USA.* Optical trap assisted nanopatterning is a viable method of producing parallel nanoscale features over rough surfaces and large areas. The maximum writing speed on various surfaces is elucidated to evaluate the performance of the method.

AMD3 • 14:15
Laser Micro/nano Patterning of Hydrophobic Surfaces by Contact Particle Lens Array, *Ashfaq Khan[1], Zengbo Wang[1], Mohammad Sheikh[1], Zhu Liu[2], Lin Li[2]; [1]School of MACE, The Univ. of Manchester, UK; [2]School of Materials, The Univ. of Manchester, UK.* Laser micro/nanopatterning by Contact Particles Lens Array (CPLA) has been extensively utilized but it is limited to hydrophilic surfaces. A technique is presented here to transfer CPLA by an adhesive surface to pattern hydrophobic surfaces.

CLEO: Science & Innovations

13:30–15:15
CMP • Nd Lasers
Joe Alford, Lockheed Martin Coherent Technologies, USA, Presider

CMP1 • 13:30
Composite All-Ceramics, Passively Q-switched Nd:YAG/Cr^{4+}:YAG Monolithic Micro-Laser with Two-Beam Output for Multi-Point Ignition, *Nicolaie Pavel[1,2], Masaki Tsunekane[1], Kenji Kanehara[3], Takunori Taira[1]; [1]Laser Research Center, Inst. for Molecular Science, Japan; [2]Lab of Solid-State Quantum Electronics, National Inst. for Laser, Plasma and Radiation Physics, Romania; [3]Nippon Soken, Inc., Japan.* Few MW-level peak power, passively Q-switched Nd:YAG/Cr^{4+}:YAG microlasers with two-beam output were realized. The monolithic devices incorporate composite, all-ceramics components and can be used as multipoint igniters in internal combustion engines.

CMP2 • 13:45
High-power Air-cooled SiC-clad Nd:YVO_4 Slab Lasers, *Rui Zhang[1], Jianqiu Xu[1], Mingjian Wang[2], Jingzhong Xu[3]; [1]Department of Physics, Shanghai Jiao Tong Univ., China; [2]Shanghai Inst. of Optics and Fine Mechanics, China; [3]Shanghai Advanced Research Inst., China.* Two SiC-claddings are diffuse bonded to the upper and bottom surfaces of a thin Nd:YVO_4 slab. The SiC-clad Nd:YVO_4 slab is diode-pumped to provide 100-W class CW laser output without water cooling.

CMP3 • 14:00 Invited
ALADIN TxA - a Spaceborne UV Laser, *Martin Endemann[1]; [1]European Space Agency, Netherlands.* ALADIN TxA is the Transmitter-laser Assembly for the Aeolus wind lidar satellite. It is a frequency tripled, single mode Nd:YAG laser with 50 Hz PRF and a three year lifetime. The design and the development program are presented.

13:30–15:15
CMQ • Quantum Cascade Lasers
Jerry Meyer, NRL, USA, Presider

CMQ1 • 13:30
Modal Instability and Beam Steering in Quantum Cascade Lasers, *Yu Yao[1], Yuting Huang[2], Xiaojun Wang[3], Claire F. Gmachl[1]; [1]Electrical Engineering, Princeton Univ., USA; [2]Physics, Princeton Unversity, USA; [3]Adtech Optics, Inc., USA.* Time-resolved far-field measurements of Quantum Cascade lasers show beam steering on the few nano-second scale. Spatially resolved spectra show that the beam steering is accompanied with frequency locking between transverse modes.

CMQ2 • 13:45
Extremely Broad-gain Quantum-Cascade Lasers based on Dual-upper-state design, *Kazuue Fujita[1], Shinichi Furuta[1], Tatsuo Dougakiuchi[1], Atsushi Sugiyama[2], Tadataka Edamura[1], Masamichi Yamanishi[1]; [1]Central Research Labs., Hamamatsu Photonics KK, Japan; [2]Development Bureau, Laser Device R&D Group, Hamamatsu Photonics KK, Japan.* Broad-gain QC lasers based on dual-upper-state design are reported. The devices exhibit a wide (570 cm^{-1}) electroluminescence spectra, a low cw room-temperature-threshold-current-density of 1.5 kA/cm^2 and a high cw output-power of 200 mW at 300 K.

CMQ3 • 14:00
Broadband Quantum Cascade Lasers Based on Strongly-coupled Transitions with an External Cavity Tuning Range over 340 cm^{-1}, *Yu Yao[1], Tracy Tsai[1], Xiaojun Wang[2], Gerard Wysocki[1], Claire F. Gmachl[1]; [1]Electrical Engineering, Princeton Univ., USA; [2]Adtech Optics, Inc., USA.* Quantum Cascade lasers based on continuum-to-continuum design enable external cavity tuning over 340 cm^{-1} in pulsed mode operation at 15 C. Strong gain suppression over 320cm^{-1} is attributed to strong coupling between the laser transitions.

CMQ4 • 14:15
Active Wavelength Control for External Cavity Quantum Cascade Laser, *Tracy Tsai[1], Gerard Wysocki[1]; [1]Electrical Engineering, Princeton Univ., USA.* We present an active wavelength control which ensures that all wavelength-selective elements of an external cavity semiconductor laser are spectrally aligned and the diffraction grating equation accurately predicts the laser operating frequency.

13:30–15:15
CMR • Quasi-Phase Matched Nonlinear Optics
Yujie Ding, Lehigh Univ., USA, Presider

CMR1 • 13:30 Invited
Spatiotemporal Quasi Phase Matching, *Alon Bahabad[1]; [1]Tel Aviv Univ., Israel.* We present a temporal extension of quasi-phase-matching of a nonlinear optical process. This allows conserving both momentum and energy over macroscopic length and time scales. This treatment is relevant for any dynamic quasi-phase-matching scheme.

CMR2 • 14:00
Singly-Resonant Optical Parametric Oscillator in Adhesive-Free-Bonded Periodically Inverted $KTiOPO_4$ Plates: Achieving Oscillations at Dual Wavelengths, *Pu Zhao[1], Srinivasa Ragam[1], Yujie J. Ding[1], Ioulia B. Zotova[2], Xiaodong Mu[3], Huai-Chuan Lee[3], Stephanie Meissner[3], Helmuth Meissner[3]; [1]Electrical & Computer Engineering, Lehigh Univ., USA; [2]ArkLight, USA; [3]Onyx Optics, Inc., USA.* Based on adhesive-free-bonded periodically inverted $KTiOPO_4$ plates, we implemented a singly-resonant optical parametric oscillator, which has superior advantages of compensating walk-off and oscillating dual-signal wavelengths based on QPM.

CMR3 • 14:15
Optimized 4-µm OPO with Intracavity OPA Based on a Single Dual-Grating PPLN Crystal, *Antoine Godard[1], Myriam Raybaut[1], Michel Lefebvre[1], Anne-Marie Michel[2], Michel Péalat[2]; [1]ONERA - the French Aerospace Lab, France; [2]SAGEM Défense Sécurité, Groupe SAFRAN, France.* Intracavity amplification of the idler radiation of an optical parametric oscillator is achieved within a single dual-grating PPLN crystal, leading to 60 % increase of the 4-µm idler power and significant beam quality improvement.

Room 327

CLEO: Science & Innovations

13:30–15:15
CMS • Mode-Locked Fiber Lasers II
Kazi Abedin, OFS Laboratories, USA, Presider

CMS1 • 13:30
500 nJ mode-locked fiber laser at 976 nm, *Jerome Lhermite[1], Guillaume Machinet[1], Caroline Lecaplain[2], Romain Royon[1], Ammar Hideur[2], Eric Cormier[1]; [1]CELIA, France; [2]CORIA, France.* We report on high energy femtosecond pulse generation from an all-normal-dispersion fiber oscillator emitting around 976nm. The laser delivers chirped pulses of 23ps and an energy of 500nJ. Pulses are externally recompressed down to 460fs.

CMS2 • 13:45
40 W picosecond fiber laser at 976 nm, *Guillaume Machinet[1], Jerome Lhermite[1], Eric Cormier[1]; [1]Laboratoire CELIA, France.* We report on the generation of nearly transform-limited 1-ps pulses at 40 MHz based on amplification in the nonlinear regime at 976nm. The fiber laser system emits pulses with a duration of 1.56 ps and an energy of 1 μJ.

CMS3 • 14:00
Optical mode structure of a harmonically mode-locked Yb femtosecond fiber laser, *Simon Herr[1,2], Tilo Steinmetz[1,2], Tobias Wilken[1], Martin Engelbrecht[2], Theodor W. Hänsch[1], Thomas Udem[1], Ronald Holzwarth[1,2]; [1]Max-Planck-Inst. for Quantum Optics, Germany; [2]Menlo Systems GmbH, Germany.* In the optical spectrum of a passive harmonically mode-locked Yb fiber laser all fundamental modes oscillate with equal intensity. This is possible when the spectral phase follows a quadratic distribution and it is favored over suppression of modes.

CMS4 • 14:15
330 MHz repetition rate femtosecond Yb:fiber ring laser, *Peng Li[1], Aimin Wang[1], Xi Wang[1], Zhigang Zhang[1]; [1]School of Electronics Engineering and Computer Science, Peking Univ., China.* We demonstrate 330 MHz repetition rate operation in a ring cavity Yb:fiber laser with novel and compact devices. The spectral bandwidth of the pulse is 30 nm and the dechirped pulse width is 48 fs.

Room 336

CLEO: Science & Innovations

13:30–15:15
CMT • Enhanced Efficiency Photovoltaics
Jonathan Wierer, Sandia National Laboratories, USA, Presider

CMT1 • 13:30
Photonic Crystal Intermediate Reflector in Micromorph Tandem Solar Cells, *Stephan Fahr[1], Carsten Rockstuhl[1], Falk Lederer[1], Matthias Kroll[2], Thomas Pertsch[2], Thomas Beckers[3], Reinhard Carius[3], Uwe Rau[3], Lorenz Steidl[4], Rudolf Zentel[4], Johannes Üpping[5], Ralf Wehspohn[5]; [1]Inst. of Condensed Matter Theory and Solid State Optics, Friedrich-Schiller-Univ. Jena, Germany; [2]Inst. of Applied Physics, Friedrich-Schiller-Univ. Jena, Germany; [3]Inst. of Energy and Climate Research 5 - Photovoltaics, Forschungszentrum Jülich GmbH, Germany; [4]Dept. of Chemistry, Pharmacy and Earth Science, Johannes Gutenberg Univ. of Mainz, Germany; [5]Inst. of Physics, Martin-Luther-Univ. Halle-Wittenberg, Germany.* Experimental and numerical evidences are presented which show that the efficiency of silicon based tandem solar-cells can be increased by incorporating a three-dimensional photonic crystal as an intermediate reflector.

CMT2 • 13:45
Cascaded Interband/Intersubband Thermophotovoltaic Energy Conversion, *Jian Yin[1], Roberto Paiella[1]; [1]Electrical and Computer Engineering, Boston Univ., USA.* The use of interband/intersubband photodetection for thermophotovoltaic energy conversion is numerically investigated. The simulation results indicate that this approach can double the present state-of-the-art in thermophotovoltaic power generation.

CMT3 • 14:00
Enhanced conversion efficiency of a crystalline silicon solar cell with frustum nanorod arrays, *Min An Tsai[2], Ping-chen Tseng[1], Hsin-Chu Chen[1], Hao-chung Kuo[1], Pei Chen Yu[1]; [1]Photonics and Inst. of Electro-Optical Engineering, National Chiao Tung Univ., Taiwan; [2]Electrophysics, National Chiao Tung Uiversity, Taiwan.* Enhanced photoelectric conversion is demonstrated in a crystalline silicon solar cell with frustum nanorod arrays. The omnidirectional antireflection of FNAs is investigated using an angle-resolved reflectance spectroscopy and simulated by RCWA.

CMT4 • 14:15
Simulations of Silicon Nanowire Arrays for Photovoltaics—More Absorption with Less Silicon, *Björn C. Sturmberg[1], Kokou B. Dossou[2], Lindsay C. Botten[2], Ara A. Asatryan[2], Christopher G. Poulton[2], C. Martijn de Sterke[1], Ross C. McPhedran[1]; [1]School of Physics, Univ. of Sydney, Australia; [2]Department of Mathematical Sciences, Univ. of Technology, Sydney, Australia.* Using a novel numerical method we calculate the energy absorption of a silicon nanowire array, for photovoltaics. We show that dilute arrays deliver optimal integrated absorption on a per-silicon-volume basis, and identify the enhancement mechanism.

Room 337

CLEO: QELS-Fundamental Science

13:30–15:15
QMH • Coherent Phenomena in Semiconductors
Samuel Carter, NRL, USA, Presider

QMH1 • 13:30
Giant AC Stark shift in Germanium, *Kolja Kolata[1], Niko S. Köster[1], Ronja Woscholski[1], Christoph Lange[1], Sangam Chatterjee[1], Giovanni Isella[2], Daniel Chrastina[2], Hans von Känel[2]; [1]Physik, Philipps-Universität Marburg, Germany; [2]L-NESS Dipartimento di Fisica del Politecnico di Milano, Polo di Como, Italy.* We observe a strong ultrafast AC Stark shift of the direct band transition in strained germanium quantum wells grown on silicon.

