7:00 a.m.–5:00 p.m. Registration Open, *San Jose McEnery Convention Center, Concourse Level*

8:00 a.m.–9:45 a.m. CMA • Ultrafast Dynamics and Measurements

Zhiwen Liu; Pennsylvania State Univ., USA, Presider

CMA1 • 8:00 a.m.
Sub-50 fs Time-Domain Spectroscopy Using High-Speed ASOPS, *Raphael Gebs*, *Gregor Klatt, Christof Janke, Thomas Dekorsy, Albrecht Bartels; Univ. of Konstanz, Germany.* We present an ultrafast time-domain spectrometer based on high-speed asynchronous optical sampling. A time resolution of 45-fs is obtained at kilohertz scan rates over a 1 ns time-delay window without mechanical moving parts.

CMA2 • 8:15 a.m.
Silicon Waveguide Based 320 Gbit/s Optical Sampling, *Hua Ji*[1], *Michael Galili[1], Minhao Pu[1], Liu Liu[1], Leif Katsuo Oxenløwe[1], Palle Jeppesen[1], Torben Veng[2], Lars Grüner-Nielsen[2]; [1] Dept. of Photonics Engineering, DTU Fotonik, Denmark, [2]D and E Dept.,OFS Denmark, Denmark.* A silicon waveguide-based ultra-fast optical sampling system is successfully demonstrated using a free-running fiber laser with a carbon nanotube-based mode-locker as the sampling source. A clear eye-diagram of a 320 Gbit/s data signal is obtained.

CMA3 • 8:30 a.m.
Time-Domain Optical Response Function Reconstruction of an Individual Plasmonic Nanostructure, *Xiaoji G. Xu*[1], *Kseniya S. Derykx[1], Alexandria Anderson[1], Günter Steinmeyer[2], Markus B. Raschke[1]; [1]Univ. of Washington, USA, [2]Max-Born-Inst., Germany.* The precise characterization of ultrafast electronic responses in metallic nanostructures are achieved using a combination of spectrogram measurement of collinear interferometric second-harmonic scattering and treatment of Frequency Resolved Optical Gating (FROG).

8:00 a.m.–9:45 a.m. CMB • CLEO Symposium on Photonics for Advanced Energy Technology: "Green" Photonic Sources and Networks

S. J. Ben Yoo; Univ. of California at Davis, USA, Presider

CMB1 • 8:00 a.m. Invited
Recent Progress in High Efficiency InGaN LEDs, *Matthias Peter*, *Karl Engl, Frank Baumann, Ralph Wirth, Ansgar Laubsch, Johannes Baur, Berthold Hahn; OSRAM Opto Semiconductors GmbH, Germany.* InGaN high-brightness LEDs are penetrating many lighting applications. However, the LED efficiency depends significantly on current density, emission wavelength and junction temperature. Therefore a careful LED design is needed to obtain best application performance.

CMB2 • 8:30 a.m.
Growth Evolution and Time-Resolved Photoluminescence Studies of III-Nitride Light-Emitting Diodes Grown by Abbreviated Growth Mode on Patterned AGOG Substrate, *Yik-Khoon Ee*, *Xiao-Hang Li, Jeff Biser, Wanjun Cao, Helen M. Chan, Richard P. Vinci, Nelson Tansu; Lehigh Univ., USA.* Abbreviated growth mode of InGaN-based light-emitting diodes on nano-patterned sapphire leads to reduction in dislocation density and non-radiative recombination rate, and 37% increase in internal quantum efficiency.

8:00 a.m.–9:45 a.m. CMC • Novel Pulse Fiber Sources

Ingmar Hartl; IMRA America, Inc., USA, Presider

CMC1 • 8:00 a.m.
Linearly Polarized, 135-nm Bandwidth Pulse Generation in an Erbium-Doped Fiber Ring Laser, *Luis Alonso Vazquez-Zuniga*[1], *Hoon Jeong[2], Yoonchan Jeong[1]; [1]Optoelectronics Res. Ctr., Univ. of Southampton, UK, [2]Korea Inst. of Industrial Technology, Republic of Korea.* We present a linearly-polarized erbium-doped fiber laser generating 135-nm bandwidth pico-second pulses with excellent temporal and spectral stability. The pulse energy and width are readily reconfigurable via controlling the internal polarization state and pumping power.

CMC2 • 8:15 a.m.
Pulse-Shape Selection of an Ultra-High Repetition Rate Wavelength and Repetition Rate Tunable Mode-locked Laser: From Bright to Dark Pulses, *Jochen B. Schroeder*[1], *Stephane Coen[2], Thibaut Sylvestre[3], Benjamin J. Eggleton[1]; [1]CUDOS, Univ. of Sydney, Australia, [2]Physics Dept., Univ. of Aukland, New Zealand, [3]Dept. d'Optique, Univ. de Franche-Comté, France.* We control the output pulse-shape of a wavelength and repetition rate tunable passively mode-locked laser with a wavelength selective switch (WSS) inside the cavity. We observe a periodic variation between bright and dark pulses.

CMC3 • 8:30 a.m.
Picosecond Sliding Frequency Mode-Locked Fiber Laser, *Carlo Amadeo Alonzo*, *Seok Hyun Yun; Harvard Medical School and Wellman Ctr. for Photomedicine, Massachusetts General Hospital, USA.* We demonstrate an Er^{3+}-doped fiber laser with a broad bandwidth (2.6 nm) intracavity filter that produces 10-ps pulses at 38-MHz repetition. Pulse center-wavelengths sweep at 1.6-pm intervals over a 60-nm range about 1542 nm.

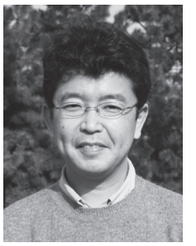
8:00 a.m.–9:45 a.m. CMD • Lattice Clocks and EUV Generation

Christopher W. Oates; NIST, USA, Presider

CMD1 • 8:00 a.m.
High-Intensity Bessel-Gauss Beam Enhancement Cavities, *William P. Putnam*, *Gilberto Abram, Edilson L. Falcão-Filho, Jonathan R. Birge, Franz X. Kärtner; MIT, USA.* An enhancement cavity design with significant intensity gain from the mirror surfaces to the focus and larger than millimeter sized apertures in the cavity mirrors is presented. A continuous-wave version of the cavity is demonstrated.

CMD2 • 8:15 a.m.
Low Noise EUV Generation via a Femtosecond Enhancement Cavity, *Arthur K. Mills*, *T.J. Hammond, Rob Stead, David J. Jones; Univ. of British Columbia, Canada.* Using a femtosecond enhancement cavity in combination with high harmonic generation, we generate EUV radiation out to 61 nm at high (50 MHz) repetition rates with extremely low amplitude noise.

CMD3 • 8:30 a.m. Tutorial
Optical Lattice Clocks toward 10-17 Uncertainty, *Hidetoshi Katori*; *Univ. of Tokyo, Japan.* The concept and recent progress of optical lattice clocks are reviewed. With the clock uncertainty of 10^{-17} in perspective, we discuss new challenges and possible applications of such highly accurate and stable atomic clocks.



Hidetoshi Katori is an Associate Professor in the Graduate School of Engineering at the University of Tokyo, Japan. He has been working in the field of laser cooling of atoms, atom optics, and development of novel atomic clocks, namely, an "optical lattice clock".

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

7:00 a.m.–5:00 p.m. Registration Open, *San Jose McEnery Convention Center, Concourse Level*

8:00 a.m.–9:45 a.m. QMA • Novel Phenomena I

Demetrios Christodoulides; CREOL, College of Optics and Photonics, Univ. of Central Florida, USA, Presider

QMA1 • 8:00 a.m.
Breaking of Dirac Dynamics Due to Nonlinear Interactions, *Omri Bahat-Treidel,* *Or Peleg, Mordechai Segev; Technion - Israel Inst. of Technology, Israel.* We study nonlinear dynamics of electromagnetic waves in honeycomb photonic lattices, and find that nonlinearity breaks the effective Dirac equation. Furthermore, we show that the nonlinearity cannot be described simply by the nonlinear Dirac equation.

QMA2 • 8:15 a.m.
Gaussian Beam and Solar Power Conversion Using Magneto-Electric Charge Separation, *William M. Fisher,* *Stephen C. Rand; Univ. of Michigan, USA.* This detailed proposal exploits optically-induced charge separation for solar power conversion in transparent dielectrics. The core process, though nonlinear, is both efficient and robust against phase and polarization disruptions of the driving field.

QMA3 • 8:30 a.m.
Optical Linear Bullets with Hydrogen-Like Symmetries, *Georgios A. Siviloglou*[1], *Nikolaos K. Efremidis*[2], *Pavel Polynkin*[3], *Jerome V. Moloney*[3], *Demetrios N. Christodoulides*[1]; [1]*CREOL, College of Optics and Photonics, Univ. of Central Florida, USA,* [2]*Dept. of Applied Mathematics, Univ. of Crete, Greece,* [3]*College of Optical Sciences, Univ. of Arizona, USA.* We introduce a new class of propagation invariant spatiotemporal wavepackets. The evolution of these light orbitals is here considered theoretically. Archimedean photonic lattices can be generated through the concept of *spherical superposition* of optical wavefronts.

8:00 a.m.–9:45 a.m. CME • VCSEL I

Connie Chang-Hasnain; Univ. of California at Berkeley, USA, Presider

CME1 • 8:00 a.m. Invited
Recent Progress on High-Speed and Tunable VCSELs in the 1.3 to 2.6μm Wavelength Range, *Markus Amann;* *Walter Schottky Inst., Technische Univ. München, Germany.* Recent developments on InP- and GaSb-based high-speed and tunable singlemode VCSELs in the 1.3-2.6 μm wavelength range are presented. The relevant laser parameters are discussed and several applications in communications and trace-gas-sensing are illustrated.

CME2 • 8:30 a.m.
850 nm VCSELs for up to 40 Gbit/s Short Reach Data Links, *J. A. Lott*[1], *N. N. Ledentsov*[1], *V. A. Shchukin*[1], *S. A. Blokhin*[2,3], *A. Mutig*[2], *G. Fiol*[2], *A. M. Nadtochiy*[2,3], *D. Bimberg*[2]; [1]*VI Systems GmbH, Germany,* [2]*Technische Univ. Berlin, Germany,* [3]*A. F. Ioffe Physical Technical Inst., Russian Acad. of Sciences, Russian Federation.* We report highly linear oxide-confined 850nm-range VCSEL chips and fiber-coupled subassemblies operating up to 40 Gbit/s at < 10kA/cm² with a rise-time of < 10 ps at up to 100°C.

8:00 a.m.–9:45 a.m. QMB • Plasmonic Devices

Michelle L. Povinelli; Univ. of Southern California, USA, Presider

QMB1 • 8:00 a.m. Tutorial
New Concepts in Nanoplasmonics, *Stefan Maier;* *Imperial College London, UK.* The field of plasmonics is currently at the exciting stage of a move from passive structures to hybrid assemblies with active functions. This tutorial will provide an overview of current trends in this development.

Stefan Maier is Professor of Nanophotonics in the Physics Department of Imperial College London. He is also a co-director of the College's new Centre for Photonics and Metamaterials. His main research interests lie in plasmonics and metamaterials.

7:00 a.m.–5:00 p.m. Registration Open, *San Jose McEnery Convention Center, Concourse Level*

8:00 a.m.–9:45 a.m. CMF • THz Detection

Jerry Chen; MIT Lincoln Lab, USA, Presider

CMF1 • 8:00 a.m.
Superconducting Microbolometer with Microsecond Time Constant Coupled to Quantum Cascade Lasers, *Sara Cibella*[1], *Michele Ortolani[1], Roberto Leoni[1], Guido Torrioli[1], Alessandro Tredicucci[2], L. Mahler[2], Ji-Hua Xu[2], H. E. Beere[3], D. A. Ritchie[3]; [1]Inst. di Fotonica e Nanotecnologie del CNR, Italy, [2]NEST, CNR-INFM and Scuola Normale Superiore, Italy, [3]Cavendish Lab, Univ. of Cambridge, UK.* A superconducting bolometer with an on-chip lithographic terahertz antenna has been illuminated by two quantum cascade lasers operating at 2.5 and 4.4 THz to be used for wide dynamic range Terahertz imaging applications.

CMF2 • 8:15 a.m.
Coherent Electro-Optical Detection of Nanosecond THz Pulses from a Parametric Oscillator, *Fanzhen Meng*[1], *Mark D. Thomson[1], Daniel Molter[2], Torsten Löffler[1], René Beigang[2], Hartmut G. Roskos[1]; [1] Physikalisches Inst., Johann Wolfgang Goethe-Univ., Germany, [2] Dept. of Terahertz Measurement and Systems, Fraunhofer Inst. for Physical Measurement Techniques IPM, Germany.* We successfully realized electro-optical detection of nanosecond THz pulses based on a THz optical parametric oscillator. A maximum dynamic range of ~30 dB/sqrt(Hz) is achieved in the electro-optical measurements.

CMF3 • 8:30 a.m. Invited
Single-Photon Detection in THz and Its Application, *Susumu Komiyama;* *Univ. of Tokyo, Japan.* Photon-counting semiconductor photo-detectors, in a wavelength range from the long-wavelength infrared through sub-millimetr waves, are described, along with several applications in the photonjcounting imaging and in superr-wavelength near field microscopy.

8:00 a.m.–9:45 a.m. CMG • Quasi Phasematching Materials

Yushi Kaneda; Univ. of Arizona, USA, Presider

CMG1 • 8:00 a.m. Invited
QPM Wavelength Conversion Using Engineered $LiNbO_3$ Waveguides, *M. Asobe,* *T. Umeki, O. Tadanaga, H. B. Song, I. Tomita, K. Magari; NTT Photonics Labs, NTT Corp., Japan.* New waveguide technologies, namely direct bonding and dry etching, have improved damage resistance, transparent wavelength range, efficiency, and functionality. An engineered QPM structure enables variable wavelength conversion and reduces waveband crosstalk.

CMG2 • 8:30 a.m.
Efficient Lithium Niobate Waveguide for Wide-Dynamic-Range Wavelength Conversion, *Kiyofumi Kikuchi*[1,2], *Sunao Kurimura[1,2], Rai Kou[1,2], Akihiro Terasaki[1,2], Hirochika Nakajima[2], Katsutoshi Kondou[3], Junichiro Ichikawa[3]; [1]Natl. Inst. for Materials Science, Japan, [2]Waseda Univ., Japan, [3]Sumitomo Osaka Cement Co., Ltd., Japan.* We report an accurate measurement of $\chi^{(2)}$ nonlinear optical effects and wide wavelength-conversion dynamic range of 50 dB in lithium niobate waveguide. Linear responses of DF power to pump and signal light are also obtained.

8:00 a.m.–9:45 a.m. CMH • Laser Surface Structuring

Carmen N. Afonso; Laser Processing Group, Inst. de Optica, CSIC, Spain, Presider

CMH1 • 8:00 a.m.
Label-Free Detection in a Lab-on-a-Chip with a Three-Dimensional Mach-Zehnder Interferometer, *Andrea Crespi*[1], *Yu Gu[2], Bongkot Ngamsom[3], Chaitanya Dongre[4], Hugo Hoekstra[4], Hans van den Vlekkert[5], Paul Watts[3], Markus Pollnau[4], Giulio Cerullo[1], Roberto Osellame[1]; [1]IFN-CNR, Dept. di Fisica, Politecnico di Milano, Italy, [2]MIT, USA, [3]Dept. of Chemistry, Univ. of Hull, UK, [4]Integrated Optical MicroSystems, MESA+ Inst. for Nanotechnology, Univ. of Twente, Netherlands, [5]LioniX BV, Netherlands.* A Mach-Zehnder refractive index sensor is inscribed in a microfluidic lab-on-a-chip by exploiting the unique three-dimensional capabilities of femtosecond laser fabrication. This enables high sensitivity and spatially resolved label-free detection of biomolecules.

CMH2 • 8:15 a.m.
100-nm Internal Gain Bandwidth in Er:Yb-Doped Phospho-Tellurite Waveguides Written by Femtosecond Laser, *Shane M. Eaton*[1], *Toney Fernandez[2], Giuseppe Della Valle[2], Mehrdad Irannejad[3], Gin Jose[3], Animesh Jha[3], Giulio Cerullo[2], Paolo Laporta[2], Roberto Osellame[1]; [1]Inst. for Photonics and Nanotechnologies, INF-CNR, Italy, [2]Dept. di Fisica, Politecnico di Milano, Italy, [3]Inst. for Materials Res., Univ. of Leeds, UK.* Waveguides were femtosecond laser-written in Er:Yb-doped phospho-tellurite glass yielding internal gain across an unprecedented 100-nm bandwidth covering the whole C+L communications bands. The waveguide modes were highly confined, showing promise for improved photonic integration.

CMH3 • 8:30 a.m.
Resonant Infrared Pulsed Laser Ablation of Polymers with Single Picosecond Pulses Generated by an Optical Parametric Amplifier, *Malte Duering[1], Richard Haglund[2],* ***Barry Luther-Davies****[1]; [1]Laser Physics Ctr., Res. School of Physical Sciences and Engineering, Australian Natl. Univ., Australia, [2]Vanderbilt Univ., USA.* We have used a mid-IR optical parametric amplifier for single pulse ablation of polystyrene via resonant infra-red pulsed laser ablation. We investigate the morphology of the ablated region, the ablation threshold and its wavelength dependence.

8:00 a.m.–9:45 a.m. JMA • Joint CLEO/QELS Symposium on Optomechanics for Physical and Biological Sciences I: Physics

Tobias J. Kippenberg; Max-Planck-Inst. fur Quantenoptik, Germany, Presider

JMA1 • 8:00 a.m. Invited
Nonequilibrium Quantum Dynamics in Optomechanical Systems, *Florian Marquardt;* *Ludwig-Maximilians-Univ. Munich, Germany.* We discuss the dynamics of optical modes coupled to vibrating nanostructures. Examples include the shuttling of photons in a cavity containing a vibrating membrane, and a single atom coupled to a membrane via the cavity.

JMA2 • 8:30 a.m. Invited
Feasability of Measuring Radiation Pressure Quantum Back-Action in Zipper Photonic Crystal Optomechanical Cavities, *Jeffrey T. Hill,* *Ryan Camacho, Alexander G. Krause, Oskar J. Painter; Caltech, USA.* We design, fabricate and measure high-Q mechanical modes (~ 10^5) of optomechanical zipper cavities, as a first step to observing quantum back-action in an optomechanical system.

7:00 a.m.–5:00 p.m. Registration Open, *San Jose McEnery Convention Center, Concourse Level*

8:00 a.m.–9:45 a.m. AMA • Imaging and Restoring the Eye

Brian E. Applegate; Texas A&M Univ., USA, Presider

AMA1 • 8:00 a.m.
Imaging of Corneal Incisions by Second- and Third-Harmonic Generation Microscopy, ***Louis Jay****[1], Carolyne Djon[1], Arnaud Brocas[2], Kanwarpal Singh[1], Jean-Claude Kieffer[1], Isabelle Brunette[3], Tsuneyuki Ozaki[1]; [1]INRS, Canada, [2]Lab Laser, Plasmas et Procédés Photoniques, France, [3]Maisonneuve-Rosemont Hospital Res. Ctr., Canada.* Second and third harmonic imaging were investigated to observe a corneal flap created by an ophthalmic knife or a microkeratome as it can be processed during a LASIK surgery.

AMA2 • 8:15 a.m.
Post-Surgical Volumetric Evaluation of Clear Corneal Incision Quality Using a High-Resolution 3-D Spectral-Domain Optical Coherence Tomography, ***Kang Zhang****[1,2], Esen Akpek[3], Richard P. Weiblinger[2], Do-Hyun Kim[2], Jin U. Kang[1], Ilko K. Ilev[2]; [1]Johns Hopkins Univ., USA, [2]U.S. Food and Drug Administration, USA, [3]Johns Hopkins Hospital, USA.* A novel approach for post-surgical volumetric evaluation of the quality of corneal incisions and wound healing is presented. It is based on high-resolution 3-D spectral-domain optical coherence tomography providing both multiple-cross-sectional and volumetric images.

AMA3 • 8:30 a.m. Invited
Retinal Prosthesis - Restoring Vision to the Blind, ***Robert Greenberg****; Second Sight Medical Products, Inc., USA.* Abstract not available.

8:00 a.m.–9:45 a.m. CMI • Passive and Active Resonators

Zheng Wang; MIT, USA, Presider

CMI1 • 8:00 a.m.
Linewidth Narrowing and Purcell Enhancement in Photonic Crystal Cavities on an Er-Doped Silicon Nitride Platform, ***Yiyang Gong****[1], Maria Makarova[1], Selcuk Yerci[2], Rui Li[2], Luca Dal Negro[2], Jelena Vuckovic[1]; [1]Stanford Univ., USA, [2]Boston Univ., USA.* Light emission from Er-doped amorphous silicon nitride coupled to photonic crystal resonators is studied. The results demonstrate Purcell enhanced Er absorption and linewidth narrowing of the cavity resonance with increasing pump power.