QMH2 • 13:45
Optical Orientation in Bulk Germanium, *Christine Hautmann[1,2], Berhard Surrer[1], Markus Betz[2]; [1]Physik-Department, TU München, Germany; [2]Experimentelle Physik 2, TU Dortmund, Germany.* Ultrafast magneto-optics in bulk germanium reveals optical orientation of charge carriers via both direct and indirect optical transitions. At low temperatures, electron (hole) spins have remarkably long coherence times of ~1ns (~100ps).

QMH3 • 14:00 Invited
Persistent Spin Helix in GaAs Quantum Wells, *Joe Orenstein, Univ. of California at Berkeley, USA.* We use transient spin grating spectroscopy to study the propagation of the persistent spin helix state of a 2D electron gas, leading to measurement of both spin mobility and spin diffusion coefficients.

Room 338

CLEO: Science & Innovations

13:30–15:15
CMU • Nano-Structured LEDs
Christian Wetzel, Rensselaer Polytechnic Inst., USA, Presider

CMU1 • 13:30
Wavelength Engineered Luminescent Material Incorporating Colloidal Quantum Dot within a Nanoporous Gallium Nitride Matrix, *Cuong Dang[1], Yu Zhang[2], Joonhee Lee[1], Jung Han[2], Arto Nurmikko[1], Craig Breen[3], Jonathan Steckel[3], Seth Coe-Sullivan[3]; [1]School of Engineering, Brown Univ., USA; [2]Electrical Engineering, Yale Univ., USA; [3]QD Vision, USA.* A nanocomposite material was created by embedding colloidal QDs within nanoporous GaN. High efficiency luminescence and wavelength engineered ability of colloidal QDs combined with high performance of nitride LEDs suggest its potential for SSL.

CMU2 • 13:45
Resonant Cavity Colloidal Quantum Dot LEDs, *Yasuhiro Shirasaki[1], Vanessa Wood[1,2], Yaakov Tischler[3], Geoffrey Supran[4], Vladimir Bulović[1]; [1]Electrical Engineering and Computer Science, Massachusetts Inst. of Technology, USA; [2]Information Technology and Electrical Engineering, ETH Zürich, Switzerland; [3]Chemistry, Bar-Ilan Univ., Israel; [4]Materials Science and Engineering, Massachusetts Inst. of Technology, USA.* We demonstrate resonant-cavity colloidal quantum dot light-emitting diodes that exhibit electroluminescence with enhanced spectral purity and directionality and show that the enhancement is due to modification of the optical modes of the system.

CMU3 • 14:00
Differential Carrier Lifetimes and Efficiency of InGaN/GaN Quantum Well and Quantum Dot Light Emitting Diodes, *Animesh Banerjee[1], Meng Zhang[1], Pallab Bhattacharya[1]; [1]Electrical Engineering and Computer Science, Univ. of Michigan, USA.* Temperature-dependent efficiency and differential carrier lifetimes have been measured on InGaN/GaN quantum well and quantum dot LEDs. The roles of Auger recombination and carrier leakage in LED efficiency roll-off are elucidated.

CMU4 • 14:15
High Efficiency InGaN/GaN Dot-in-a-Wire Light Emitting Diodes Grown by Molecular Beam Epitaxy on Si(111), *Hieu P. Nguyen[1], Shaofei Zhang[1], Kai Cui[1], Xuegang Han[1], Zetian Mi[1]; [1]Electrical and Computer Engineering Department, McGill Univ., Canada.* A record high internal quantum efficiency of 36.7% was achieved for nanowire LEDs by using InGaN/GaN dot-in-a-wire heterostructures. The devices can exhibit strong green, red, and white emission, depending on the dot sizes and compositions.

CLEO: Science & Innovations

13:30–15:15
CMV • Fabrication and Characterization of Nano Plasmonic Devices
Kristjan Leosson, Science Inst., Univ. of Iceland, Iceland, Presider

CMV1 • 13:30
Varying-density hole-array grating fabrication for plasmonic waveguide sensors, *Michelle Y. Xu[1], J. Stewart Aitchison[1]; [1]Univ. of Toronto, Canada.* Varying-density hole-array-embedded trapezoidal SPP waveguides are designed to halve the resonant spectral width and to reduce the EBL machine time by 20 fold. Experimental observations are shown.

CMV2 • 13:45
Tunable 3D Plasmonic Swiss Rolls, *Fumin Huang[1], Jatin Sinha[2], Nick Gibbons[1], Philip N. Bartlett[2], Jeremy J. Baumberg[1]; [1]Physics, Univ. of Cambridge, UK; [2]Chemistry, Univ. of Southampton, UK.* Novel 3D plasmonic rolls are fabricated through strain-induced self-rolling of metallic nanopore sheets, with optical properties tunable by varying the size and thickness of nanopores, and dynamically by light irradiation.

CMV3 • 14:00
Large Area Near-IR Optical 'Fishnet' Metamaterials, *Neilanjan Dutta[1], Shouyuan Shi[1], Dennis Prather[1]; [1]Univ. of Delaware, USA.* We demonstrate a CMOS compatible fabrication method for large area near-IR fishnet metamaterials. This process involves patterning a template structures using lithography and dry etching, depositing an Au-SiO_2-Au stack and template lift-off.

CMV4 • 14:15
Near Field Phase Mapping exploiting Intrinsic Oscillations of NSOM probe, *Liron Stern[1], Ilya Goykhman[1], Boris Desiatov[1], Uriel Levy[1]; [1]Department of Applied Physics, The Benin School of Engineering and Computer Science, The Center for Nanoscience and Nanotechnology, The Hebrew Univ. of Jerusalem, Israel.* An innovative, simple compact and low cost approach for phase mapping based on the intrinsic modulation of a Near Field Scanning Optical Microscope probe is analyzed and experimentally demonstrated.

13:30–15:15
CMW • THz Sources II
Richard Averitt, Boston Univ., USA, Presider

CMW1 • 13:30
Reaching Maximum Conversion Efficiency for Terahertz Generation in Reversely Stacked GaP Plates, *Yi Jiang[1], Da Li[1], Yujie J. Ding[1], Ioulia B. Zotova[2]; [1]Electrical & Computer Engineering, Lehigh Univ., USA; [2]ArkLight, USA.* Terahertz output peak power as high as 2.7 kW is achieved by difference-frequency generation. Conversion efficiency reaching maximum value of 40% is obtained by reversely stacking four GaP plates.

CMW2 • 13:45
Efficient Parametric Cavity Enhanced Terahertz Generation Based on Quasi-Phase Matched GaP Bonded Structures, *Eliot Petersen[1,2], Wei Shi[1], Arturo Chavez-Pirson[1], Nasser Peyghambarian[1,3]; [1]NP Photonics, USA; [2]Physics, Univ. of Arizona, USA; [3]Optical Sciences, Univ. of Arizona, USA.* We demonstrate cavity enhanced parametric THz generation with power of 339μW and enhancement factor of ~151 through quasi-phase-matched GaP pumped by 1.5μm pulsed fiber lasers.

CMW3 • 14:00
High Power Single-cycle and Multi-cycle Terahertz Generation by Phase-matched Optical Rectification, *Xibin Zhou[1], Zhao Chen[1], Christophor A. Werley[1], Harold Hwang[1], Keith A. Nelson[1]; [1]Chemistry, MIT, USA.* High power single- and multi-cycle terahertz (THz) pulses have been generated with tilt intensity front scheme in Lithium niobate crystal, with more than 50 μJ and 10 μJ pulse energy respectively.

CMW4 • 14:15
Coherent and Tunable Terahertz Emission from Nano-metric Field Effect Transistor at Room Temperature, *Stephane A. Boubanga Tombet[1], Taiichi Otsuji[1], W. Knap[2]; [1]Research Inst. of Electrical Communication, Tohoku Univ., Japan; [2]Groupe d'Etude des Semiconducteurs, Montpellier 2 Univ. and CNRS UMR 5650, France.* We report on TeraHertz coherent and tunable emission from nanometer-gate-length InGaAs-based HEMTs at room temperature and demonstrate that properly exciting nanotransistors can pave the way for new class of coherent and easily tunable THz sources.

CLEO: Applications & Technology

13:30–15:15
AME • Biomedical Therapeutic Applications
Josh Pfefer, Food and Drug Administration, USA, Presider

AME1 • 13:30 Tutorial
Therapeutic applications of light: PDT - the killer; LLLT - the healer, *Michael R. Hamblin[1,2]; [1]Wellman Center for Photomedicine, Massachusetts General Hospital, USA; [2]Dept Dermatology, Harvard Medical School, USA.* Visible and near-infrared light can treat all human diseases. Light plus non-toxic dyes can kill cancer cells, pathogens and destroy unwanted tissue. In contrast light alone can reduce inflammation, stimulate healing and tissue repair.

Dr. Hamblin is a Principal Investigator at the Wellman Center for Photomedicine at Massachusetts General Hospital and an Associate Professor of Dermatology at Harvard Medical School. He received his PhD from Trent Univ. in England in synthetic organic chemistry. His research interests lie in the areas of photodynamic therapy for infections, cancer, and heart disease and in low-level light therapy for wound healing, arthritis, traumatic brain injury and hair regrowth. His research program is supported by NIH, CDMRP and CIMIT among others. He has published over 125 peer-reviewed articles, over 120 conference proceedings, book chapters and international abstracts and holds 8 patents.

Room 318-320 — JOINT

JMF • Joint Symposium on Hybrid Quantum Nanoplasmonic Systems - Towards Active Nanoplasmonics III: Single Photons and Plasmonic Antennas—Continued

JMF4 • 14:30 Invited

Plasmonic modes of strongly-coupled single-crystalline gold nanoparticle dimmers, *Bert Hecht[1], Jer-Shing Huang[3], Johannes Kern[1], Jord Prangsma[1], Peter Geisler[1], Pia Weinmann[2], Martin Kamp[2], Alfred Forchel[2], Paolo Biagioni[4]; [1]Nano-Optics & Biophotonics Group, Experimentelle Physik 5, Physikalisches Institut, Röntgen Research Center for Complex Material Systems, Universität Würzburg, Germany; [2]Technische Physik, Physikalisches Institut, Röntgen Research Center for Complex Material Systems, Universität Würzburg, Germany; [3]Department of Chemistry, National Tsing Hua Univ., Taiwan; [4]CNISM - Dipartimento di Fisica, Politecnico di Milano, Italy.* Plasmonic modes of single-crystalline gold nanoparticle dimers with ultrasmall gaps are studied. Large mode splittings separate bonding and antibonding modes which can be addressed individually. Q-factors are studied using FDTD simulations.

JMF5 • 15:00

Plasmon Nano-Antenna Enhanced Light Emission from InP MQW- Towards faster LEDs, *David Arbel[1], Nikolai Berkovitch[1], Amir Nevet[1], Meir Orenstein[1]; [1]Electrical Engineering, Technion, Israel.* Arrays of plasmonic nano-antennas were fabricated on InGaAs/InP multi quantum well structure. Photo-luminescence enhancement of x9 was measured in correspondence with nano-antennas resonance, attributed to x25 increase in radiative recombination rate.

Room 321-323 — CLEO: Science & Innovations

CMO • Nanophotonic Integration—Continued

CMO2 • 14:30

Nanolasers on Si-MOSFET: A Monolithic Integration, *Fanglu Lu[1], Thai-Truong D. Tran[1], Wai Son Ko[1], Kar Wei Ng[1], Roger Chen[1], Connie J. Chang-Hasnain[1]; [1]Electrical Engineering and Computer Sciences, Univ. of California, Berkeley, USA.* InGaAs nanopillar lasers directly grown on the gate, source and drain areas of Si-MOSFET are demonstrated for the first time using 410°C MOCVD. This represents the first monolithic integration of lasers on functional transistors.

CMO3 • 14:45

Direct band Ge photoluminescence at 1.6 μm coupled to Ge-on-Si microdisk resonators, *Gary Shambat[1], Szu-Lin Cheng[1], Jesse Lu[1], Yoshio Nishi[1], Jelena Vuckovic[1]; [1]Stanford Univ., USA.* Germanium microdisks on silicon are fabricated and analyzed under various optical pumping conditions. WGMs are observed in transmission as well as PL via coupling to fiber tapers. It is concluded that heavy doping is required for lasing.

CMO4 • 15:00

Subwavelength Waveguide Grating Coupler for Fiber-to-Chip Coupling on SOI with 80nm 1dB-Bandwidth, *Xia Chen[1], Christy Fung[1], Yi Min Chen[1], Hon K. Tsang[1]; [1]Department of Electronic Engineering, The Chinese Univ. of Hong Kong, Hong Kong.* We propose and experimentally demonstrate a novel subwavelength grating coupler on SOI for coupling between fiber and nanophotonic waveguide with a wide bandwidth. 80nm 1dB-bandwidth was experimentally demonstrated.