CMI2 • 8:15 a.m.
Self-Pulsing in On-Chip Er-Doped Microcavity Lasers, ***Lina He****, Sahin Kaya Ozdemir, Jiangang Zhu, Lan Yang; Washington Univ. in St. Louis, USA.* We characterize self-pulsing in erbium-doped microtoroidal lasers fabricated from sol-gel silica layer deposited on a silicon wafer. Effects of pump and taper-cavity coupling on peak power, period and width of laser pulses are investigated experimentally.

CMI3 • 8:30 a.m.
Single-Mode Emission from Si Nanocrystal Embedded Si-Rich SiOx Film with Photonic Crystal Resonant Cavity, ***Yung-Hsiang Lin****[1], Shih-Min Lin[2], Chien-Chieh Lee[3], Chii-Chang Chen[2], Gong-Ru Lin[1]; [1]Graduate Inst. of Electro-Optical Engineering, Natl. Taiwan Univ., Taiwan, [2]Dept. of Optics and Photonics, Natl. Central Univ., Taiwan, [3]Optical Sciences Ctr., Natl. Central Univ., Taiwan.* A photonic crystal resonator incorporated Si-rich SiOx film with buried Si nanocrystals showing room-temperature single-mode emission at 639 nm is demonstrated with spectral linewidth of 1 nm and threshold pumping intensity of 50.3 kW/cm^2.

8:00 a.m.–9:45 a.m. CMJ • Novel Sources and Systems for Spectroscopic Sensing

Sukesh Roy; Spectral Energies, LLC, USA, Presider

CMJ1 • 8:00 a.m. Invited
Supercontinuum Radiation for Optical Sensing, ***Clemens Kaminski****, Johan Hult, Toni Laurila; Univ. of Cambridge, UK.* Supercontinuum radiation offers numerous new possibilities for chemical sensing. This paper discusses novel developments in liquid and gas phase sensing applications as well as for microscopic imaging of biological samples with supercontinuum light.

CMJ2 • 8:30 a.m.
2.4 µm Dual-Comb Spectroscopy, ***Birgitta Bernhardt****[1], Evgeni Sorokin[2], Patrick Jacquet[3], Raphael Thon[3], Thomas Becker[1], Irina T. Sorokina[4], Theodor W. Hänsch[1,5], Nathalie Picqué[1,3]; [1]Max-Planck-Inst. für Quantenoptik, Germany, [2]Inst. für Photonik, Technische Univ. Wien, Austria, [3]Lab de Photophysique Moléculaire, CNRS, France, [4]Norwegian Univ. of Science and Technology, Norway, [5]Ludwig-Maximilians-Univ., Germany.* A proof-of-principle experiment of mid-infrared frequency comb Fourier transform spectroscopy is carried out with two interfering Cr^{2+}:ZnSe femtosecond oscillators, emitting around 2400 nm. Spectra of acetylene are measured within 10 µs with 12 GHz resolution.

CMA • Ultrafast Dynamics and Measurements—Continued

CMA4 • 8:45 a.m.
A Rapid Inspection of Atomic Interference Using Superfluorescent Picosecond Pulses, ***Gombojav O. Ariunbold****, Vladimir Sautenkov, Marlan Scully; Texas A&M Univ., USA.* Producing superfluorescent picosecond pulses in Rb vapor, we report an observation of quantum beat due to D-lines. The delay of the superfluorescent pulses is measured by the streak camera, which exhibits also atomic interference.

CMA5 • 9:00 a.m.
Ultrafast Control of Polariton Stimulated Scattering in Semiconductor Microcavities, ***Gabriel Christmann****[1], Christopher Coulson[1], Jeremy J. Baumberg[1], Nikolaos T. Pelekanos[2], Zacharias Hatzopoulos[2], Simeon I. Tsintzos[2], Pavlos G. Savvidis[2]; [1]Cavendish Laboratory, Univ. of Cambridge, UK, [2]Dept. of Materials Science and Technology, Univ. of Crete, Greece.* We report high-speed electronic control of ultrafast polariton amplification in a semiconductor microcavity. A >90% reduction of the parametric scattering gain is obtained by tuning the intracavity electric field to turn on inter-well resonant tunneling.

CMA6 • 9:15 a.m.
Numerical Investigations on Femtosecond Supercontinuum Generation with Feedback, ***Michael Kues****, Nicoletta Brauckmann, Till Walbaum, Petra Groß, Carsten Fallnich; Inst. of Applied Physics, Westfälische Wilhelms-Univ., Germany.* Femtosecond supercontinuum systems with feedback show nonlinear dynamical behaviors like period multiplication, limit cycle and chaos. By numerical simulations we show that the stability changes and bistabilities occur in the transition regions between different dynamics.

CMA7 • 9:30 a.m.
A 10 GHz Opto-Electronic Oscillator at 1.1 µm Using a Gain-Switched InGaAs VCSEL and a Photonic Crystal Fiber, ***Kengo Koizumi****, Masato Yoshida, Masataka Nakazawa; Res. Inst. of Electrical Communication, Tohoku Univ., Japan.* We report a self-starting opto-electronic oscillator operating at 1.1 µm using a gain-switched VCSEL and a single-mode photonic crystal fiber. A 10-GHz 11.5-ps optical pulse with a timing jitter of 0.9 ps was successfully generated.

CMB • CLEO Symposium on Photonics for Advanced Energy Technology: "Green" Photonic Sources and Networks—Continued

CMB3 • 8:45 a.m.
Reliability and Performance of Pseudomorphic Ultraviolet Light Emitting Diodes on Bulk Aluminum Nitride Substrates, ***James R. Grandusky****, Yongjie Cui, Mark C. Mendrick, Shawn Gibb, Leo J. Schowalter; Crystal IS, USA.* The development of pseudomorphic layers on low dislocation density AlN substrates is leading to improvements in reliability and performance of devices operating in the UVC range.

CMB4 • 9:00 a.m. Invited
Energy Footprint and Opportunities of ICT Networks, ***Loukas Paraschis****; Cisco Systems, USA.* The access network currently dominates energy consumption, which has otherwise been contained benefiting by IC and optical advancements, despite the multi-year > 50% CAGR of traffic. Further network technology, architectural, and application opportunities exist.

CMB5 • 9:30 a.m.
Low-Power CMOS-Driven Transmitters and Receivers, ***Benjamin G. Lee****, Clint L. Schow, Alexander V. Rylyakov, Fuad E. Doany, Richard A. John, Jeffrey A. Kash; IBM Res., USA.* Multimode optical transmitters and receivers are demonstrated with record low power consumptions and at data rates up to 20 Gb/s using 90-nm CMOS analog integrated circuits and GaAs-based VCSELs and photodiodes.

CMC • Novel Pulse Fiber Sources—Continued

CMC4 • 8:45 a.m.
Bidirectional Mode-Locked Fiber Ring Laser Using Passively Controlled Threshold Gating, ***Alexandre Braga****, Jean-Claude Diels, Ravi Jain, Ronald Kay, Li Wang; Univ. of New Mexico, USA.* An innovative technique to achieve bidirectional mode-locking of a fiber ring laser is demonstrated using two amplitude modulators passively driven by a signal regenerated from the laser's own 5.1MHz repetition rate.

CMC5 • 9:00 a.m.
Starting Dynamics in Normal-Dispersion Mode-Locked Fiber Lasers, *Heng Li[1], Dimitre G. Ouzounov[1],* ***Frank W. Wise****[2]; [1]CLASSE, Physics Dept., Cornell Univ., USA, [2]Dept. of Applied Physics, Cornell Univ., USA.* Self-starting of mode-locking in normal-dispersion Yb fiber lasers is studied experimentally and theoretically. Starting can be initiated by quantum noise or relaxation oscillations, and is much faster than in soliton lasers.

CMC6 • 9:15 a.m.
Dual-Pumping Scheme for High-Energy Femtosecond Er-Doped Fiber Laser at 1.6 µm, *Franck Morin, Frédéric Druon,* ***Marc Hanna****, Patrick Georges; Lab Charles Fabry de l'Inst. d'Optique, Univ. Paris-Sud, France.* We present the first microjoule-class sub-picosecond erbium-doped fiber laser at 1600 nm, and demonstrate the generation of 2.2 µJ, 650 fs pulses at 100 kHz. Dual-pumping schemes at 980 and/or 1550 nm are investigated.

CMC7 • 9:30 a.m.
Ultrashort Pulse Generation from cw Beam by Trapped Pulse Amplification in Birefringent Fibers, ***Eiji Shiraki****, Norihiko Nishizawa, Kazuyoshi Itoh; Osaka Univ., Japan.* 248 pJ and 322 fs ultrashort pulse was generated from cw beam using pulse trapping and Raman amplification by ultrashort soliton pulse in birefringent fibers. The physical mechanism and characteristics were also analyzed numerically.

CMD • Lattice Clocks and EUV Generation—Continued

CMD4 • 9:30 a.m.
Yb Optical Lattice Clock at NMIJ, AIST, ***Masami Yasuda****[1,2], Takuya Kohno[2], Kazumoto Hosaka[1,2], Hajime Inaba[1,2], Yoshiaki Nakajima[1,2,3], Feng-Lei Hong[1,2]; [1]AIST, Japan, [2]CREST, JST, Japan, [3]Univ. of Fukui, Japan.* We have developed a one-dimensional optical lattice clock using a fermionic isotope of ^{171}Yb. The absolute frequency of the $^1S_0$-$^3P_0$ clock transition in ^{171}Yb is determined with respect to the SI second.

9:45 a.m.–10:15 a.m. Coffee Break, *San Jose McEnery Convention Center, Concourse Level*

Room A5

QELS

QMA • Novel Phenomena I—Continued

QMA4 • 8:45 a.m.
Anomalous Optical Force Fields around High-Contrast Subwavelength Nanowaveguides, ***Haicui Ren****, Alessandro Salandrino, Georgios A. Siviloglou, Demetrios N. Christodoulides; CREOL/School of Optics, USA.* We show that anomalous-even repulsive-force fields can be induced around high-contrast optical nanowaveguides. Interestingly the longitudinal scattering force attains a maximum value even within regions where the Poynting vector is negative.

QMA5 • 9:00 a.m.
Nonlinearity-Controlled Reshaping and Anomalous Diffraction of Airy Beams, *Yi Hu[1,2], Simon Huang[1], Peng Zhang[1], Jingjun Xu[2],* ***Zhigang Chen****[1,2]; [1]San Francisco State Univ., USA, [2]Nankai Univ., China.* Two-dimensional Airy beams controlled with self-focusing and self-defocusing nonlinearities exhibit unexpected behavior in free-space and scattering media, including stagnation and anomalous diffraction, and resistance to vibration and distortion, solely depending on the initial control.