Room 324-326 — CLEO: QELS-Fundamental Science

QMG • Attosecond Science—Continued

QMG2 • 14:30

Probing AC Stark shift with attosecond transient absorption, *Michael Chini[1,2], Baozhen Zhao[2], Zenghu Chang[1]; [1]CREOL and Dept. of Physics, Univ. of Central Florida, USA; [2]Dept. of Physics, Kansas State Univ., USA.* The dynamics of helium 1s*n*p excited states in an intense, few-cycle laser pulse are probed using isolated attosecond pulses in a transient absorption scheme. In addition to the dynamic Stark shift, we observe half-cycle oscillations.

QMG3 • 14:45

Attosecond Time-Resolved Autoionization, *He Wang[1], Michael Chini[1,2], Shouyuan Chen[1], Changhua Zhang[1], Feng He[1], Yan Cheng[1], Yi Wu[1,2], Uwe Thumm[1], Zenghu Chang[1,2]; [1]J. R. Macdonald Lab, Department of Physics, Kansas State Univ., USA; [2]CREOL and Department of Physics, Univ. of Central Florida, USA.* Autoionization in argon atoms was studied by transient absorption spectroscopy with isolated attosecond XUV pulses. The peak position, line shape and population of the resonant states were modified by intense near infrared laser pulses.

QMG4 • 15:00

Frequency-tuned isolated attosecond pulses characterized by both 750 nm and 400 nm wavelength streak fields, *Hiroki Mashiko[1,2], Justine M. Bell[1,2], Annelise R. Beck[1,2], Mark J. Abel[1,2], Philip M. Nagel[1,2], Colby P. Steiner[1,2], Joseph S. Robinson[3], Katrin R. Siefermann[1,2], Daniel M. Neumark[1,2], Stephen R. Leone[1,2]; [1]Ultrafast X-ray Science Lab, Chemical sciences division, Lawrence Berkeley National Lab, USA; [2]Chemistry and Physics, Univ. of California, USA; [3]Material Sciences Division, Lawrence Berkeley National Lab, USA.* A novel Mach-Zehnder type interferometer coupled with the double optical gating technique provides tunable XUV or VUV isolated attosecond pulses and streak field detection with fields centered at both 750 nm and 400 nm wavelength.

Room 314 — CLEO: Applications & Technology

AMD • Laser Micro and Nano Structuring—Continued

AMD4 • 14:30 Invited

Laser Microstructuring and Processing in Printing Industry, *Guido Hennig[1], Stefan Bruening[2], Beat Neuenschwander[3]; [1]Daetwyler Graphics AG, Switzerland; [2]Schepers GmbH, Germany; [3]BFH Burgdorf, Switzerland.* New lasers and modulation techniques improve printing applications, e.g. high power MOPA fiber laser improve engraving of rotogravure printforms, ps-laser embossing, and fast modulation of high power cw-lasers printing by Laser induced ink transfer.

AMD5 • 15:00

Increase of capacity retention by laser structuring of thin film battery materials, *Johannes Proell[1], Robert Kohler[1], Carlos Ziebert[1], Wilhelm Pfleging[1]; [1]Inst. for Materials Research I, Karlsruhe Inst. of Technology, Germany.* Laser processes for fabrication of microstructures in thin film electrodes were developed with respect to a significant improvement of capacity retention of batteries. Several types of battery materials and surface structures were investigated.

13:30–15:15 Coffee Break, *300 Level Foyer*

NOTES

CLEO: Science & Innovations

CMP • Nd Lasers—Continued

CMP4 • 14:30
Power Scaling of Actively Q-Switched Synchronized Dual-Frequency Laser Pulses based on Two Nd:YLF Crystals, *Srinivasa Ragam[1], Pu Zhao[1], Yujie J. Ding[1], Ioulia B. Zotova[2]; [1]Electrical & Computer Engineering, Lehigh Univ., USA; [2]ArkLight, USA.* By introducing two Nd:YLF crystals into two laser cavities as a new configuration, we have scaled up the total output power of actively Q-switched synchronized dual-frequency laser pulses by more than 6 times.

CMP5 • 14:45
High Efficient Laser Action by Nd^{3+} Complex, *Hiroaki Yoshioka[1], Wang Weibo[1], Kota Kuwamitsu[1], Wataru Iwasaki[2], Yukihiko Yamashita[2], Nobuo Miyadera[2], Yuji Oki[1]; [1]Graduate School of Information Science and Electrical Engineering, Kyushu Univ., Japan; [2]Hitachi Chemical Co., Ltd., Japan.* We obtained the slope efficiency of 20% and the maximum output energy of 5.3mJ by Nd^{3+} complex laser. To the best of knowledge, this is the highest slope efficiency in bulky lasers using Nd^{3+} complex.

CMP6 • 15:00
Detailed fluorescent study of Nd:YAG dependent on doping concentration, *Yoichi Sato[1], Takunori Taira[1]; [1]Laser Research Center for Molecular Science, Inst. for Molecular Science, Japan.* It was confirmed that both line-strength and linewidth of Nd:YAG depended on Nd^{3+}-concentration. 30.9% decrease in stimulated emission cross section of 5.4at.% Nd:YAG ceramics at 1319 nm was estimated compared to 0.4at.% Nd:YAG ceramics.

CMQ • Quantum Cascade Lasers—Continued

CMQ5 • 14:30 Invited
Nonlinear Dynamics, Phase Coherence, and Mode Locking in Quantum Cascade Lasers, *Alexey Belyanin[1], Aleksander Wojcik[1], Nanfang Yu[2], Laurent Diehl[2], Federico Capasso[2]; [1]Physics and Astronomy, Texas A&M Univ., USA; [2]School of Engineering and Applied Sciences, Harvard Univ., USA.* We overview our recent theoretical and experimental studies of nonlinear interaction of laser modes in quantum cascade lasers which results in phase coherence, frequency locking, and in some cases complete synchronization of laser modes.

CMQ6 • 15:00
Quantum Cascade Laser Master Oscillator Power Amplifier with 1.5W output power at T=300K, *Stefan Menzel[1]; [1]Harvard Univ., USA.* Quantum cascade laser (QCL) master oscillator power amplifiers (MOPAs) reaching output power levels of P=1.5W at room temperature were realized. We discuss results and describe directions for future QCL MOPA design.

CMR • Quasi-Phase Matched Nonlinear Optics—Continued

CMR4 • 14:30
Spectral Narrowing and Manipulation in Optical Parametric Oscillator Using APPLN Electro-optic Polarization-mode Converter, *Yen-Hung Chen[1], Jui-Wen Chang[1], Ying-Yu Lai[1], Wei-Kun Chang[1], Ning Hsu[1], Quan-Hsiang Tseng[1], Reinhard Geiss[2,1], Thomas Pertsch[2,1]; [1]Department of Optics and Photonics, National Central Univ., Taiwan; [2]Friedrich-Schiller-Universität Jena, Germany.* We report a spectral narrowing and manipulation technique in a PPLN optical parametric oscillator using an APPLN EO polarization-mode converter. Single to multiple spectral-narrowed and intensity-enhanced signal peaks were produced from this system.

CMR5 • 14:45
High-Power Mid-Infrared Optical Parametric Chirped-Pulse Amplifier Based on Aperiodically Poled $Mg:LiNbO_3$, *Clemens Heese[1], Christopher R. Phillips[1], Lukas Gallmann[1], Martin M. Fejer[2], Ursula Keller[2]; [1]Department of Physics, Inst. of Quantum Electronics, ETH Zurich, Switzerland; [2]E. L. Ginzton Lab, Stanford Univ., USA.* We present a 3.3-μm ultrabroadband, low-noise optical parametric amplification system based on aperiodically poled $Mg:LiNbO_3$ yielding 1.4-W average power at 100-kHz repetition rate. The output spectrum supports 56-fs transform-limited pulses.

CMR6 • 15:00
Dispersion Interferometry Based on Second-Harmonic Generation of a Carbon Dioxide Laser in Orientation-Patterned GaAs, *Douglas J. Bamford[1], Dmitriy Panasenko[1], David B. Fenner[2], Joel M. Hensley[2]; [1]Physical Sciences Inc., USA; [2]Physical Sciences Inc., USA.* Orientation-patterned GaAs has been fabricated for use in dispersion interferometry. Second-harmonic generation of a CO_2 laser yields a cw output power of 6.5 mW with a device efficiency of 0.005% W^{-1}.

13:30–15:15 Coffee Break, *300 Level Foyer*

NOTES

Room 327 | Room 336 | Room 337 | Room 338

CLEO: Science & Innovations

CMS • Mode-Locked Fiber Lasers II—Continued

CMS5 • 14:30
Net Normal-Dispersion Yb-Fiber Laser with Anomalous Dispersion Higher-Order-Mode Fiber, *Lingxiao Zhu[1], Alma D. Fernandez[1], Aart J. Verhoef[1], Kim Jespersen[2], Lars Grüner-Nielsen[2], Andrius Baltuska[1]; [1]Photonics Inst., Vienna Univ. of Technology, Austria; [2]OFS Denmark, Denmark.* We present a modelocked 24 MHz Yb-doped fiber oscillator with a higher-order mode fiber for dispersion compensation. The oscillator operates in the net normal dispersion regime and generates clean 6 nJ pulses that can be dechirped down to 150 fs.

CMS6 • 14:45
High-Fidelity 165-fs 5-μJ Pulses from an Integrated Ytterbium Fiber System, *Alma D. Fernandez[1], Aart J. Verhoef[1], Kim Jespersen[2], Lingxiao Zhu[1], Lars Grüner-Nielsen[2], Almantas Galvanauskas[3], Andrius Baltuska[1]; [1]Photonics Inst., Vienna Univ. of Technology, Austria; [2]OFS Denmark, Denmark; [3]Center for Ultrafast Optical Science, Univ. of Michigan, USA.* Energy scaling of μJ fs pulses from monolithic YDFAs is limited by pulse pedestal formation. We demonstrate a chirped-pulse fiber-amplifier that uses a newly developed dispersion compensating fiber stretcher matching the dispersion of a grating pair.

CMS7 • 15:00
Scaling Mode-Locked Fiber Lasers to High Energies Using Chirally-Coupled Core Fiber, *Simon Lefrancois[1], Thomas S. Sosnowski[2], Chi-Hung Liu[2], Almantas Galvanauskas[3], Frank Wise[1]; [1]Applied Physics, Cornell Univ., USA; [2]Arbor Photonics, USA; [3]Department of Electrical Engineering and Computer Science, Univ. of Michigan, USA.* We report energy scaling of mode-locked fiber lasers using chirally-coupled core fiber. Pulse energies above 40 nJ dechirping below 200 fs are demonstrated, as well as dechirped durations around 100 fs at pump-limited energies.

CMT • Enhanced Efficiency Photovoltaics—Continued

CMT5 • 14:30 Invited
Present and Future of High Efficiency Multi-Junction Solar Cells, *Masafumi Yamaguchi[1], Tatsuya Takamoto[2], Kenji Araki[3], Mitsuru Imaizumi[4], Nobuaki Kojima[1], Yoshio Ohshita[1]; [1]Toyota Technological Inst., Japan; [2]Sharp Co., Japan; [3]Daido Co., Japan; [4]JAXA, Japan.* This paper reviews our research activities for III-V compound multi-junction (MJ) solar cells and recent R&D topics on concentrator MJ solar cells under the NEDO's R&D Project on Innovative Solar Cells initiated since 2008.

CMT6 • 15:00
Stable and near-omni-directional high-efficiency amorphous Si photovoltaic devices, *Chih-Wei Hsu[1], Jia-Min Shieh[1,2], Chang-Hong Shen[2], Jung Y. Huang[1], Hao-chung Kuo[1,2], Bau-Tong Dai[2], Ching-Ting Lee[3], Ci-Ling Pan[1,4], Fu-Liang Yang[2]; [1]Inst. of Electro-Optical Engineering, National Chiao Tung Univ., Taiwan; [2]National Applied Research Laboratories-National Nano Device Laboratories, Taiwan; [3]Inst. of Microelectronics, Department of Electrical Engineering, National Cheng Kung Univ., Taiwan; [4]Department of Physics and Inst. of Photonics Technologies, National Tsing Hua Univ., Hsinchu, Taiwan.* Highly stable high-density plasma-fabricated amorphous Si solar cells (7-9%) exhibit ultra-low photo-induced degradation in conversion-efficiency by 5.7%. This photovoltaic device with low-defect absorption layer is also a near-omni-directional solar-electricity generator.

CLEO: QELS-Fundamental Science

QMH • Coherent Phenomena in Semiconductors—Continued

QMH4 • 14:30
Transition from Amplified Spontaneous Emission to Superfluorescence from Biexcitons in Semiconductor Quantum Dots, *Kensuke Miyajima[1,2], Yuji Kagotani[1], Kosuke Maeno[1], Tasuku Sumino[1], Shingo Saito[3], Masaaki Ashida[1]; [1]Graduate School of Engineering Science, Osaka Univ., Japan; [2]PRESTO, JST, Japan; [3]National Inst. of Information and Communications Technology, Japan.* A transition from amplified spontaneous emission to superfluorescnece from biexcitons in semiconductor quantum dots was observed with increasing the excitation density under resonant two-photon excitation of the biexcitons.