QMA6 • 9:15 a.m.
Nonconservative Optical Torques, ***David P. Haefner****, Sergey Sukhov, Aristide Dogariu; CREOL and FPCE, College of Optics and Photonics, Univ. of Central Florida, USA.* We demonstrate that mutual electromagnetic interaction induces torques even in lossless spheres. This constitutes a new mechanism to gain energy from an external field, besides radiation pressure and absorption, and is fully controlled by polarization.

QMA7 • 9:30 a.m.
Two-Dimensional Dynamic Localization of Light, ***Alexander Szameit****[1], Ivan L. Garanovich[2], Matthias Heinrich[3], Andrey A. Sukhorukov[2], Felix Dreisow[3], Stefan Nolte[3], Andreas Tünnermann[3], Stefano Longhi[4], Yuri S. Kivshar[2]; [1]Technion - Israel Inst. of Technology, Israel, [2]Nonlinear Physics Ctr., Australian Natl. Univ., Australia, [3]Inst. of Applied Physics, Friedrich-Schiller-Univ., Germany, [4]Dept. di Fisica and Inst. di Fotonica e Nanotecnologie del CNR, Politecnico di Milano, Italy.* We report on the first experimental observation of two-dimensional dynamic localization of light. We demonstrate suppression of beam diffraction in femtosecond laser-written modulated waveguide arrays of hexagonal and zig-zag geometries.

Room A6

CLEO

CME • VCSEL I—Continued

CME3 • 8:45 a.m.
30 Gb/s Direct Modulation of Holey VCSELs with Thermoelectric Cooling, ***Zhaobing Tian****[1], Chen Chen[1], Kent D. Choquette[2], David V. Plant[1]; [1]McGill Univ., Canada, [2]Univ. of Illinois at Urbana-Champaign, USA.* We demonstrate a 25 Gb/s error-free operation of a directly modulated holey VCSEL, and the data rate can be extended to above 30 Gb/s when the VCSEL substrate temperature is stabilized by a thermoelectric cooler.

CME4 • 9:00 a.m.
100°C, 25 Gbit/s Direct Modulation of 1.3-µm Surface Emitting Laser, ***Koichiro Adachi****[1,2], Kazunori Shinoda[1,2], Takashi Shiota[1,2], Toshihiko Fukamachi[1,2], Takeshi Kitatani[1], Yasunobu Matsuoka[1], Daichi Kawamura[1], Toshiki Sugawara[1], Shinji Tsuji[1,2]; [1]Central Res. Lab, Hitachi, Ltd., Japan, [2]Optoelectronic Industry and Technology Development Association, Japan.* The uncooled 25-Gbit/s direct modulation of a 1.3-µm horizontal-cavity surface-emitting laser was demonstrated. A fabricated laser, which is directly mountable on a high-frequency coplanar line, exhibited 25-Gbit/s eye openings up to 100°C.

CME5 • 9:15 a.m.
Low-Parasitics 1.55 µm VCSELs with Modulation Bandwidths beyond 17 GHz, ***Michael Mueller****[1], Werner Hofmann[2], Markus Horn[1], Gerhard Boehm[1], Markus-Christian Amann[1]; [1]Walter Schottky Inst., Technische Univ. München, Germany, [2]Dept. of Electrical Engineering and Computer Science, Univ. of California at Berkeley, USA.* We present 1.55µm BTJ Short-Cavity VCSELs with modulation bandwidths in excess of 17GHz. As shown by impedance measurements and impedance modeling, this excellent performance can be attributed to an improved parasitic roll-off frequency of 23GHz.

CME6 • 9:30 a.m.
Gigahertz Circular Polarization Oscillations in Spin-Polarized Vertical-Cavity Surface-Emitting Lasers, ***Nils C. Gerhardt****[1], Mingyuan Li[1], Hendrik Jaehme[1], Henning Soldat[1], Martin R. Hofmann[1], Thorsten Ackemann[2]; [1]Photonics and Terahertz Technology, Ruhr-Univ. Bochum, Germany, [2]SUPA and Dept. of Physics, Univ. of Strathclyde, UK.* We analyze ultrafast circular polarization oscillations in a commercial vertical-cavity surface-emitting laser after spin injection at room temperature. The circular polarization exhibits faster dynamics than the intensity and longer persistence than the spin relaxation time.

Room A7

QELS

QMB • Plasmonic Devices—Continued

QMB2 • 9:00 a.m.
Color-Selective Quantum Dot Photodetection through Plasmonic Integration, ***Ludan Huang****, Lih Y. Lin; Univ. of Washington, USA.* We propose a color-selective photodetection scheme through integration of Au nanoparticles with CdSe/ZnS quantum dot photodetectors. Preliminary experimental results confirm enhancement of photodetector external quantum efficiency at wavelengths near the plasmonic resonance of Au nanoparticles.

QMB3 • 9:15 a.m.
Plasmonic Sensor Based on Perfect Absorption, ***Na Liu****, Martin Mesch, Thomas Weiss, Harald Giessen; 4th Physics Inst., Univ. of Stuttgart, Germany.* We introduce a novel concept to plasmonic sensing. Specifically, we demonstrate a perfect narrow-band plasmonic absorber, which allows for the extremely sensitive detection of the concentration change of glucose solution at a fixed frequency.

QMB4 • 9:30 a.m.
Optimizing Nano-Patterned Metal Films for Use as Transparent Electrodes in Optoelectronic Devices, ***Peter Catrysse****, Shanhui Fan; Stanford Univ., USA.* We optimize the optical properties of nano-patterned metallic films for use as transparent conductive electrodes in optoelectronic devices by performing a constant-sheet-resistance transformation. Our design principles apply to both one- and two-dimensionally patterned films.

9:45 a.m.–10:15 a.m. Coffee Break, *San Jose McEnery Convention Center, Concourse Level*

Room A8	Room C1&2	Room C3&4	San Jose Ballroom IV (San Jose Marriott)
CLEO			JOINT

CMF • THz Detection—Continued

CMF4 • 9:00 a.m.
High-Order Resonant Modes in an Antenna Coupled Terahertz 2-D Plasmonic Detector, ***Gregory C. Dyer***[1]*, Gregory R. Aizin*[2]*, Eric A. Shaner*[3]*, Michael C. Wanke*[3]*, John L. Reno*[3]*, S. James Allen*[1]*;* [1]*Univ. of California at Santa Barbara, USA,* [2]*CUNY, USA,* [3]*Sandia Natl. Labs, USA.* We demonstrate excitation of terahertz 2-D plasmons in a grating-gated transistor at the vertex of a broadband antenna. This functions as a plasmonic crystal, with modes associated with both the grating period and channel length.

CMF5 • 9:15 a.m.
Sensing by Metal Cylinders Compressing THz Surface Waves, ***Michael Theuer***[1,2]*, Rene Beigang*[2]*, Daniel R. Grischkowsky*[1]*;* [1] *Dept. of Electrical Engineering, Oklahoma State Univ., USA,* [2]*Fraunhofer Inst. for Physical Measurement Techniques IPM, Germany.* Terahertz surface waves propagating on dielectric coated metal sheets are investigated. With respect to sensor applications the interaction of the guided THz-wave and closely approaching coated metallic cylinders is discussed. Unexpected coupling efficiencies are obtained.

CMF6 • 9:30 a.m.
THz Field Detection of the Coherent Synchrotron Radiation Produced by Laser Bunch Slicing, ***Ikufumi Katayama***[1]*, Hiroshi Shimosato*[2]*, Michitaka Bito*[2]*, Kei Furusawa*[2]*, Masahiro Adachi*[3,4]*, Miho Shimada*[5]*, Heishun Zen*[3,4]*, Shin-ichi Kimura*[3,4]*, Naoto Yamamoto*[6]*, Masahito Hosaka*[6]*, Masahiro Katoh*[3,4]*, Masaaki Ashida*[2,7]*;* [1]*Yokohama Natl. Univ., Japan,* [2]*Osaka Univ., Japan,* [3]*Inst. of Molecular Science, Japan,* [4]*Graduate Universities for Advanced Studies, Japan,* [5]*High Energy Accelerator Res. Organization, KEK, Japan,* [6]*Nagoya Univ., Japan,* [7]*PRESTO JST, Japan.* Electric field of coherent synchrotron radiation produced by laser bunch slicing at a storage ring has been measured for the first time. A 24 m-long fiber was used to deliver the probe for electro-optic sampling.

CMG • Quasi Phasematching Materials—Continued

CMG3 • 8:45 a.m.
Grey-Track Resistant Periodically Poled Rb-Doped $KTiOPO_4$ For Blue-Light Generation, *Andrius Zukauskas, Valdas Pasiskevicius, Fredrik Laurell,* ***Carlota Canalias****; Royal Inst. of Technology, Sweden.* We present periodic poling of Rb-doped KTiOPO4. The crystal is used to obtain blue radiation at 398 nm with an efficiency of 30% and a peak intensity of 2 MW/cm2 without grey-tracking.

CMG4 • 9:00 a.m.
Sub-Watts 355 nm Generation with 2nd- and 3rd-Order-QPM PPMgSLT, ***Junji Hirohashi****, Koichi Imai, Hiroshi Motegi, Yasuhiro Tomihari, Tatsuo Fukui, Yasunori Furukawa; OXIDE Corp., Japan.* 0.7 watts 355nm laser is achieved from 3rd-order-QPM PPMgSLT by sum-frequency generation of fundamental and second-harmonic of pulsed Nd: YVO_4 laser. 2nd-order-QPM PPMgSLT is successfully fabricated, which promises 355 nm generation of sub-watts order.

CMG5 • 9:15 a.m.
Opto-Fluidic Characterization of Nonlinear-Optical Waveguide, ***Sunao Kurimura***[1,2]*, Akihiro Terasaki*[1,2]*, Kiyofumi Kikuchi*[1,2]*, Yoshihiro Ogiso*[2]*, Rai Koh*[1,2]*, Hirochika Nakajima*[2]*, Katsutoshi Kondou*[3]*, Junichiro Ichikawa*[3]*;* [1]*Natl. Inst. for Materials Science, Japan,* [2]*Waseda Univ., Japan,* [3]*Sumitomo Osaka Cement Co., Ltd., Japan.* Opto-fluidic technique demonstrated non-destructive characterization of nonlinear optical waveguide by modifying effective index of optical mode. Nonuniformity of phase matching wavelength, degradation factor of NLO performance, is revealed in a waveguide wavelength converter.

CMG6 • 9:30 a.m.
Non-Invasive Study of Domain Boundary in Periodically Poled Ferroelectrics Using Ultrahigh Resolution Optical Coherence Tomography, ***Shan-Chuang Pei***[1]*, Tuan-Shu Ho*[1]*, Chien-Chung Tsai*[1]*, Ting-Hao Chen*[1]*, A.H. Kung*[2,3]*, Sheng-Lung Huang*[1,4]*;* [1]*Inst. of Photonics and Optoelectronics, Natl. Taiwan Univ., Taiwan,* [2]*Inst. of Photonics Technologies, Natl. Tsing Hua Univ., Taiwan,* [3]*Inst. of Atomic and Molecular Sciences, Academia Sinica, Taiwan,* [4]*Dept. of Electrical Engineering, Natl. Taiwan Univ., Taiwan.* Ultrahigh-resolution and polarization-sensitive optical coherence tomography was used to examine the domain boundary of periodically poled lithium niobate (PPLN). A 3-D image of antiparallel domains in PPLN crystal was characterized with a sub-micron axial resolution.

CMH • Laser Surface Structuring—Continued

CMH4 • 8:45 a.m.
Time-Resolved Microscopic Imaging of Laser-Induced Material Modifications in Optical Materials, ***Raluca A. Negres****, Rajesh Raman, Paul DeMange, Stavros G. Demos; Lawrence Livermore Natl. Lab, USA.* We report on time-resolved imaging of material response to localized laser energy deposition in the bulk of optical materials. The key processes include shockwave formation, crack propagation, formation of residual stress fields, and transient absorption.

CMH5 • 9:00 a.m.
Manipulation of Form Birefringence in Isotropic Material, ***Yasuhiko Shimotsuma***[1]*, Masaaki Sakakura*[1]*, Peter G. Kazansky*[2]*, Kiyotaka Miura*[3]*, Kazuyuki Hirao*[3]*;* [1]*Innovative Collaboration Ctr., Kyoto Univ., Japan,* [2]*Optoelectronics Res. Ctr., Univ. of Southampton, UK,* [3]*Dept. of Material Chemistry, Kyoto Univ., Japan.* Form-birefringent nanostructure composed of the self-organized oxygen defects can be created by light pulses with a width of 70 fs. Such rewritable and directionally controllable nanostructures have evolved by lowering threshold for defect formation.

CMH6 • 9:15 a.m.
Polarization Diffraction Grating Produced by Femtosecond Laser Nanostructuring in Glass, ***Martynas Beresna****, Peter G. Kazansky; Optoelectronics Res. Ctr., Univ. of Southampton, UK.* We demonstrate polarization sensitive diffractive optical element fabrication by femtosecond direct writing in the bulk of silica glass. Modulation of the anisotropic properties is produced by controlling photo-induced self-assembled nano-gratings.

CMH7 • 9:30 a.m.
Computer-Generated Holograms Written Directly on a Silicon Surface Including 3-D and Rainbow Effects, ***Kristian J. Waedegaard****, Peter Balling; Aarhus Univ., Denmark.* A femtosecond laser has been used to write computer-generated holograms directly on a silicon surface with a resolution of up to 28 kpixels/mm2. 3-D and rainbow effects in off-axis holograms have been demonstrated.

JMA • Joint CLEO/QELS Symposium on Optomechanics for Physical and Biological Sciences I: Physics—Continued

JMA3 • 9:00 a.m.
Optical Measurement of Nanomechanical Motion with an Imprecision at the Standard Quantum Limit, ***Georg Anetsberger***[1]*, Olivier Arcizet*[1]*, Emanuel Gavartin*[2]*, Quirin P. Unterreithmeier*[3]*, Eva M. Weig*[3]*, Michael L. Gorodetsky*[4]*, Jörg P. Kotthaus*[3]*, Tobias J. Kippenberg*[1,2]*;* [1]*Max-Planck-Inst. of Quantum Optics, Germany,* [2]*École Polytechnique Fédérale de Lausanne, Switzerland,* [3]*Ludwig-Maximilians-Univ., Germany,* [4]*Moscow State Univ., Russian Federation.* Ultra-high Q optical microresonators allow measuring nanomechanical motion with unprecedented sensitivity. For the first time, we reach a measurement imprecision at the standard quantum limit which has been a long sought-after goal for nanomechanical oscillators.

JMA4 • 9:15 a.m.
Tunable Optical Forces and Mode Beating in Coupled Nano-Mechanical Beam Waveguides, ***Wolfram H. P. Pernice****, Mo Li, Kingyan Fong, Hong Tang; Yale Univ., USA.* We analyze the effect of spatial mode beating on optical forces in coupled waveguide resonators. Continuous sign and amplitude change is achieved through optical phase tuning. Competing force components are decomposed via optical mode expansion.

JMA5 • 9:30 a.m.
Efficient On-Chip Phonon-Photon Translation, ***Amir H. Safavi-Naeini****, Thiago P. Mayer Alegre, Oskar J. Painter; Dept. of Applied Physics, Caltech, USA.* We propose, analyze, design, and take the first experimental steps towards the demonstration of an on-chip device capable of converting photons to phonons, and vice versa, in a nearly quantum-limited setting.

9:45 a.m.–10:15 a.m. Coffee Break, *San Jose McEnery Convention Center, Concourse Level*

AMA • Imaging and Restoring the Eye—Continued

AMA4 • 9:00 a.m. Invited
Biomedical Engineering, *Sohi Rastegar, Natl. Science Foundation, USA.* Biophotonics at NSF has been supported through individual investigators, groups, and Centers. In this presentation an overview of active research including those supported by Emerging Frontiers in Research and Innovation (EFRI) will be provided.

AMA5 • 9:30 a.m.
Full-Field Spectral Domain Optical Coherence Tomography with Improved Extended Depth of Focus, *Alex Zlotnik[1], *Yoed Abraham*[1,2], *Lior Lirtz*[2], *Ibrahim Ibraliim Abdulhalim*[2], *Zeev Zalevsky*[2]; [1]*Bar Ilan Univ., Israel,* [2]*Ben-Gurion Univ. of the Negev, Israel.* In full field optical coherence tomography (FFOCT) lateral resolution is achieved by high NA lenses. However, it decreases depth of focus (DOF). We incorporate interfering phase mask allowing to extend the DOF of a FFOCT.

CMI • Passive and Active Resonators—Continued

CMI4 • 8:45 a.m.
High-Q Silica Microsphere by Poly(methyl methacrylate) Coating and Modifying, *Chun-Hua Dong, Fang-Wen Sun, Chang-Ling Zou, Guang-Can Guo, Zheng-Fu Han; Univ. of Science and technology of China, China.* We experimentally characterize the *Q*-factor (>10^8) in silica microsphere by the PMMA coating. The *Q*-factor of microsphere with deposited QDs is increased after the coating which draws the maximal field outside and increases the interaction.

CMI5 • 9:00 a.m.
High-Q Polymeric Microcavities, *Mario Hauser, Tobias Grossmann, Simone Schleede, Julian Fischer, Torsten Beck, Christoph Vannahme, Timo Mappes, Heinz Kalt; Karlsruhe Inst. of Technology, Germany.* We report on the fabrication of high-Q microresonators made of poly(methyl methacrylate) (PMMA) with a conical shape due to a thermal reflow step. The quality factor is above $2x10^6$ in the 1300 nm wavelength range.

CMI6 • 9:15 a.m.
Demonstration of the Optical Microbubble Resonator, *Misha Sumetsky, Yury Dulashko, Robert S. Windeler; OFS Labs, USA.* We create silica microbubbles along a microcapillary with the CO_2 laser heating and demonstrate the first optical microbubble resonator. It has 370 micron diameter, 2 micron wall thickness, and Q-factor exceeding $5{\cdot}10^5$.

CMI7 • 9:30 a.m.
Fabrication of High Q Microdisk Resonators using Thermal Nanoimprint Lithography, *Patrick Schiavone[1,2], *Nicolas Chaix*[3], *Qing Li*[1], *Ali Asghar Eftekhar*[1], *Siva Yegnanarayanan*[1], *Ali Adibi*[1]; [1]*Georgia Tech, USA,* [2]*Lab des Technologies de la Microélectronique CNRS, France,* [3]*CEA/LETI/DOPT, France.* We demonstrate the fabrication of high Q microdisk resonators on an SOI platform using thermal nanoimprint lithography. The achieved Q factor is 60000 for 2μm disks. Arrays of 32 resonators show uniform spectral response.

CMJ • Novel Sources and Systems for Spectroscopic Sensing—Continued

CMJ3 • 8:45 a.m.
Sensitive and Simple Frequency Comb Fourier Transform Spectrometer with a Multipass Cell, *Julien Mandon[1,2], *Patrick Jacquet*[1], *Birgitta Bernhardt*[3], *Marion Jacquey*[1], *Guy Guelachvili*[1], *Theodor W. Hänsch*[3,4], *Nathalie Picqué*[1,3]; [1]*Lab de Photophysique Moléculaire, Univ. Paris-Sud, France,* [2]*Dept. of Molecular and Laser Physics, Inst. for Molecules and Materials, Radboud Univ. Nijmegen, Netherlands,* [3]*Max-Planck-Inst. für Quantenoptik, Germany,* [4]*Ludwig-Maximilians-Univ. München, Germany.* Multipass cells offer a simple manner to enhance the sensitivity of dual-comb Fourier transform spectrometer. 1.5 μm spectra spanning 125 nm and exhibiting a noise-equivalent absorption coefficient of $4{\cdot}10^{-9}$ $cm^{-1}Hz^{-1/2}$ are recorded within 63 μs.

CMJ4 • 9:00 a.m.
High Dynamic Range Laser Dispersion Spectroscopy of Saturated Absorption Lines, *Kale Franz*[1], *Damien Weidmann*[2], ***Gerard Wysocki***[1]; [1]*Princeton Univ., USA,* [2]*STFC Rutherford Appleton Lab, UK.* A spectroscopic detection of molecular dispersion based on frequency-chirped laser is presented. Unlike non-linear direct absorption methods yielding line saturation, this method provides linear signal response and accuracy over a wide range of sample concentrations.

CMJ5 • 9:15 a.m.
Faraday Rotation Spectroscopic Sensing of Oxygen using Static Magnetic Fields and Balanced Photodetection, *Stephen G. So, Evan Jeng, Gerard Wysocki; Princeton Univ., USA.* We describe the development of a Faraday Rotation Spectroscopic trace-gas sensor for quantification of molecular oxygen. Static magnetic field and balanced detection of polarization rotation is proposed for high precision and ultra-low power operation.