QMH5 • 14:45
Decay Dynamics of Radiatively Coupled Quantum Dots in Photonic Crystal Slabs, *Philip T. Kristensen[1], Jesper Mørk[1], Peter Lodahl[1], Stephen Hughes[2]; [1]DTU Fotonik, Technical Univ. of Denmark, Denmark; [2]Department of Physics, Queen's Univ., Canada.* We model spontaneous emission dynamics of two optically-coupled quantum dots in a photonic crystal slab. Due to the different light scattering pathways from the dots, we observe a pronounced non-exponential decay in the emitted intensity.

QMH6 • 15:00
Two-photon resonance spectroscopy of single quantum-dots, *Yael Benny[1], Yaron Kodriano[1], Eilon Poem[1], Stanislav Khatsevich[1], David Gershoni[1]; [1]Technion, Israel.* We study two photon absorption resonances in single semiconductor quantum dots, using polarization sensitive two beam time resolved spectroscopy. The rich spectrum of the biexciton resonances is fully understood, for the first time.

CLEO: Science & Innovations

CMU • Nano-Structured LEDs—Continued

CMU5 • 14:30 Invited
Nitride-based Nanocolumns and Applications, *Katsumi Kishino[1,2], Kouji Yamano[1], Shunsuke Ishizawa[1], Kazuya Nagashima[1], Meiki Goto[1], Ryuichi Araki[1], Akihiko Kikuchi[1,2], Tatsuya Kouno[1]; [1]Engineering and Applied Science, Sophia Univ., Japan; [2]Sophia Nanotechnology Research Center, Sophia Univ., Japan.* InGaN-based nanocolumn arrays were grown by selective area growth of rf-MBE. Using the nanocolumn arrays, the emission color control, green light stimulated emissions from 520 to 566 nm, and green emission LEDs were successfully demonstrated.

CMU6 • 15:00
Diffraction-Coupled Plasmon-Enhanced Light Emission from InGaN/GaN Quantum Wells, *John Henson[1], Emmanouil Dimakis[1], Jeff DiMaria[1], Theodore Moustakas[1], Roberto Paiella[1]; [1]Electrical and Computer Engineering, Boston Univ., USA.* Plasmon-enhanced near-green light emission from InGaN/GaN quantum wells is demonstrated using periodic arrays of Ag nanoparticles. Particularly large enhancements are obtained when the array dimensions are near the onset of the diffractive regime.

13:30–15:15 Coffee Break, *300 Level Foyer*

NOTES

CLEO: Science & Innovations

CMV • Fabrication and Characterization of Nano Plasmonic Devices—Continued

CMV5 • 14:30 Invited

Nanoplasmonics for guiding, focusing and detection applications, *Uriel Levy[1], Gilad M. Lerman[1], Yoav Zuta[1], Boris Desiatov[1], Ilya Goykhman[1]; [1]Hebrew Univ., Israel.* In this talk we demonstrate configurations and devices that allow plasmonic assisted guiding and confinement of electromagnetic energy at the nanoscale. We also demonstrate silicon plasmonic Schottky detector for telecom wavelengths.

CMV6 • 15:00

Nano-scale Strain Mapping using Near-field Spectroscopy, *Antonio Llopis[1], Sergio Pereira[2], Ian M. Watson[3], Arkadii Krokhin[1], A. Neogi[1]; [1]Physics, Univ. of North Texas, USA; [2]CICECO, Univ. of Aveiro, Portugal; [3]Inst. of Photonics, Univ. of Strathclyde, UK.* A technique is presented for mapping the strain in light-emitting nano- and hetero-structures using near-field spectroscopy. This technique makes use of theoretical calculations to extract the strain from near-field data.

CMW • THz Sources II—Continued

CMW5 • 14:30

Key factors in achieving ultra-broadband THz emission from a laser-induced gas plasma, *Volker Blank[1], Mark D. Thomson[1], Hartmut G. Roskos[1]; [1]Physikalisches Institut, Univ. of Frankfurt, Germany.* We demonstrate how the observed emission of ultra-broadband THz pulses (>100 THz) from a two-color (ω-2ω) laser-induced gas plasma is strongly dictated by the precise spectral and temporal characteristics of the input optical fields.

CMW6 • 14:45

Power-Enhanced Narrow-Band Sub-THz Generation by Use of a Photonic Transmitter and Shaped Optical Pulses, *Jim-Wein Lin[1], Hsiu-Po Chuang[2], Feng Ming Kuo[3], Cheng-Han Lin[1], Tze-An Liu[4], Jin Wei Shi[3], Chen-Bin Huang[2], Ci-Ling Pan[1]; [1]Physics, National Tsing Hua Univ., Taiwan; [2]Inst. of Photonics Technologies, National Tsing Hua Univ., Taiwan; [3]Electrical Engineering, National Central Univ., Taiwan; [4]Center for Measurement Standards, Industrial Technology Research Inst., Taiwan.* By using optimized shaped optical pulses, we demonstrate a factor-of-~25 enhancement in the spectral power density of sub-THz wave at 93 GHz compared with that for quasi-sinusoidal optical modulation.

CMW7 • 15:00

Generation of >100 μJ, Broadband THz Transients with >10 MV/cm Fields via Coherent Transition Radiation at the Linac Coherent Light Source, *Dan Daranciang[3], John Goodfellow[2], Shambhu Ghimire[1], Henrik Loos[1], David Reis[1], Alan S. Fisher[1], Aaron M. Lindenberg[1,2]; [1]SLAC National Accelerator Lab, USA; [2]Materials Science and Engineering, Stanford Univ., USA; [3]Chemistry, Stanford Univ., USA.* Highly compressed, relativistic electron bunches are fired through a thin Be foil to generate intense, broadband, high-field THz transients. Pulse energies greater than 100 μJ and field strengths greater than 10 MV/cm are measured.

CLEO: Applications & Technology

AME • Biomedical Therapeutic Applications—Continued

AME2 • 14:30

Visualization of Dose Effects on Cultivated Cells in Photodynamic Therapy by a Laser Speckle Microscopy, *Yasuyuki Hirakawa[1], Yukihiro Fukunaga[2], Norio Miyoshi[2]; [1]Kurume National College of Technology, Japan; [2]Univ. of Fukui, Japan.* Visualization of regent-dose effects on cancer cells in photodynamic therapy was tried by laser speckle microscopy. It suggested that the laser speckle fluctuations at cellular membranes and inside cells indicate different behaviors each other.

AME3 • 14:45

Ultra-precise Focusing Multimodal Microprobes for Contact Laser Tissue Surgery, *Arash Darafsheh[1], Amir Fardad[2], Nathaniel M. Fried[1], Andrew N. Antoszyk[3], Howard S. Ying[4], Vasily N. Astratov[1]; [1]Physics and Optical Science, Univ. of North Carolina at Charlotte, USA; [2]PhotonTech, LLC, USA; [3]Retina Service, Charlotte Eye Ear Nose and Throat Associates, USA; [4]Wilmer Eye Inst., Johns Hopkins Univ., USA.* Using numerical modeling it is demonstrated that chains of spheres with a refractive index of 1.65-1.75 provide two times more compact focused beams compared to single spheres under conditions of illumination typical for laser surgery.

AME4 • 15:00

Ultrafast-Laser Interactions with Soft Biological Tissues - a Study with Viable 3-D Hydrogel Cell Cultures, *Aghapi Mordovanakis[1], Zuoming Qian[1], Andres Covarrubias[3], Yuanfeng Feng[1], Lothar Lilge[2], Robin Marjoribanks[1]; [1]Department of Physics, Univeristy of Toronto, Canada; [2]Department of Medical Biophysics, Univ. of Toronto, Canada.* We've developed a 3-dimensional hydrogel cell culture to investigate the effects of ultrafast laser pulses on soft biological tissues. We characterize the physical and histological impact of intense laser irradiation at >100MHz repetition rates.

13:30–15:15 Coffee Break, *300 Level Foyer*

NOTES

Room 318-320

CLEO: QELS-Fundamental Science

15:45–17:30
QMI • Integrated Nonlinear Devices
Presider to Be Announced

QMI1 • 15:45
Continuous-wave Second Harmonic Generation in Sub-micron AlGaAs Waveguides, *David Duchesne[1], Katarzyna A. Rutkowska[1,2], Maite Volatier[3], François Légaré[1], Sebastien Delprat[1], Mohammad Chaker[1], Daniele Modotto[4], Andrea Locatelli[4], Constantino De Angelis[4], Marc Sorel[5], Demetrios Christodoulides[6], Gregory J. Salamo[7], Richard Ares[3], Vincent Aimez[3], Roberto Morandotti[1]; [1]INRS-EMT, Canada; [2]Physics, Warsaw Univ. of Technology, Poland; [3]CRN2, Univeristy of Sherbrooke, Canada; [4]Ingegneria dell'Informazione, Univ. of Brescia, Italy; [5]Electrical and Electronic Engineering, Univ. of Glasgow, UK; [6]Univ. of Central Florida, USA; [7]Physics, Univ. of Arkansas, USA.* Modal phase-matched second harmonic generation is obtained in sub-micron AlGaAs waveguides using a continuous-wave laser at λ=1580nm. The tunability and robust fabrication process make this device ideal for integrated wavelength conversion.

QMI2 • 16:00
Continuous-Wave Mid-Infrared Frequency Conversion in Silicon Nanowaveguides, *Ryan K. Lau[1], Michaël Ménard[1], Yoshitomo Okawachi[1], Mark A. Foster[1], Amy Turner-Foster[1], Reza Salem[2], Michal Lipson[1], Alexander L. Gaeta[1]; [1]Cornell Univ., USA; [2]PicoLuz, USA.* We report continuous-wave wavelength conversion from the telecom band to the mid-infrared via four-wave mixing in silicon nanowaveguides. We convert a 1636-nm signal to produce a 2384-nm idler, demonstrating a parametric bandwidth of 748 nm.

QMI3 • 16:15
Low-power continuous-wave generation of second- and third-harmonic light in silicon photonic crystal nanocavities, *Matteo Galli[1], Dario Gerace[1], Simone L. Portalupi[1], Karl Welna[2], Christopher Reardon[2], Thomas F. Krauss[2], Liam O'Faolain[2], Giorgio Guizzetti[1], Lucio C. Andreani[1]; [1]Physics Department A. Volta, Univ. of Pavia, Italy; [2]School of Physics and Astronomy, Univ. of St. Andrews, UK.* We show visible frequency conversion by simultaneous second- and third-harmonic generation in a silicon photonic crystal nanocavity optimized for efficient far-field in-coupling of a low-power continuous-wave optical excitation at 1.5 microns.

QMI4 • 16:30
Four-wave mixing in short silicon slow-light engineered photonic crystal waveguides, *Christian Grillet[1], Christelle Monat[1], Bill Corcoran[1], Benjamin J. Eggleton[1], Liam O'Faolain[2], Thomas White[2], Majid Ebnali-Heidari[1], Juntao Li[2], Thomas F. Krauss[2]; [1]Univ. of Sydney, Australia; [2]St Andrews Univ., UK.* We report FWM (- 9dB conversion) in a short (80μm) silicon dispersion engineered slow (c/30) light photonic crystal waveguide through launching a pulsed pump and a CW probe signal.

Room 321-323

CLEO: Science & Innovations

15:45–17:30
CMX • Plasmonic Devices
Rafael Piestun, Univ. of Colorado at Boulder, USA, Presider

CMX1 • 15:45
Engineered nonlinear optical structures based on metal nanocomposite photonic crystals, *Saima Husaini[1,2], Vinod Menon[1]; [1]Physics, Queens College of the City Univ. of New York, USA; [2]Physics, Graduate School and Univ. Center of the City Univ. of New York, USA.* We demonstrate a three-fold increase in the nonlinear optical absorption of an engineered metal-nanocomposite based photonic crystal as compared to a single metal-nanocomposite film of comparable thickness using Z-scan measurements.

CMX2 • 16:00
Surface Enhanced Raman Scattering Enhancements from Silver Atomic Layer Deposition Coated Nanowire, *Joshua D. Caldwell[1], Orest J. Glembocki[1], Francisco J. Bezares[1], Hua Qi[1], Maarit Karinieni[2], Sharka M. Prokes[1], Jaako Nivinisto[2], Timo Hatanpaa[2], Mikko Ritala[2], Markuu Leskela[2], Michael Mastro[1]; [1]Electronic Science and Technology, Naval Research Lab, USA; [2]Chemistry Department, Univ. of Helsinki, Finland.* Significant enhancement in SERS response from periodic and aperiodic arrays of nanowires coated with silver by atomic layer deposition was observed in comparison to other deposition methods. SERS detection at 10 meters was also observed.