CMJ6 • 9:30 a.m.
Numerical and Experimental Investigation for a Resonant Optothermoacoustic Sensor, *Noemi Petra[1], *Anatoliy A. Kosterev*[2], *John Zweck*[1], *Susan E. Minkoff*[3], *James H. Doty , III*[2]; [1]*Univ. of Maryland, Baltimore County, USA,* [2]*Rice Univ., USA.* A theoretical study of a resonant optothermoacoustic sensor employing a laser source and a quartz tuning fork receiver validates experimental results showing that the source should be positioned near the base of the receiver.

9:45 a.m.–10:15 a.m. Coffee Break, *San Jose McEnery Convention Center, Concourse Level*

Room A1	Room A2	Room A3	Room A4
CLEO			

10:15 a.m.–12:00 p.m.
CMK • Pulse Measurement
Daniel J. Kane; Mesa Photonics, USA, Presider

CMK1 • 10:15 a.m.
Simply Measuring the Temporal Electric Field of Very Complex Ultrashort Pulses, ***Jacob Cohen****, Pamela Bowlan, Vikrant Chauhan, Rick Trebino; Georgia Tech, USA.* Using a low-resolution spectrometer, we developed a technique for measuring relatively long and complex ultrashort pulses. It is a spectral-interferometry variation, which we used to measure pulses up to 105 ps with 34 fs resolution.

CMK2 • 10:30 a.m.
Blind FROG Pulse Characterization for Quantitative Differential Multiphoton Microscopy, ***Jeffrey J. Field****, Charles G. Durfee, Jeff A. Squier; Colorado School of Mines, USA.* Quantitative multiphoton microscopy requires knowledge of the spatio-temporal characteristics of the excitation electric field. With a unique multifocal system, we completely characterize the excitation intensity at the full numerical aperture of the excitation objective.

CMK3 • 10:45 a.m.
Self-Diffraction SPIDER, ***Sebastian Koke****, Simon Birkholz, Jens Bethge, Christian Grebing, Günter Steinmeyer; Max-Born-Inst., Germany.* Using microjoule supercontinuum pulses, two novel SPIDER variants based on the $\chi^{(3)}$ -process of self-diffraction are experimentally demonstrated for the first time. The upshift variant appears particularly interesting for ultraviolet femtosecond pulse characterization.

CMK4 • 11:00 a.m.
Spectral Amplitude and Phase Measurement of Ultrafast Pulses Using All-Optical Differential Tomography, ***Pablo S. Londero****, Onur Kuzucu, Alexander L. Gaeta; Cornell Univ., USA.* We demonstrate an all-optical method for characterizing ultrafast pulses by differential tomography, using four-wave mixing. The technique is used to measure dispersion for various lengths of silica fiber.

CMK5 • 11:15 a.m.
Complete Characterization of Single Attosecond Pulses by the Modified Spectral Phase Interferometry with an All-Optical Apparatus, ***Jiangfeng Zhu****, Shaobo Fang, Tao Chen, Keisaku Yamane, Mikio Yamashita; Dept. of Applied Physics, Hokkaido Univ., Japan.* We present the complete characterization of single attosecond pulses by the modified SPIDER method with a frequency-dependent spectral shear. The validity of this method shows no principle limitation of characterizing arbitrary short single attosecond pulses.

10:15 a.m.–12:00 p.m.
CML • CLEO Symposium on Photonics for Advanced Energy Technology: Photonics for Power Generation and Delivery
Michael Wraback; ARL, USA, Presider

CML1 • 10:15 a.m. Invited
High-Efficiency Photovoltaic Technology, ***Sarah Kurtz****; Natl. Renewable Energy Lab, USA.* Multi-junction solar cells with near-perfect material quality have exceeded 40% in efficiency under concentrated sunlight. Dozens of companies are implementing these cells into power-generation systems, toward creating a solar-powered world.

CML2 • 10:45 a.m.
Flexible Solar Cells Based on Stacked Crystalline Semiconductor Nanomembranes on Plastic Substrates, *Weiquan Yang[1],* ***Weidong Zhou****[1], Zhenqiang Ma[2], Jesper Berggren[3], Mattias Hammar[3]; [1]Univ. of Texas at Arlington, USA, [2]Univ. of Wisconsin at Madison, USA, [3]Royal Inst. of Technology, Sweden.* We report flexible solar cells based on crystalline semiconductor nanomembranes (NMs). We obtained cell efficiency of 1.5% for 1 um thick InP cells. It agrees very well with the anticipated thin film solar cell performance.

CML3 • 11:00 a.m.
Fundamental Limit of Nanophotonic Light-Trapping in Solar Cells, ***Zongfu Yu****, Aaswath Raman, Shanhui Fan; Stanford Univ., USA.* We use a rigorous electromagnetic approach to develop a light-trapping theory, which reveals that the standard limit developed by Yablonovitch can be substantially surpassed in nanophotonic regimes, opening new avenues for highly efficient solar cells.

CML4 • 11:15 a.m. Invited
Photonic Power Delivery, ***Jan-Gustav Werthen****; JDS Uniphase Corp., USA.* Photonic Power delivery, or "Power-over-fiber" is an emerging technology for powering without the need for electrical wiring. Suitable to power data communication devices, this proven technology could now enter FTTH and eliminate costly copper installations.

10:15 a.m.–12:00 p.m.
CMM • Non-Silica Fiber
Shibin Jiang; AdValue Photonics Inc., USA, Presider

CMM1 • 10:15 a.m.
Narrow-Line All-Fiber Bismuth Ring Laser, ***E. J. R. Kelleher****[1], J. C. Travers[1], K. M. Golant[2], S. V. Popov[1], J. R. Taylor[1]; [1]Imperial College London, UK, [2]Kotel'nikov Inst. of Radio Engineering and Electronics, Russian Federation.* A narrow-line continuous-wave bismuth-doped all-fiber laser, with 10 mW output power in a 4 GHz linewidth is demonstrated. We use a narrow-band FBG and fiber-integrated Fabry-Perot filters to achieve a factor of 20 mode suppression.

CMM2 • 10:30 a.m.
Long Term Stable, High Power 3 µm Fiber Laser, ***Dominic Faucher****, Martin Bernier, Nicolas Caron, Réal Vallée; Ctr. d'Optique, Photonique et Lasers, Univ. Laval, Canada.* We report the longest stable laser emission at 3.8 W over 65 hours in a Er-doped fluoride fiber laser at 2.936 µm. The slope efficiency was 24% with respect to the launched pump power.

CMM3 • 10:45 a.m.
Diode-Laser-Pumped Ti:Sapphire Double-clad Crystal Fiber Broadband Light Source, ***Kuang-Yu Hsu****, Dong-Yo Jheng, Yi-Han Liao, Mu-Han Yang, Sheng-Lung Huang; Graduate Inst. of Photonics and Optoelectronics, Natl. Taiwan Univ., Taiwan.* Ti^{3+}:Al_2O_3 double-clad crystal fiber was grown for the first time. As much as 2.2 µW of collimated broadband output power was obtained by using a 446-nm diode laser. The coherence length is 1.38 µm.

CMM4 • 11:00 a.m.
Multi-Color Laser Oscillation in a Waterproof Pr^{3+}-Doped Fluoro-Aluminate Glass Fiber Pumped by GaN Laser Diode, ***Yasushi Fujimoto****[1], Osamu Ishii[2], Masaaki Yamazaki[2]; [1]Inst. of Laser Engineering, Osaka Univ., Japan, [2]Production Engineering Section, Optical Glass Production Dept., Sumita Optical Glass, Inc., Japan, [3]Glass Res. Div., R&D Dept., Sumita Optical Glass, Inc., Japan.* We successfully drew a Pr-doped optical fiber of a waterproof fluoro-aluminate glass in an AlF_3-YF_3-PbF_2 system with low loss (0.1 dB/m) and demonstrated multi-color laser oscillation pumped by a 442.6-nm GaN laser diode.

CMM5 • 11:15 a.m. Invited
Bismuth-Doped Fiber Amplifiers, *Evgeny M. Dianov,* ***Igor A. Bufetov****; Fiber Optics Res. Ctr., Russian Acad. of Sciences, Russian Federation.* We will discuss the luminescence, gain and lasing properties of Bi-doped fibers of different core composition. Bi-doped fiber amplifiers operating in the wavelength range 1300-1500 nm with peak gain >20dB are demonstrated.

10:15 a.m.–12:00 p.m.
CMN • Frequency Combs I
Brian R. Washburn; Kansas State Univ., USA, Presider

CMN1 • 10:15 a.m. Invited
75 W Yb-Fiber Laser Frequency Comb, ***Axel Ruehl****, A. Marcinkevicius, M. E. Fermann, I. Hartl; IMRA America, Inc., USA.* We report on an Yb-fiber frequency-comb based on linear chirped pulse amplification delivering 120fs pulses at 75W compressed average power at a repetition rate of 154MHz. Coherent phase locking of the self-referenced comb is demonstrated.

CMN2 • 10:45 a.m.
Optical Frequency-Tunable Cs Atomic Clock with a Mode-Hop-Free Fiber Laser, ***Takahito Morisaki****, Masato Yoshida, Masataka Nakazawa; Res. Inst. of Electrical Communication, Tohoku Univ., Japan.* We have successfully realized an optical frequency tunable Cs atomic clock with a mode-hop-free fiber laser. The optical frequency of the 9.1926 GHz clock was continuously tuned over 1 GHz without changing the clock frequency.

CMN3 • 11:00 a.m.
1.3-GHz, 20-W, Femtosecond Chirped-pulse Amplifier System, ***Yohei Kobayashi****, Yutaka Nomura, Shuntaro Watanabe; Inst. for Solid State Pyhsics, Univ. of Tokyo, Japan.* We demonstrated a 1.3-GHz, Yb:KYW Kerr-lens mode-locked oscillator and a chirped-pulse amplifier system by using a double-clad Yb-doped fiber. The pulse duration of 180 fs was obtained with the average power of 20 W.

CMN4 • 11:15 a.m.
Carrier Envelope Offset Frequency of a 10 GHz Etalon-Stabilized Comb Source , ***Mehmetcan Akbulut****, Josue Davila-Rodriguez, Ibrahim Ozdur, Nazanin Hoghooghi, Peter J. Delfyett; CREOL, Univ. of Central Florida, USA.* We report CEO frequency measurements of a 10 GHz harmonically modelocked, etalon stabilized comb source using a multi-heterodyne beating technique. Also, preliminary results from an attempt at f-2f self referencing measurement are presented.

Room A5

QELS

10:15 a.m.–12:00 p.m.
QMC • Novel Phenomena II
Mansoor Sheik-Bahae; Univ. of New Mexico, USA, Presider

QMC1 • 10:15 a.m.
Observation of the Condensation of Classical Waves, ***Can Sun***[1], *Shu Jia*[1], *Christopher Barsi*[1], *Antonio Picozzi*[2], *Sergio Rica*[3], *Jason W. Fleischer*[1]; [1]*Princeton Univ., USA,* [2]*Inst. Carnot de Bourgogne, UMR 5029 CNRS, Univ. de Bourgogne, USA,* [3]*Ecole Normale Supérieure, France.* We report a theoretical, numerical and experimental study of condensation of classical optical waves. The condensation is observed directly, as a function of nonlinearity and wave kinetic energy, in a self-defocusing photorefractive crystal.

QMC2 • 10:30 a.m.
Switching from Nonlinear Beam Focusing to Defocusing in Periodic Structures, ***Francis H. Bennet***[1], *Inés A. Amuli*[1], *Dragomir N. Neshev*[1], *Andrey A. Sukhorukov*[1], *Wieslaw Z. Krolikowski*[2], *Yuri S. Kivshar*[1]; [1]*Nonlinear Physics Ctr., Australian Natl. Univ., Australia,* [2]*Laser Physics Ctr., Australian Natl. Univ., Australia.* We demonstrate experimentally the transition of nonlinear beam focusing to defocusing by varying the modulation depth of a periodic system. The observed effect illustrates the fundamental crossover when the periodic system changes properties to homogeneous.

QMC3 • 10:45 a.m.
Memory Functions for Comparative Nonlinear Dynamics: A New Class of Dynamic Systems Unifying Chaotic Optofluidics and Electronics , ***Elad Greenfield****, Mordechai Segev, Alexander Szameit; Technion – Israel Inst. of Technology, Israel.* We unite chaotic optofluidics and chaotic electronics in a single class of topologically-equivalent dynamic systems. This is made possible with a new comparative approach for dynamic systems research, based on the memories of the systems.

QMC4 • 11:00 a.m.
Resonant Delocalization of Light in Engineered Bloch Waveguide Arrays, ***Ramy A. El-Ganainy***[1], *Demetrios Christodoulides*[1], *Christian Rüter*[2], *Detlef Kip*[2]; [1]*CREOL, College of Optics and Photonics, Univ. of Central Florida, USA,* [2]*Clausthal Univ. of Technology, Germany.* We study the propagation of light in Bloch waveguide arrays exhibiting periodic coupling. Intriguing wavepacket revival patterns as well as beating Bloch oscillations are demonstrated. A new resonant delocalization phase transition is also predicted.

QMC5 • 11:15 a.m.
Rotational Stochastic Resonance, ***Kyle M. Douglass****, Gabriel Biener, Sergey Sukhov, Aristide Dogariu; Univ. of Central Florida, USA.* We demonstrate the concept of stochastic resonance in optically induced rotations and discuss its applications for optimizing the effects of optical torques on small anisotropic particles and optically bound systems of particles.

Room A6

CLEO

10:15 a.m.–12:00 p.m.
CMO • VCSEL II
Seth Bank; Univ. of Texas at Austin, USA, Presider

CMO1 • 10:15 a.m.
Long-Wavelength BTJ-VCSEL with High-Contrast Grating, ***Werner H. Hofmann***[1]*, Christopher Chase*[1]*, Michael Müller*[2]*, Yi Rao*[1]*, Christian Grasse*[2]*, Gerhard Böhm*[2]*, Markus-Christian Amann*[2]*, Connie Chang-Hasnain*[1]*;* [1]*Univ. of California at Berkeley, USA,* [2]*Walter Schottky Inst. Technische Univ. München, Germany.* InP-based, long-wavelength buried tunnel junction (BTJ) VCSELs, emitting at 1.32 μm with a high-contrast grating (HCG) are demonstrated. This is the first HCG VCSEL presented emitting at long wavelengths. CW-operation is demonstrated up to 18°C.

CMO2 • 10:30 a.m.
Proton-Implanted 850-nm Photonic Crystal Vertical-Cavity Surface-Emitting Lasers with Improved Performance, ***Meng Peun Tan****, Ansas M. Kasten, Dominic F. Siriani, Joshua D. Sulkin, Kent D. Choquette; Univ. of Illinois at Urbana-Champaign, USA.* Proton-implanted 850-nm photonic crystal vertical-cavity surface-emitting lasers are fabricated and characterized. Strong and more stable index guiding is introduced, resulting in planar lasers with generally decreased threshold current and increased slope efficiency.

CMO3 • 10:45 a.m.
Lithographic and Oxide-Free Vertical Cavity Surface Emitting Laser, ***Abdullah Demir****, Guowei Zhao, Gokhan Ozgur, Sabine Freisem, Dennis G. Deppe; CREOL, College of Optics and Photonics, Univ. of Central Florida, USA.* All-epitaxial oxide-free vertical-cavity surface-emitting lasers (VCSELs) are demonstrated. 4-μm-diameter VCSEL is shown with threshold current of 350 μA, slope efficiency of 0.77 W/A, wall-plug efficiency of 21% and output power of 6.3 mW.

CMO4 • 11:00 a.m.
Comparison of Plasma-Effect in Different InP-Based VCSELs, ***Andreas Hangauer***[1,2]*, Jia Chen*[1,2]*, Markus-Christian Amann*[2]*;* [1]*Siemens AG, Germany,* [2]*Walter Schottky Inst. Technische Univ. München, Germany.* The FM amplitude/phase response of InP-based VCSELs at 1.5μm, 1.8μm and 2.3μm is presented and compared. The plasma effect is clearly observed, although at 2.3μm it is significantly lower. This interesting result is discussed.

CMO5 • 11:15 a.m.
Mode Control of 1.3 μm Wavelength Coupled VCSEL Arrays by Cavity Structuring, ***Lukas Mutter***[1]*, Elodie Lamothe*[1]*, Vladimir Iakovlev*[2]*, Andrei Caliman*[1]*, Benjamin Dwir*[1]*, Alexandru Mereuta*[1]*, Alexei Sirbu*[1]*, Eli Kapon*[1]*;* [1]*Swiss Federal Inst. of Technology, École Polytechnique Fédérale de Lausanne, Switzerland,* [2]*Beam Express S.A., Switzerland.* Mode control in wafer-fused 1.3μm wavelength coupled-VCSEL arrays is achieved by cavity structuring and investigated by spectrally resolved near- and far-field measurements. Improved mode discrimination is attained by combining index- and gain-patterning.

Room A7

QELS

10:15 a.m.–12:00 p.m.
QMD • Surface Plasmon Polaritons
Igor Smolyaninov; BAE Systems, USA, Presider

QMD1 • 10:15 a.m.
One-Way Extraordinary Transmission and Nonreciprocal Plasmons, ***Alexander B. Khanikaev***[1]*, Gennady Shvets*[1]*, Yuri S. Kivshar*[2]*;* [1]*Dept. of Physics, Univ. of Texas at Austin, USA,* [2]*Nonlinear Physics Ctr., Res. School of Physics and Engineering, Australian Natl. Univ., Australia.* We predict that the engineered spoof surface plasmons supported by structured conductors in magneto-optical environment exhibit nonreciprocal dispersion. We suggest the geometries where this property results in nonreciprocal optical response observed as one-way extraordinary transmission.

QMD2 • 10:30 a.m.
Airy Plasmon: A Non-Diffracting Surface Wave, ***Alessandro Salandrino****, Demetrios N. Christodoulides; CREOL, College of Optics and Photonics, Univ. of Central Florida, USA.* We introduce a new class of non-diffracting surface plasmons: the Airy plasmon. The self bending and self healing behavior of these solutions is analyzed. Schemes for experimental realization and potential applications are discussed.

QMD3 • 10:45 a.m. Invited
Light-to-Current and Current-to-Light Coupling in Plasmonic System, *Natalia Noginova, Andrey V. Yakim,* ***Mikhail Noginov****; Norfolk State Univ., USA.* Electron drag effect in silver film increases dramatically and changes its sign at the resonant condition of the excitation of surface plasmon polariton. Conversely, external voltage applied to the film can modulate its reflectance.

QMD4 • 11:15 a.m.
Quasi-Guided Surface Plasmon Polaritons in Anisotropic Materials, ***Marco Liscidini***[1]*, John E. Sipe*[2]*;* [1]*Univ. degli Studi di Pavia, Italy,* [2]*Univ. of Toronto, Canada.* We show theoretically that the hybridization of radiative and guided modes at a metal/dielectric interface, where the dielectric is a homogeneous but anisotropic medium, can lead to the existence of quasi-guided surface plasmon polaritons (SPPs).

Room A8	Room C1&2	Room C3&4	San Jose Ballroom IV (San Jose Marriott)
CLEO	CLEO	CLEO	JOINT

10:15 a.m.–12:00 p.m.
CMP • Intense THz Phenomena
Richard D. Averitt; Boston Univ., USA, Presider

CMP1 • 10:15 a.m. Invited
Mechanism and Potential Applications of THz Air Photonics, *Jianming Dai,* *Jingle Liu, I-Chen Ho, Nicholas Karpowicz, X. C. Zhang; Rensselaer Polytechnic Inst., USA.* We Present experimental and theoretical investigations on the THz wave generation and detection using ambient air or selected gases as the THz emitter and sensor, as well as the potential applications of THz air photonics.

CMP2 • 10:45 a.m.
Spatiotemporally Resolved Plasma Effect on Two-Color Laser Pumped Terahertz Generation, *Haidan Wen*[1]*, Dan Daranciang*[2]*, Aaron M. Lindenberg*[1,3]*;* [1]*PULSE Inst., SLAC Natl. Accelerator Lab, USA,* [2]*Dept. of Chemistry, Stanford Univ., USA,* [3]*Dept. of Materials Science and Engineering, Stanford Univ., USA.* Spatiotemporally resolved measurements reveal how a plasma affects the terahertz generation from photoionized air in two-color optical fields.

CMP3 • 11:00 a.m.
Observation of Amplified Stimulated Terahertz Emission in Optically Pumped Epitaxial Graphene Heterostructures, *Hiromi Karasawa*[1]*, **Takayuki Watanabe***[1]*, Taiichi Otsuji*[1]*, Maxim Ryzhii*[2]*, Akira Satou*[2]*, Victor Ryzhii*[2]*;* [1]*Tohoku Univ., Japan,* [2]*Univ. of Aizu, Japan.* We experimentally observed an amplified stimulated terahertz emission from an epitaxial graphene-on-silicon heterostructure. The result well supports the occurrence of negative dynamic conductivity leading to a new type of terahertz lasers.