CMX3 • 16:15 Invited
Coupled Nanocavity-Grating Resonances: Large Plasmonic Enhancement of Nonlinear Optical Phenomena, *Federico Capasso[1,2], Patrice Genevet[1,2], Jean-Philippe Tetienne[1], Evangelos Gatzogiannis[4], Romain Blanchard[1], Mikhail A. Kats[1], Marlan O. Scully[2,3]; [1]School of Engineering and Applied Sciences, Harvard Univ., USA; [2]Inst. for Quantum Studies and Department of Physics, Texas A&M Univ., USA; [3]College of Engineering and Applied Science, Princeton Univ., USA; [4]Center for Nanoscale System, USA.* A grating of nanogrooves is designed to form resonant nanocavities in a gold film. The large plasmonic enhancement of fourwave mixing makes such structures attractive for surface nonlinear optics.

Room 324-326

CLEO: QELS-Fundamental Science

15:45–17:30
QMJ • High Field—Plasmas and Sources
Presider to Be Announced

QMJ1 • 15:45
Ultrafast Electron Diffraction Using Femtosecond Electron Pulses from Laser-Produced Plasmas, *Shigeki Tokita[1], Masaki Hashida[1], Shunsuke Inoue[1], Toshihiko Nishoji[1], Kazuto Otani[1], Shuji Sakabe[1]; [1]Inst. for Chemical Research, Kyoto Univ., Japan.* We have demonstrated single-shot measurement of electron diffraction patterns for a gold crystal using laser-accelerated 350-keV electron pulses. The electron pulse duration was shortened to be 500 fs on the crystal by a magnetic pulse compressor.

QMJ2 • 16:00
CO_2 Laser Driven Ion Acceleration in a Gas Jet, *Sergei Tochitsky[1], Dan Haberberger[1], Chao Gong[1], Chan Joshi[1]; [1]Univ. of California at Los Angeles, USA.* A train of multiterawatt, 3 ps CO_2 laser pulses is used for proton acceleration in a plasma at the critical density. Maximum energy of ions is strongly affected by a temporal structure of the pulse.

QMJ3 • 16:15
Self-injected Petawatt Laser-driven Plasma Electron Acceleration in 1017 cm^{-3} Plasma, *Xiaoming Wang[1]; [1]Univ. of Texas at Austin, USA.* We report observation of electron self-injection and acceleration in a plasma accelerator driven by the Texas petawatt laser at 1017 cm^{-3} plasma density, an order of magnitude lower density than previous self-injected laser-plasma accelerators.

QMJ4 • 16:30
Tripling of Plasma Filament Length by Molecular Quantum Wakes in Atmosphere, *Sanjay R. Varma[1], Howard Milchberg[1], Arman Fallahkhair[1], Yu-hsin Chen[1]; [1]Electrical Engineering, Univ. of Maryland, USA.* We tripled the length of the plasma filament from an ultrafast pulse by injecting it into the molecular rotational quantum wake of a pump filament. The plasma was measured using a sensitive interferometric plasma diagnostic.

Room 314

JOINT

15:45–17:30
JMG • Novel Optical Systems for Industrial Applications
Saulius Juodkazis, Swinburne Univ. of Technology, Australia, Presider

JMG1 • 15:45
Parallel laser microfabrication of three-dimensional structures corrected for optical aberrations, *Patrick S. Salter[1], Alexander Jesacher[2], Richard Simmonds[1], Martin Booth[1]; [1]Engineering Science, Univ. of Oxford, UK; [2]Division of Biomedical Physics, Innsbruck Medical Univ., Austria.* An adaptive optical element is employed to generate multiple fabrication spots while also compensating for any optical aberration present in the system. We present rapid diffraction limited optical fabrication in a range of interesting substrates.

JMG2 • 16:00
Dual adaptive optics system for laser processing of diamond, *Richard Simmonds[1], Alexander Jesacher[2], Tony Wilson[1], Martin Booth[1]; [1]Engineering Science, Oxford Univ., UK; [2]Division of Biomedical Physics, Innsbruck Medical Univ., Austria.* Laser fabrication depth in diamond is limited by refractive index mismatch induced aberrations that can be corrected by using adaptive optics; we demonstrate a dual active element system that considerably extends practical fabrication depth.

JMG3 • 16:15
Study of the transient behavior of a tunable acoustic gradient index lens for laser processing, *Marti Duocastella[1], Craig B. Arnold[1]; [1]Mechanical and Aerospace Engineering, Princeton Univ., USA.* A tunable acoustic gradient lens is an adaptive optical system adequate for the processing of materials. In this study, the modulation in refractive index of the lens at the initial moments of operation is determined.

JMG4 • 16:30
Combination of Diffractive Shaper and Splitter for Multiple Beam Laser Processing System, *Sin-An Chen[1], Cheng-Huan Chen[1], Yu-Chung Lin[2], Min-Kai Lee[2], Sung-Ho Liu[2]; [1]Power Mechanical Engineering, National Tsing Hua Univ., Taiwan; [2]Laser Application Technology Center, Industrial Technology Research Inst. South, Taiwan.* Transforming Gaussian laser into top-hat profile is accomplished by a four-level diffractive element. A binary diffractive grating is further integrated for generating multiple top-hat laser spots to improve the efficiency of laser processing system.

CLEO: Science & Innovations

15:45–17:30
CMY • 1.5-5μm Lasers
Jonathan Zuegel, Univ. of Rochester, USA, Presider

CMY1 • 15:45
Er^{3+} Doped Diode-Pumped Ceramic Laser Delivers 14 W CW at 2.7-μm, *Tigran Sanamyan[1], Mark Dubinskii[1]; [1]Army Research Lab, USA.* We report diode-pumped Er^{3+}:Y_2O_3 ceramic laser with 14W CW output at 2.7 μm and ~26% slope efficiency. This is believed to be the highest power ever reported from Er^{3+}-doped ceramic laser at this wavelength.

CMY2 • 16:00
High-power radially-polarized Er:YAG laser with Laguerre-Gaussian (LG01) mode output, *Ji Won Kim[1], Jacob Mackenzie[1], John Hayes[1], William A. Clarkson[1]; [1]Optoelectronics Research Center, UK.* A simple method to allow direct excitation of the first-order Laguerre-Gaussian mode has been applied to a hybrid Er:YAG laser. The laser yielded 13.1W of radially-polarized LG01 output at 1645nm for 34W of pump power.

CMY3 • 16:15
Nearly Quantum Defect-Limited Efficiency Laser Operation of a Resonantly Pumped Er^{3+}-Doped YVO_4, *Nikolay Ter-Gabrielyan[1], Vuktor Fromzel[1], Tadeush Lukasiewicz[2], Witold Ryba-Romanowski[3], Mark Dubinskii[1]; [1]US Army Research Lab, USA; [2]Inst. of Electronic Materials Technology, Poland; [3]Inst. of Low Temperature and Structure Research, Poland.* Nearly quantum defect-limited laser operation of a resonantly-pumped Er^{3+}:YVO_4 at 1593.5 nm is demonstrated. Achieved slope efficiency of ~85% is, to the best of our knowledge, the highest efficiency ever reported for crystalline Er-doped laser.

CMY4 • 16:30
High-Energy Gain-Switched Mid-IR Lasers Based on Cr and Fe Doped ZnSe, *NoSoung Myoung[1], Mikhail S. Mirov[2], Vladimir V. Fedorov[1,2], Sergey B. Mirov[1,2]; [1]Center for Optical Sensors and Spectroscopies and the Department of Physics, Univ. of Alabama at Birmingham, USA; [2]IPG Photonics Corporation, Mid-IR Lasers, USA.* We report an optimization of transition-metal (Cr and Fe) doped ZnSe crystals fabrication and energy scaling of gain-switched Cr:ZnSe (10mJ@2.4μm) and Fe:ZnSe (3.6mJ@4.37μm) lasers operating at 300K.

15:45–17:00
CMZ • Fiber Devices
Jacques Albert, Carleton Univ., Canada, Presider

CMZ1 • 15:45
Optical Circuits in Fiber Cladding: Femtosecond laser-written Bragg Grating Waveguides, *Jason R. Grenier[1], Luis A. Fernandes[1,2], Paulo V. Marques[2], J. Stewart Aitchison[1], Peter R. Herman[1]; [1]Inst. for Optical Sciences and Electrical & Computer Engineering, Univ. of Toronto, Canada; [2]Fisica e Astonomia, Universidade do Porto, Portugal.* First order Bragg Grating Waveguides are inscribed in the core and cladding of optical fibers using oil immersion femtosecond direct laser-writing. A laser-induced birefringence of 2.05×10^{-4} was inferred from polarization split Bragg resonances.

CMZ2 • 16:00
Diffraction control of Bessel beams generated in fiber, *Paul Steinvurzel[1], Khwanchai Tantiwanichapan[1], Masao Goto[1], Siddharth Ramachandran[1]; [1]Electrical and Computer Engineering, Boston Univ., USA.* LP0,m fiber cladding modes propagate as Bessel beams in free space. We show that selecting the mode order with a long period grating enables tuning of the propagation distance and width of the center spot.

CMZ3 • 16:15
Fiber DFB Laser Bend Sensor with RF Signal Interrogation, *Kazi S. Abedin[1], Jerome Porque[1], Jeffrey Nicholson[1], Paul S. Westbrook[1]; [1]OFS Laboratories, USA.* We report on the properties of a dual-polarization distributed feedback fiber laser as the fiber cavity is bent. We show that the RF polarization beat note can sense fiber bend and temperature.

CMZ4 • 16:30
Continuous and Discrete Multimode Interference Liquid Level Sensor, *Jose E. Antonio-Lopez[1,3], Daniel Lopez-Cortes[1], Jose J. Sanchez-Mondragon[1], Patrick LiKamWa[3], Daniel A. May-Arrioja[2]; [1]Optics Department, INAOE, Mexico; [2]Depto. de Ingenieria Electrica, Universidad Autonoma de Tamaulipas, USA; [3]CREOL, The College of Optics and Photonics, Univ. of Central Florida, USA.* An all-fiber continuous and discrete liquid level sensor using Multimode Interference (MMI) effects is demonstrated. The sensing range and also multiplexed operation can be easily controlled by just changing the length of the MMI sensor.

15:45–17:30
CMAA • Nonlinear Optics in Waveguides and Nanostructures
Narasimha Prasad, NASA Langley Res. Ctr., USA, Presider

CMAA1 • 15:45
Ultra-Broadband Tunable Wavelength Conversion of Sub-Picosecond Pulses in a Silicon Nanowire, *Minhao Pu[1], Hao Hu[1], Michael Galili[1], Hua Ji[1], Leif K. Oxenloewe[1], Kresten Yvind[1], Palle Jeppesen[1], Jørn M. Hvam[1]; [1]Photonics Engineering, Technical Univ. of Denmark, Denmark.* We present a tunable wavelength conversion of sub-picosecond pulses based on four-wave mixing in a dispersion engineered silicon nanowire. A 100-nm tuning range of the converted wavelength is demonstrated with almost constant conversion efficiency.

CMAA2 • 16:00
Continuously Tunable Wavelength Conversion of Data with Record Probe-Idler Separations in a Silicon Nanowire, *Noam Ophir[1], Michaël Ménard[2], Kishore Padmaraju[1], Ryan K. Lau[3], Yoshitomo Okawachi[3], Michal Lipson[2,4], Alexander L. Gaeta[3], Keren Bergman[1]; [1]Electrical Engineering, Columbia Univ., USA; [2]Electrical and Computer Engineering, Cornell Univ., USA; [3]Applied and Engineering Phyics, Cornell Univ., USA; [4]Kavli Inst. at Cornell for Nanoscale Science, Cornell Univ., USA.* We demonstrate tunable wavelength conversion of 10-Gb/s data with up to 168-nm probe-idler separation based on four-wave mixing in silicon nanowires. We incorporate an NRZ-to-RZ format change using a pulsed pump and achieve error-free operation.

CMAA3 • 16:15
Broadband Wavelength Conversion of Incoherent Light in Silicon Nanowaveguides, *Ryan K. Lau[1], Yoshitomo Okawachi[1], Michaël Ménard[1], Michal Lipson[1], Alexander L. Gaeta[1]; [1]Cornell Univ., USA.* We demonstrate broadband wavelength conversion of an incoherent light source via four-wave mixing in a silicon rib nanowaveguide. We observe a conversion efficiency of -24 dB over the entire wavelength range of the incoherent source.

CMAA4 • 16:30
Second and Third-Order Nonlinear Optical Effects in ZnO Channel Waveguides, *Tomohiro Kita[1], Edgar Yoshio Morales Teraoka[1], Yoshitomo Okawachi[2], Atsushi Tsukazaki[3,4], Masashi Kawasaki[5,6], Alexander L. Gaeta[2], Hirohito Yamada[1]; [1]Tohoku Univ., Japan; [2]Cornell Univ., USA; [3]Univ. of Tokyo, Japan; [4]PREST, JST, Japan; [5]IMR, Tohoku Univ., Japan; [6]WPI, Tohoku Univ., Japan.* We demonstrate simultaneous self-phase modulation and second harmonic generation in ZnO channel waveguides. We estimate a value of $\gamma = 13.9 \pm 3.0$ $W^{-1}m^{-1}$, indicating that ZnO offers promise as a platform for nonlinear devices.

Room 327

CLEO: Science & Innovations

15:45–17:30
CMBB • High-Repetition-Rate Pulsed Sources
Shibin Jiang, AdValue Photonics Inc., USA, Presider

CMBB1 • 15:45 Tutorial
Optical Comb and Pulse Generation from CW light, *Takahide Sakamoto[1]; [1]National Inst. of Information and Communications Technology, Japan.* Recent progress in compact optical comb/pulse sources is reviewed, mainly focusing on electro-optic synthesizing methods from a CW light. The features, applications, challenges are discussed comparing with other technologies like mode-locked lasers.

Takahide Sakamoto, born in 1975, is a Senior Researcher at National Inst. of Information and Communications Technology (NICT), Tokyo, Japan. Currently, he is also with Univ. of California, Davis as a Visiting Scholar supported by Japan Society for the Promotion of Science. He received the Ph.D. degree in electronic engineering from the Univ. of Tokyo in 2003. Since 2003, he has been with NICT, engaged in optical fiber communications. His current interests are in fiber-optic devices and subsystems for optical modulation/demodulation and signal processing, involving coherent synthesis of optical comb, pulse and special modulation formats for telecom use.

Room 336

CLEO: Science & Innovations

15:45–17:30
CMCC • Nanostructures for Photovoltaics
Masafumi Yamaguchi, Toyota Technological Inst., Japan, Presider

CMCC1 • 15:45
Plasmonic Organic Solar Cell and Its Absorption Enhancement Analysis Using Cylindrical Ag Nano-Particle Model based on Finite Difference Time Domain (FDTD), *Seongku Kim[1], Kang L. Wang[1], Qibing Pei[2], GyeChoon Park[3]; [1]Electrical Engineering, Univ. of California Los Angeles, USA; [2]Materials Science and Engineering, Univ. of California Los Angeles, USA; [3]Chemical Engineering, Univ. of Florida, USA.* We report plasmon-assisted photocurrent enhancement in Ag-nanoparticles-embedded organic solar cells, and theoretically investigate the causes of improved optical absorption based on a FDTD cylindrical particle model.

CMCC2 • 16:00
Patterned Plasmonic Nano-Antennas Embedded in the Active Layer of Organic Photovoltaic Cells - Enhanced Absorption, *Iddo Diukman[1], Lior Tzabari[1], Nikolai Berkovitch[1], Nir Tesler[1], Meir Orenstein[1]; [1]Electrical Engineering, Technion, Israel.* Ordered arrays of Au nanodisks, extending into the active layer of organic photovoltaic device exhibit enhanced external quantum efficiency, stemming from resonances of plasmon and nanopatch antennas. Design rules were verified experimentally.

CMCC3 • 16:15
Enhancing solar cells with localized plasmons in nanovoids, *Niraj N. Lal[1], Bruno F. Soares[1], Jatin Sinha[2], Fumin Huang[1], Philip N. Bartlett[2], Neil Greenham[1], Javier Garcia de Abajo[3], Jeremy J. Baumberg[1]; [1]Physics, Univ. of Cambridge, UK; [2]Chemistry, Univ. of Southampton, UK; [3]Instituto de Optica, Spain.* Localized plasmons in silver nanovoids enhance organic solar cell efficiencies experimentally by a factor of four and similarly in a-Si cells, accounted for by theoretical and computational analysis of absorption at the plasmonic interface.

CMCC4 • 16:30
Dielectric nanostructures for broadband light trapping in organic solar cells, *Aaswath Raman[1], Zongfu Yu[2], Shanhui Fan[2]; [1]Applied Physics, Stanford Univ., USA; [2]Ginzton Lab, Stanford Univ., USA.* We investigate broadband light trapping using only dielectric components to improve organic solar cell efficiency. We show that substantial absorption and photocurrent enhancement is possible using top-surface ITO gratings in these devices.

Room 337

CLEO: QELS-Fundamental Science

15:45–17:30
QMK • Quantum Control in Solid-State Systems
Ryo Shimano, Univ. of Tokyo, Japan, Presider

QMK1 • 15:45 Invited
Ultrafast Optical Entanglement Control between two Quantum Dot Spins, *Samuel G. Carter[1], Danny Kim[1], Alex Greilich[1], Allan S. Bracker[1], Daniel Gammon[1]; [1]Naval Research Lab, USA.* Using continuous-wave lasers and picosecond optical pulses, we demonstrate initialization, single qubit gates, and two qubit gates in a system of two electron spins in separate tunnel-coupled InAs quantum dots.

QMK2 • 16:15
Robust Optical Inversion of the Excitonic Population of InGaAs Quantum Dots via Adiabatic Rapid Passage, *Peter Brereton[1], Yanwen Wu[1], Isobel Piper[1], Matthias Ediger[1], Emma Schmidgall[1], Richard Phillips[1], Paul Eastham[2], Maxime Hugues[3], Mark Hopkinson[3]; [1]AMOP Cavendish Lab, Univ. of Cambridge, UK; [2]School of Physics, Trinity College, Ireland; [3]Electronic and Electrical Engineering, Univ. of Sheffield, UK.* We show population inversion in a semiconductor quantum dot with a chirped optical pulse via adiabatic rapid passage. This method is insensitive to variations in the dipole coupling and provides a new tool for preparing ensembles of quantum states.

QMK3 • 16:30
Chirp Controls Nonlinear Response of Excitons in Semiconductor Quantum Wells, *Ryan Smith[1], Ryan Smith[1], Andrew Hunter[1], Andrew Funk[1], Steven Cundiff[1], Mackillo Kira[2], Stephan W. Koch[2]; [1]Physics, JILA, Univ. of Colorado, USA; [2]Department of Physics and Material Sciences Center, Philipps-Univ., Germany.* We characterize chirped excitation on excitonic resonances in GaAs quantum wells using spectrally resolved transient absorption. Positive chirp enhances nonlinearities, despite the increased pulse duration compared with transform-limited excitation.

Room 338

CLEO: Science & Innovations

15:45–17:30
CMDD • Optofluidic Cell, Particle and Fluid Manipulation
David Sinton, Univ. of Victoria, Canada, Presider

CMDD1 • 15:45 Invited
Optical Techniques For Tracking Cells In Vivo, *Charles Lin[1]; [1]MGH Wellman Center for Photomedicine, Harvard Medical School, USA.* I will focus on tracking cancer cells, immune cells, and stem cells in vivo using (i) intravital microscopy for 3D tissue imaging, and (ii) in vivo flow cytometry for detection and quantification of circulating cells.

CMDD2 • 16:15
Pulsed Laser Triggered High Speed Microfluidic Fluorescence Activated Cell Sorter, *Ting-Hsiang Wu[1,2], Yue Chen[1], Sung-Yong Park[1], Pei-Yu Chiou[1]; [1]Mechanical and Aerospace Engineering, Univ. of California at Los Angeles, USA; [2]Pathology and Lab Medicine, Univ. of California at Los Angeles, USA.* We report a pulsed laser triggered high speed microfluidic fluorescence activated cell sorter capable of sorting at a throughput of 3000 beads/sec and 560 cells/sec with >90% sample purity and 90% cell viability after sorting.

CMDD3 • 16:30
Sized-Based Optical Particle Sorting Using an Orthogonal Beam in Optofluidic Waveguides, *Kaelyn D. Leake[1], Brian Phillips[2], Aaron R. Hawkins[2], Holger Schmidt[1]; [1]EE, Univ. of California, Santa Cruz, USA; [2]EE, Brigham Young Univ., USA.* We demonstrate on-chip, sized-based, optical sorting in optofluidic ARROW waveguides. Large particles are separated out of a mixture of particles of varying size as they pass through an intersecting beam.

CLEO: Science & Innovations

15:45–17:30
CMEE • Novel Nanofabrication Concepts
Uriel Levy, Hebrew Univ., Israel, Presider

CMEE1 • 15:45
Ultrathin Optomechanical SiN_x Nanomembranes with Photonic Crystal Fano Resonances for Enhanced Radiation Pressure, *Catvu H. Bui[1], Jiangjun Zheng[1], Israel-Marc Kositsky[2], Lennon Lee[1], Jack Harris[2], Chee Wei Wong[1]; [1]Columbia Univ., USA; [2]Yale Univ., USA.* We fabricate 50-nm-thick SiN_x photonic crystal nanomembranes for cavity optomechanics, supported by ab-initio simulations. Transmission spectra measurements show guided Fano resonances near 1064-nm for enhanced reflectivity and radiation pressure.

CMEE2 • 16:00
Encrypting messages in 3D photonic crystals with patterned surface chemistry, *Ian B. Burgess[1], Lidiya Mishchenko[1], Benjamin D. Hatton[1,2], Mathias Kolle[1], Marko Loncar[1], Joanna Aizenberg[1,3]; [1]School of Engineering and Applied Sciences, Harvard Univ., USA; [2]Wyss Inst. for Biologically Inspired Engineering, Harvard Univ., USA; [3]Department of Chemistry and Chemical Biology, Harvard Univ., USA.* We describe a 3D porous photonic crystal whose inner surfaces are chemically functionalized in arbitrary spatial patterns with micron-scale resolution. We use this platform to demonstrate a method for solvent-specific multi-layer message encryption.

CMEE3 • 16:15
Direct Imprinting of Porous Substrates, *Judson D. Ryckman[1], Marco Liscidini[2], J. E. Sipe[3], Sharon M. Weiss[1]; [1]Department of Electrical Engineering and Computer Science, Vanderbilt Univ., USA; [2]Dipartimento di Fisica "A. Volta", Universita degli Studi di Pavia, Italy; [3]Department of Physics and Inst. for Optical Sciences, Univ. of Toronto, Canada.* We present direct imprinting of porous substrates (DIPS) as a strategy for nanoscaled (<100nm) patterning of porous nanomaterials. DIPS is further investigated as a low-cost technique for fabricating structures for enhanced light-matter interaction.

CMEE4 • 16:30
Talbot Effect: A Venerable Idea with New Applications in Nanofabrication, *Lukasz Urbanski[1], Przemyslaw Wachulak[2], Artak Isoyan[3], Aaron Stein[4], Carmen Menoni[1], Jorge Rocca[1], Mario C. Marconi[1]; [1]Electrical and Computer Engineering, Colorado State Univ., USA; [2]Inst. of Optoelectronics, Military Univ. of Technology, Poland; [3]Synopsys Inc, USA; [4]Center for Functional Nanomaterials, Brookhaven National Lab, USA.* We describe a coherent nanolithography approach using the Talbot effect in combination with a table top EUV laser emitting at 46.9 nm. The method was used to print large areas of periodic features with nanometer resolution.

15:45–17:30
CMFF • THz Technology
Hiromasa Ito, RIKEN, Japan, Presider

CMFF1 • 15:45
Intracavity Generation of Continuous Wave Terahertz Radiation in the Milliwatt Regime, *Maik Scheller[1,3], J. Michael Yarborough[2,3], Jerome V. Moloney[2,3], Mahmoud Fallahi[2,3], Martin Koch[1,3], Stephan W. Koch[1,3]; [1]Faculty of Physics, Philipps-Univ. of Marburg, Germany; [2]College of Optical Sciences, Univ. of Arizona, USA; [3]Desert Beam Technologies LLC, USA.* We present a terahertz source based on intracavity difference frequency generation within a dual color vertical external cavity surface emitting laser. The generation of continuous wave terahertz radiation in the milliwatt regime is demonstrated.

CMFF2 • 16:00
Prospects of Heterodyning in Electro-Optic Detector, *Juraj Darmo[1], Daniel Dietze[1], Michael Martl[1], Karl Unterrainer[1]; [1]Photonics Inst., Vienna Univ. of Technology, Austria.* We derive and discuss conditions for the heterodyning in electro-optic detector of the electric field. Proof of principle of this technique is provided for detecting terahertz radiation.

CMFF3 • 16:15 Invited
Semiconductor Laser Based THz Technology, *Carsten Brenner[1], Martin R. Hofmann[1]; [1]Photonics and Terahertz Technology, Ruhr Univ. Bochum, Germany.* We review the potential of compact diode laser based systems for pulsed (fs regime) and continuous wave THz technology. We present a compact multi modal system capable of fast switching between narrow and broadband THz emission for THz spectroscopy.

CLEO: Applications & Technology

15:45–17:30
AMF • Medical Applications of Fluorescence
Xingde Li, Johns Hopkins Univ., USA, Presider

AMF1 • 15:45 Invited
Assessing Human Skin with Light, *Nikiforos Kollias[1]; [1]Johnson & Johnson, USA.* We present a variety of methods based on optical spectroscopy for assessing human skin health.

AMF2 • 16:15 Invited
Near-infrared Fluorescence Imaging in Humans: New Discoveries from a New Modality, *Eva Sevick, Univ. of Texas Health Science Ctr., USA.* The first applications of non-invasive, near-infrared fluorescence imaging in humans provide new, exciting discoveries of health and disease that would not otherwise be possible with conventional imaging modalities.

Room 318-320	Room 321-323	Room 324-326	Room 314
CLEO: QELS-Fundamental Science	CLEO: Science & Innovations	CLEO: QELS-Fundamental Science	JOINT

QMI • Integrated Nonlinear Devices—Continued

QMI5 • 16:45
Observation of gain due to Four-Wave-Mixing in photonic crystal waveguides, *Pierre Colman[1], Isabelle Cestier[2], Vardit Eckhouse[2], Sylvain Combrié[1], Gaelle Lehoucq[1], Gadi Eisenstein[2], Alfredo De Rossi[1]; [1]Thales Research & Technology, France; [2]Electrical Engineering, Technion, Israel.* We investigate Four-Wave-Mixing in dispersion-engineered Photonic Crystal Waveguide. For 100ps pulses, the instantaneous conversion efficiency is -24 dB and for single ps pulses we demonstrate a 3dB parametric gain for Watt level pump powers.

QMI6 • 17:00
Intracavity Second Harmonic Generation in Quantum Cascade Lasers Pumped by Femtosecond Mid-IR Pulses, *Sheng Liu[1,2], Elaine Lalanne[1], Peter Q. Liu[3], Anthony M. Johnson[1,2], Claire F. Gmachl[3]; [1]CASPR, UMBC, USA; [2]Physics, UMBC, USA; [3]Electrical Engineering, Princeton Univ., USA.* Room temperature second harmonic generation at λ=2.2 μm has been obtained from a 4.5 μm quantum cascade laser resonantly pumped by TM or TE polarized λ=4.5 μm femtosecond pulses through the front facet.

QMI7 • 17:15
Ultrafast pulse compression by two-photon gain in a semiconductor waveguide, *Amir Nevet[1], Alex Hayat[1], Meir Orenstein[1]; [1]Electrical Engineering, Technion, Israel.* We demonstrate experimentally compression of femtosecond-scale pulses by two-photon gain in an electrically-driven AlGaAs waveguide. Dynamic control of pulse width from 240 to 140 fs is achieved by varying the current injection levels.

CMX • Plasmonic Devices—Continued

CMX4 • 16:45
Grating Coupler Integrated Photodiodes for Plasmon Resonance Based Sensing in Fluidic Systems, *Burak Turker[1,2], Hasan Guner[1], Sencer Ayas[1], Okan O. Ekiz[1], Handan Acar[1], Mustafa O. Guler[1], Aykutlu Dana[1]; [1]Inst. of Materials Science and Nanotechnology, Bilkent Univ., Turkey; [2]Biomedical Engineering, Afyon Kocatepe Univ., Turkey.* We demonstrate an integrated sensor combining a grating coupled plasmon resonance surface with a planar photodiode. Plasmon enhanced transmission is employed as a sensitive refractive index sensing mechanism, monitored via the integrated photodiode.

CMX5 • 17:00
Surface Plasmonic Lens on a Single-mode Optical Fiber for Far-field Superfocusing, *Yuxiang Liu[1], Hua Xu[2,3], Felix Stief[1], Nikolai Zhitenev[2], Miao Yu[1,3]; [1]Department of Mechanical Engineering, Univ. of Maryland, USA; [2]Center for Nanoscale Science and Technology, National Inst. of Standards and Technology, USA; [3]Maryland NanoCenter, Univ. of Maryland, USA.* We experimentally demonstrate sub-diffraction-limit focuses achieved by surface plasmonic lenses fabricated on the endfaces of single-mode optical fibers. The fiber-based SP lens provides a solution to bridge nanophotonics and conventional optics.

CMX6 • 17:15
Giant Photoconductivity Gain in Nanowire Photodetectors and the Effect of Photo-Modulation of Contact Injection, *Gustavo Fernandes[1], Hongsik Park[1], Jin Ho Kim[1], Jimmy Xu[1]; [1]School of Engineering, Brown Univ., USA.* We demonstrate large photoconductive gain on single-crystalline Bi_2S_3 nanowire photodetectors. The photoconductive gain is significantly enhanced by optical modulation of the electrical contacts, which accounts for >90% of the conductivity change.

QMJ • High Field—Plasmas and Sources—Continued

QMJ5 • 16:45
Electron Density of the Femtosecond Optical Filament in Air, *Yu-hsin Chen[1], Sanjay R. Varma[1], Howard Milchberg[1]; [1]Inst. for Research in Electronics and Applied Physics, Univ. of Maryland, USA.* We present the first direct radially and axially space-resolved measurement of electron density over the full length of a femtosecond optical filament in air, allowing elucidation of the air nonlinearity leading to beam collapse.

QMJ6 • 17:00
Progress in Enhancement Cavities for XUV Generation, *Ioachim Pupeza[1], Jan Kaster[1], Tino Eidam[2], Birgitta Bernhardt[1], Johannes Weitenberg[3], Ronald Holzwarth[1], Theodor W. Hänsch[1], Thomas Udem[1], Jens Limpert[2], Andreas Tünnermann[2], Ernst Fill[1], Ferenc Krausz[1]; [1]Max-Planck-Institut für Quantenoptik, Germany; [2]Friedrich-Schiller-Universität, Germany; [3]RWTH Aachen Univ., Germany.* A resonator is presented, designed to overcome current power and intensity scaling limitations of HHG enhancement cavities and offering the prospect of MW circulating powers for ultrashort pulses. Suitable XUV output coupling mechanisms are addressed.

QMJ7 • 17:15
Tailored Transverse Modes in High-Finesse Femtosecond Enhancement Cavities, *Ioachim Pupeza[1], Johannes Weitenberg[2], Peter Russbueldt[3], Tino Eidam[4], Jens Limpert[4], Ernst Fill[1], Thomas Udem[1], Hans-Dieter Hoffmann[3], Reinhart Poprawe[2,3], Andreas Tünnermann[4], Ferenc Krausz[1]; [1]Max-Planck-Institut für Quantenoptik, Germany; [2]Lehrstuhl für Lasertechnik, Germany; [3]Fraunhofer-Institut für Lasertechnik, Germany; [4]Friedrich-Schiller-Universität, Germany.* Degenerate transverse modes are used to excite a field distribution with maximum on-axis intensity near the focus and avoiding a large on-axis aperture far away from the focus in a femtosecond resonator with finesse 3000.

JMG • Novel Optical Systems for Industrial Applications—Continued

JMG5 • 16:45
Fabrication of binary Fresnel lenses in PMMA by femtosecond laser micromachining, *Rebeca Martínez Vázquez[1], Shane M. Eaton[1], Roberta Ramponi[1], Giulio Cerullo[1], Roberto Osellame[1]; [1]IFN-CNR, Italy.* Binary Fresnel lenses are fabricated by ablation of PMMA substrates with a femtosecond laser, with a minimum feature size of 600 nm. The obatined lenses present good transparency and an efficiency close to the theoretical one.

JMG6 • 17:00
Automatic Testing of Unmounted Quantum Cascade Laser Chips in an External Cavity Configuration, *Yin Wang[1], Feng Xie[2], Catherine Caneau[2], Nick Visovsky[2], Herve LeBlanc[2], Chung-en Zah[2], Gerard Wysocki[1]; [1]Electrical Engineering, Princeton Univ., USA; [2]Science and Technology, Corning Inc., USA.* An automatic external-cavity laser system for efficient testing of unmounted quantum cascade laser (QCL) bars has been developed. QCLs emitting at 3.45 μm and broadband gain media with ~344 cm^{-1} tunability at 4.4 μm have been studied.

JMG7 • 17:15
Novel Optical Architecture for High Capacity and High Data Transfer Rate Holographic Data Storage, *Yuzuru Takashima[1], Lambertus Hesselink[1], Jian Liu[2], Lihmei Yang[2]; [1]Stanford Univ., USA; [2]PolarOnyx, USA.* A novel optical system architecture employing local holographic recording with a pico-second pulsed fiber laser and a small page size SLM has the potential towards realizing compact, high capacity and high data transfer rate optical storage.

17:30–18:00 Break

18:00–20:30 Plenary Session I and CLEO/*Laser Focus World* Innovation Award Presentation, *Rooms III-IV*

CLEO: Science & Innovations

CMY • 1.5-5μm Lasers—Continued

CMY5 • 16:45
Passive Mode-Locking of a Tm:YLF Laser, *Andreas Schmidt[1], Daniela Parisi[2], Stefano Veronesi[2], Mauro Tonelli[2], Won Bae Cho[3], Sun Young Choi[3], Jong Hyuk Yim[3], Soonil Lee[3], Fabian Rotermund[3], Uwe Griebner[1], Valentin Petrov[1]; [1]Max Born Inst., Germany; [2]Dipartimento di Fisica dell'Universita` di Pisa, Italy; [3]Ajou Univ., Republic of Korea.* Stable and self-starting mode-locking of a Tm:$LiYF_4$ laser using a single-walled carbon nanotubes based saturable absorber is demonstrated. Pulses as short as 19 ps are generated at a wavelength of ~1888 nm.

CMY6 • 17:00
Laser Pulse Energy Control using a High Speed Digital Feedback Controller, *Cobus Jacobs[1,2], Christoph Bollig[1], Thomas Jones[2]; [1]National Laser Centre, CSIR, South Africa; [2]Department of Electrical and Electronic Engineering, Stellenbosch Univ., South Africa.* We present a novel electronic feedback scheme which allows laser pulse energy control and stabilization by using a custom high speed FPGA digital controller. This scheme was tested on a high-energy fiber-laser-pumped Ho:YLF ring laser.

CMY7 • 17:15
Polarization switching in the 2-μm Tm:KLu$(WO_2)_4$ laser, *Martha Segura[1], Xavier Mateos[1], Maria Cinta Pujol[1], Joan Josep Carvajal[1], Magdalena Aguiló[1], Francesc Díaz[1], Martin Kadankov[2], Valentin Petrov[3], Uwe Griebner[3]; [1]Univ. Rovira i Virgili, Spain; [2]Sofia Univ., Bulgaria; [3]Max-Born Inst., Germany.* We report on polarization switching in the Tm:KLu$(WO_4)_2$ laser between the Nm and Np states oscillating at different wavelengths. This switching strongly depends on the thermal management of the active medium.

CMZ • Fiber Devices—Continued

CMZ5 • 16:45
The 4FAD: a high-extinction-ratio, achromatic, temperature-insensitive, high-damage-threshold, all-fiber, power-selective filter, *Jeffrey P. Koplow[1], Daniel B. Soh[1]; [1]Remote Sensing and Energetic Materials, Sandia National Laboratories, USA.* We disclose a novel, power-selective, low-insertion-loss, all-fiber device, based on the interaction of self-/cross-phase modulation in a segmented, birefringent waveguide. The 4FAD provides new functionality of great value for pulsed laser systems.

CMAA • Nonlinear Optics in Waveguides and Nanostructures—Continued

CMAA5 • 16:45
Waveguide Saturable Absorbers in Chalcognide Glass Fabricated by Ultrafast Lasers, *Tong Chen[1], Ben McMillen[1], Botao Zhang[1], Qingqing Wang[1], Kevin Chen[1], Yuankun Lin[2]; [1]Dept. of Electrical and Computer Engineering, Univ. of Pittsburgh, USA; [2]Dept. of Physics, Univ. of North Texas, USA.* We report a waveguide gap structure for nonlinear coupling, written in chalcognide glass with an ultrafast laser. The coupling efficiency between two waveguides is enhanced by the self focusing of shorter and stronger input pulse.

CMAA6 • 17:00
Generation of Four Wave Mixing in Graphene and Carbon Nanotubes Optically Deposited onto Fiber Ferrules, *Bo Xu[1], Amos Martinez[1], Kazuyuki Fuse[1], Shinji Yamashita[1]; [1]The Univ. of Tokyo, Japan.* We compared the third-order nonlinearity of graphene and carbon nanotubes optically deposited onto fiber ferrules using four-wave mixing. Significant idler waves are generated in both samples, and estimated nonlinearities are similarly high.

CMAA7 • 17:15
High-Performance Silicon-Based Multiple Wavelength Source, *Jacob S. Levy[1], Yoshitomo Okawachi[2], Alexander L. Gaeta[2], Michal Lipson[2], Kasturi Saha[1,3]; [1]Electrical and Computer Engineering, Cornell, USA; [2]Applied and Engineering Physics, Cornell Univ., USA; [3]Kavli Inst. at Cornell for Nanoscale Science, Cornell Univ., USA.* We generate a multiple-wavelength source by filtering and modulating individual lines from an on-chip optical parametric oscillator frequency comb. Bit-error-rate and eye-diagram measurements yield performance comparable to a tunable laser source.

17:30–18:00 Break

18:00–20:30 Plenary Session I and CLEO/*Laser Focus World* Innovation Award Presentation, *Rooms III-IV*

Room 327	Room 336	Room 337	Room 338
CLEO: Science & Innovations		**CLEO: QELS-Fundamental Science**	**CLEO: Science & Innovations**

CMBB • High-Repetition-Rate Pulsed Sources—Continued

CMBB2 • 16:45
10 GHz repetition rate passively mode-locked Er-Yb doped fiber laser, *Grzegorz J. Sobon[1], Karol Krzempek[1], Michal P. Nikodem[1,2], Pawel R. Kaczmarek[1], Krzysztof M. Abramski[1]; [1]Department Of Electronics, Wroclaw Univ. Of Technology, Poland; [2]Electrical Engineering Department, Princeton Univ., USA.* We report a passively mode-locked erbium/ytterbium-doped fiber laser with 10 GHz repetition frequency. Sub-ps pulses with average output power of 500 mW were obtained due to harmonic mode-locking based on nonlinear polarization rotation.

CMBB3 • 17:00
A 10 GHz 2.5 ps Regeneratively Mode-Locked Yb Fiber Laser in the 1.1 µm Band, *Kengo Koizumi[1], Masato Yoshida[1], Toshihiko Hirooka[1], Masataka Nakazawa[1]; [1]Research Inst. of Electrical Communication, Tohoku Univ., Japan.* We report a 10 GHz regeneratively and harmonically mode-locked Yb fiber laser capable of dispersion-managed soliton operation at 1.1 µm. A 2.5 ps optical pulse with a timing jitter of 134 fs was successfully generated.

CMBB4 • 17:15
Fiber Fabry-Pérot Laser Mode-Locked by Graphene for the Generation of Supercontinuum with 10GHz Mode Spacing, *Amos Martinez[1], Shinji Yamashita[1]; [1]Electronic Engineering, The Univ. of Tokyo, Japan.* We propose a passively mode-locked fiber laser with 9.67GHz fundamental repetition rate (10mm cavity length) using a graphene saturable absorber. Supercontinuum with 0.08nm mode spacing is generated using this laser and a highly nonlinear fiber.

CMCC • Nanostructures for Photovoltaics—Continued

CMCC5 • 16:45
Enhanced Omnidirectional Photon Coupling via Quasi-Periodic Patterning of Indium-Tin-Oxide for Organic Thin-Film Solar Cells, *Ping-chen Tseng[1], Min-Hsiang Hsu[1], Hsin-Chu Chen[1], Min-An Tsai[2], Pei Chen Yu[1], Hao-chung Kuo[1]; [1]National Chiao-Tung Univ., Taiwan; [2]Department of Electrophysics, National Chiao-Tung Univ., Taiwan.* Enhanced optical coupling with respect to all incident angles via an indium tin oxide quasi-periodic structure (ITO-QPS) for organic thin-film solar cells was demonstrated. The cell efficiency shows 13.8% enhancement after ITO-patterning.

CMCC6 • 17:00
Förster-type nonradiative energy transfer directed from colloidal quantum dots to epitaxial quantum wells for light harvesting applications, *Sedat Nizamoglu[1], Emre Sari[1], Jong-Hyeob Baek[2], In-Hwan Lee[3], Hilmi Volkan Demir[1,4]; [1]Bilkent Univ., Turkey; [2]Korea Photonics Technology Inst., Republic of Korea; [3]Chonbuk National Univ., Republic of Korea; [4]Nanyang Technological Univ., Singapore.* We report on Förster-type nonradiative energy transfer directed from CdSe/ZnS core/shell quantum dots to InGaN/GaN quantum wells with 69.6% efficiency at 1.527 ns-1 rate at room temperature for potential light harvesting and solar cells applications.

CMCC7 • 17:15
Near-omni-directional sub-micron Silica light-trapping monolayer for amorphous Si photovoltaic devices, *Wen-Hsien Huang[1,3], Jia-Min Shieh[1,2], Chang-Hong Shen[1], Jung Y. Huang[2], Hao-chung Kuo[2], Fu-Ming Pan[3], Chih-Wei Hsu[2], Bau-Tong Dai[1], Ching-Ting Lee[4], Ci-Ling Pan[5], Fu-Liang Yang[1]; [1]National Applied Research Laboratories-National Nano Device Laboratories, Taiwan; [2]Inst. of Electro-Optical Engineering, National Chiao Tung Univ., Taiwan; [3]Department of Materials Science and Engineerin, National Chiao Tung Univ., Taiwan; [4]Department of Electrical Engineering, National Cheng Kung Univ., Taiwan; [5]Department of Physics, National Tsing Hua Univ., Taiwan.* The non-closely packed sub-micron silica sphere light-trapping monolayer was introduced to boost photocurrent (efficiency) of thin film amorphous solar cells by 15% (6.9%). The enhancement is nearly omni-directional.

QMK • Quantum Control in Solid-State Systems—Continued

QMK4 • 16:45
Intensity dependence of optically-induced injection currents in semiconductor quantum wells, *Michal Pochwala[1], Huynh Thanh Duc[1], Jens Förstner[1], Torsten Meier[1]; [1]Department of Physics and CeoOPP, Univ. of Paderborn, Germany.* The intensity dependence of optically-induced injection currents in semiconductor quantum wells is investigated numerically. Oscillatory behavior of the electron charge current transients as function of intensity and time is predicted and explained.

QMK5 • 17:00
Optical lattices for electrons in semiconductors, *Carlo Piermarocchi[1], Michael G. Moore[1], Martin J. Schuetz[1]; [1]Michigan State Univ., USA.* We theoretically investigate the trapping of electrons in a semiconductor using counter-propagating laser beams. The presence of trion resonances leads to efficient electron trapping. Comparison to atoms and feasibility of the scheme are discussed.

QMK6 • 17:15
Two pulse control of magnetization precession in ferrimagnetic GdFe films under low-power excitation, *Kazuhiro Nishibayashi[1], Yusuke Hashimoto[2], Kiyoshi Kuga[2], Hiro Munekata[1]; [1]Tokyo Inst. of Technology, Japan; [2]Science and Technical Research Laboratories, Japan Broadcasting Corporation, Japan.* We demonstrated two pulse control of magnetization precession of GdFe films using low-power pulse of 18 µJ/cm^2. Our result suggests that the accurate control of magnetization precession should be achieved only by the low-power excitation.

CMDD • Optofluidic Cell, Particle and Fluid Manipulation—Continued

CMDD4 • 16:45
Novel Electrode Shape to Reduce Heating in Light-Actuated Digital Microfluidics, *Shao Ning Pei[1], Justin Valley[1], Hsan-Yin Hsu[1], Arash Jamshidi[1], Ming Wu[1]; [1]Electrical Engineering and Computer Sciences, Univ. of California at Berkeley, USA.* A novel, ring-shaped optical electrode is employed to reduce heating in light-actuated digital microfluidics. Using thermo-sensitive hydrogel microspheres, the temperature rise is measured to be 0.35°C, 15x lower than those using square electrodes.

CMDD5 • 17:00
All-optical particle trap using two orthogonally intersecting beams, *Holger Schmidt[1], Aaron R. Hawkins[2]; [1]Univ. of California at Santa Cruz, USA; [2]Brigham Young Univ., USA.* We introduce a novel optical particle trap using two orthogonally intersecting beams. The trapping principle is described and an optofluidic implementation using liquid-core waveguides is discussed.

CMDD6 • 17:15
Optofluidically reconfigurable channel based microfluidics, *Mekala Krishnan[1], David Erickson[1]; [1]Sibley School of Mechanical and Aerospace Engineering, Cornell Univ., USA.* Here we demonstrate the use of optofluidics to create rapidly reconfigurable channel based microfluidic systems, implemented through reversible rheological changes in a polymer solution flowing within the microfluidic device and dynamic photomasking.

17:30–18:00 Break

18:00–20:30 Plenary Session I and CLEO/*Laser Focus World* Innovation Award Presentation, *Rooms III-IV*

CLEO: Science & Innovations

CLEO: Applications & Technology

CMEE • Novel Nanofabrication Concepts—Continued

CMEE5 • 16:45
Micro-pixellated Blue/Brown Color Changing Surface using Magnetically Actuated Nanocomposite Actuators, *Jiyun Kim[1], Howon Lee[1], Sunghoon Kwon[1]; [1]Electrical Enginering, Seoul National Univ., Republic of Korea.* We propose a new magnetically tunable color changing surface composed of magnetic nanocomposite actuators and its operation method. This technique offers very simple fabrication and operoation of color changing surface with high resolution.

CMEE6 • 17:00
Growths of InGaN-Based Light-Emitting Diodes with AlInN Thin Barrier for Efficiency Droop Suppression, *Guangyu Liu[1], Hongping Zhao[1], Jing Zhang[1], Nelson Tansu[1]; [1]Department of Electrical and Computer Engineering, Lehigh Univ., USA.* The growths of InGaN quantum wells light-emitting diodes with AlInN thin barrier were performed by metal-organic chemical vapor deposition, and this approach led to reduction in thermionic carrier escape and efficiency droop.

CMEE7 • 17:15
Digital Planar Holograms fabricated by Step and Repeat UV nanoimprint lithography: from spectrometer chip to higher power laser diodes, *Christophe Peroz[1], Scott Dhuey[2], Alexander Goltsov[3], Bruce Harteneck[2], Igor Ivonin[3], Vladimir Svetikov[3], Sergey Babin[1], Stefano Cabrini[2], Vladimir Yankov[3]; [1]aBeam Technologies, USA; [2]The Molecular Foundry, USA; [3]Nano Optic Devices, USA.* The fabrication of digital planar holograms by Step and Repeat UV nanoimprint lithography is reported. It opens a route for commercial development of new nanophotonic devices based on digital planar holography.

CMFF • THz Technology—Continued

CMFF4 • 16:45
Compact and Portable Terahertz Source by Mixing Two Frequencies Generated Simultaneously by Single Solid-State Laser, *Pu Zhao[1], Srinivasa Ragam[1], Yujie J. Ding[1], Ioulia B. Zotova[2]; [1]Electrical & Computer Engineering, Lehigh Univ., USA; [2]ArkLight, USA.* By mixing two frequencies generated from a single Q-switched Nd:YLF laser in a GaSe crystal, an average terahertz output power reaches 1 μW within a bandwidth of 65 GHz at 1.64 THz.

CMFF5 • 17:00
Electro-optical THz phase control, *Cezary Sydlo[1], Michael Feiginov[1], Thorsten Goebel[2], Daniel Schoenherr[1], Peter Meissner[1], Hans Ludwig Hartnagel[1]; [1]TU Darmstadt, Germany; [2]Heinrich-Hertz-Institut, Germany.* An optical phase modulator is employed in a THz photomixing system rendering any mechanical delay stages unnecessary. Measurement times and noise floors are significantly reduced.

CMFF6 • 17:15
Absolute frequency measurement of a THz quantum cascade laser using a dual fs-fiber laser comb technique, *Marco Ravaro[1], Pierre Gellie[1], Cristophe Manquest[1], Carlo Sirtori[1], Stefano Barbieri[1], Giorgio Santarelli[2], Suraj P. Khanna[3], Edmund H. Linfield[3], Giles A. Davies[3]; [1]Laboratoire MPQ, UMR 7162, CNRS, Université Paris Diderot, France; [2]LNE-SYRTE, CNRS, UPMC, Observatoire de Paris, France; [3]School of Electronic and Electrical Engineering, Univ. of Leeds, UK.* Electro-optic sampling in ZnTe is used to phase-lock the line of a 2.5 THz quantum cascade laser to the repetition rate of a femtosecond fibre laser and to perform an absolute measurement of the laser emission frequency.

AMF • Medical Applications of Fluorescence—Continued

AMF3 • 16:45
Near Infrared Scanning Imaging of Cancerous and Normal Prostate Tissues Enhanced by a Receptor-targeted Contrast Agent (Cytate) and Independent Component Analysis, *Yang Pu[1]; [1]Physics, City College of New York, USA.* Cytate, a receptor-targeted contrast agent and independent component analysis (ICA) was used to enhance the contrast between a pair of stained small pieces of cancerous and normal prostate tissues embedded in large piece normal tissue.

AMF4 • 17:00
Wide-field Lensless Fluorescent Imaging of Transgenic *Caenorhabditis Elegans* On a Chip, *Ahmet F. Coskun[1], Ikbal Sencan[1], Ting-Wei Su[1], Aydogan Ozcan[1,2]; [1]Electrical Engineering, Univ. of California at Los Angeles (UCLA), USA; [2]California NanoSystems Inst., Univ. of California at Los Angeles(UCLA), USA.* We demonstrate lensless on-chip fluorescent imaging of transgenic *C.Elegans* over >2-8 cm^2 field-of-view with a resolution of ~10 μm. This is the first time that a lensless on-chip platform has successfully imaged transgenic *C.elegans* samples.

AMF5 • 17:15
Application of Photonic Crystal Enhanced Fluorescence to Antibody Microarrays, *Cheng-Sheng Huang[1], Sherine George[1], Meng Lu[1,3], Vikram Chaudhery[1], Ruimin Tan[2], Richard C. Zangar[2], Brian T. Cunningham[1,3]; [1]Univ. of Illinois at Urbana-Champaign, USA; [2]Biological Sciences, Pacific Northwest National Lab, USA; [3]SRU Biosystems Inc., USA.* A photonic crystal surface is utilized for detection of cancer biomarkers in a fluorescent-tagged protein microarray assay. The results indicate that the detection limit of assays are reduced by up to 90% through resonant illumination.

17:30–18:00 Break

18:00–20:30 Plenary Session I and CLEO/*Laser Focus World* Innovation Award Presentation, *Rooms III-IV*