CMP4 • 11:15 a.m.
Single-Cycle Multi-THz Transients with Electric Fields Exceeding 10 MV/cm, *Friederike Junginger*[1]*, Alexander Sell*[1]*, Olaf Schubert*[1]*, Bernhard Mayer*[1]*, Daniele Brida*[2]*, Marco Marangoni*[2]*, Giulio Cerullo*[2]*, Alfred Leitenstorfer*[1]*, Rupert Huber*[1]*;* [1]*Univ. of Konstanz, Germany,* [2]*Politecnico di Milano, Italy.* Broadband parametric amplification of 1.3-µm pulses in GaSe crystals provides intense single-cycle idler transients covering the 1-60 THz window with peak amplitudes above 10 MV/cm. Electro-optic sampling directly monitors the field of the phase-stable waveforms.

10:15 a.m.–12:00 p.m.
CMQ • Waveguides
Sunao Kurimura; Natl. Inst. for Materials Science, Japan, Presider

CMQ1 • 10:15 a.m.
Oxidized Silicon-on-Insulator (OxSOI) from Bulk Silicon: A New Photonic Platform, *Nicolás Sherwood-Droz,* *Alexander Gondarenko, Michal Lipson; Cornell Univ., USA.* We demonstrate a bulk silicon alternative to SOI, using Si_3N_4 masking and oxidation techniques. We show waveguide losses of 2.92 dB/cm with a process compatible with the front-end of a typical CMOS fabrication line.

CMQ2 • 10:30 a.m.
Widely Wavelength-Selective Integrated Ring Laser in Al_2O_3:Er^{3+}, *Jonathan D. B. Bradley*[1]*, Remco Stoffer*[2]*, Laura Agazzi*[1]*, Feridun Ay*[1]*, Kerstin Wörhoff*[2]*, Markus Pollnau*[1]*;* [1]*MESA+ Inst. for Nanotechnology, Univ. of Twente, Netherlands,* [2]*PhoeniX BV, Netherlands.* Integrated Al_2O_3:Er^{3+} ring lasers were realized on thermally oxidized silicon substrates. By varying the degree of output coupling from the ring, wavelength selection in the range 1530-1557 nm was demonstrated.

CMQ3 • 10:45 a.m.
Enhanced Waveguide Nonlinearity and Mechanical Robustness in Hybrid As_2Se_3-PMMA Microtapers, *Chams Baker,* *Martin Rochette; McGill Univ., Canada.* We report the fabrication of an As_2Se_3 microtaper with a protective polymer cladding. The 7 cm long microtaper provides an ultrahigh nonlinearity of γ=45 $W^{-1}m^{-1}$ whereas the polymer cladding provides mechanical strength to the device.

CMQ4 • 11:00 a.m.
Characterization of Bragg Gratings in Al_2O_3 Waveguides Fabricated by Focused Ion Beam Milling and Laser Interference Lithography, *Feridun Ay, Edward H. Bernhardi, Laura Agazzi, Jonathan D. B. Bradley, Kerstin Wörhoff, **Markus Pollnau,*** *René M. de Ridder; Integrated Optical MicroSystems Group, MESA and Inst. for Nanotechnology, Univ. of Twente, Netherlands.* Optical grating cavities in Al_2O_3 channel waveguides were successfully defined by focused ion beam milling and laser interference lithography. Both methods are shown to be suitable for realizing resonant structures for on-chip waveguide lasers.

CMQ5 • 11:15 a.m.
Realization of Multilayer Si/SiO_2 Super-High N.A. GRIN Lens on Si-Waveguide Coupling to Single-Mode Optical Fibre, *Ter-Hoe Loh*[1]*, Qian Wang*[1]*, Jie Zhu*[1]*, Keh-Ting Ng*[1]*, Yi-Cheng Lai*[1]*, Seng-Tiong Ho*[2]*;* [1]*Data Storage Inst., Singapore,* [2]*Northwestern Univ., USA.* Vertical optical mode-size transformation from 260nm-thick Si-nanowaveguide to 10~12µm matching the single-mode-fibre-core has been demonstrated using compact multilayer Si/SiO_2 asymmetric GRIN lens (length:~24µm). GRIN lens to single-mode-fibre practical coupling loss of -3.45 dB was achieved.

10:15 a.m.–12:00 p.m.
CMR • Laser Nanostructuring
Craig B. Arnold; Princeton Univ., USA, Presider

CMR1 • 10:15 a.m. Tutorial
Nanostructuring: A Route for Understanding Interaction Phenomena and Enhancing Materials Performance, *Carmen N. Afonso;* *Laser Processing Group, Inst. de Optica, CSIC, Spain.* Engineering materials in the nanoscale is an attractive route to either improve properties or achieve new responses. Examples will be given for promoting/preventing transfer energy mechanisms or enhancing optical responses or rare-earth ion related photoluminescence.

Carmen N. Afonso is a Research Professor at the Optics Institute of the Spanish Research Council (CSIC) where, in the eighties, she initiated the Laser Processing Group which is currently a 20-person group. The research activities of the Group initially focused on the understanding and controlling of laser - matter interactions. This was mainly done through dynamic studies using real time optical measurements with nano and picosecond resolution, with particular emphasis on ultrafast phase transformations for optical data storage. More recently, research has also focused on the production of nanostructured materials with improved responses and their application to integrated optical devices. The Group is one of the pioneers in using pulsed laser deposition for nanostructuring materials and using this nanostructuring concept for both understanding interactions in the nanometer scale and optimising optical response of materials.

CMR2 • 11:15 a.m.
Optical Trap Assisted Nanopatterning for Structured Surfaces, *Romain Fardel,* *Yu-Cheng Tsai, Craig B. Arnold; Princeton Univ., USA.* We investigate the use of optical trap assisted nanopatterning for creating nanoscale features on surfaces with pre-existing topography. Uniform patterns over silicon and polyimide surfaces with several micrometer deep grooves are demonstrated.

10:15 a.m.–12:00 p.m.
JMB • Joint CLEO/QELS Symposium on Optomechanics for Physical and Biological Sciences II: Physics
Tobias J. Kippenberg; Max-Planck-Inst. fur Quantenoptik, Germany, Presider

JMB1 • 10:15 a.m. Invited
The Physics of a Dissipative Optomechanical Coupling, *Aashish Clerk;* *McGill Univ., Canada.* We analyze theoretically a novel cavity electromechanical system where a mechanical resonator modulates the damping rate of a driven cavity. Destructive quantum noise interference can allow ground state cooling even in the unresolved sideband regime.

JMB2 • 10:45 a.m.
Near-Field Cavity Optomechanics with Nanomechanical Oscillators, *Georg Anetsberger*[1]*, Olivier Arcizet*[1]*, Emanuel Gavartin*[2]*, Quirin P. Unterreithmeier*[3]*, Eva M. Weig*[3]*, Jörg P. Kotthaus*[3]*, Tobias J. Kippenberg*[1,2]*;* [1]*Max-Planck-Inst. of Quantum Optics, Germany,* [2]*École Polytechnique Fédérale de Lausanne, Switzerland,* [3]*Ludwig-Maximilians-Univ., Germany.* We use evanescent near-fields of high-Q optical microresonators to extend cavity-optomechanical coupling to nanomechanical oscillators. Pure radiation pressure coupling to SiN nanomechanical strings is demonstrated. Dynamical backaction allows creating laser-like nanomechanical oscillation at nanowatt threshold.

JMB3 • 11:00 a.m.
Optical Forces between a High-Q Micro-Disk Resonator and an Integrated Waveguide, *Mo Li,* *Wolfram Pernice, Kingyan Fong, Hong Tang; Yale Univ., USA.* We demonstrate enhanced gradient optical force between a high-Q micro-disk resonator and a waveguide. We find that the total optical force is composed of contributions from the cavity backaction, the reactive and evanescent coupling.

JMB4 • 11:15 a.m. Invited
Preparation and Detection of a Radio Frequency Mechanical Resonator Near the Ground State of Motion, *Keith Schwab;* *Caltech, USA.* Abstract not available.

CLEO: Applications

10:15 a.m.–12:00 p.m. AMB • Microscopy and Endoscopy

Sohi Rastegar; Natl. Science Foundation, USA, Presider

AMB1 • 10:15 a.m. Tutorial

Endoscopic Confocal Microscopy of GI Cancers for Diagnosis and Directed Therapy, ***Chris Contag****; Stanford Univ., USA.* Abstract not available.

Dr. Contag is an Associate Professor of Pediatrics in the Division of Neonatal and Developmental Medicine, and a member of the BioX faculty at Stanford University. He is the Director of the Stanford Infrared Optical Science and Photomedicine Program, director of Stanford's Center for Innovation in *In Vivo* Imaging (SCI^2) and co-director of the Molecular Imaging Program at Stanford (MIPS). Dr. Contag received his B.S. in Biology from the University of Minnesota, St. Paul in 1982; and earned his Ph.D. in Microbiology from the University of Minnesota, Minneapolis in 1988. He is a founding member, and a past president, of the Society for Molecular Imaging, and for his fundamental contributions in imaging, is a recipient of the Achievement Award from the Society for Molecular Imaging. Dr. Contag is a scientific founder of Xenogen Corp.—now Caliper LifeSciences. He is also a founder of ConcentRx Corp.

AMB2 • 11:15 a.m.

Endoscope Lens with Dual Field of View and Resolution for Multiphoton Imaging, ***Minghan Chen****, Chris Xu, Watt W. Webb; Cornell Univ., USA.* We demonstrated the optical "zooming" capability of an endoscope lens for multiphoton imaging by using a novel multifocal objective lens design. Multiphoton images with dual field of view and resolution were recorded.

CLEO

10:15 a.m.–12:00 p.m. CMS • Microring Resonator Optical and RF Processing

Michal Lipson; Cornell Univ., USA, Presider

CMS1 • 10:15 a.m.

Experimental Demonstration of the Longitudinal Offset Technique for the Apodization of Coupled Resonator Optical Waveguide Devices, ***Jose David Domenech Gomez****, Pascual Muñoz Muñoz, Jose Capmany Francoy; Univ. Politecnica de Valencia, Spain.* In this paper, an experimental demonstration of the apodization of coupled resonator optical waveguide (CROW) devices through the longitudinal offset technique is presented for a 3 racetracks CROW device and compared against the uniform case.

CMS2 • 10:30 a.m.

On-Chip Radio Frequency Arbitrary Waveform Generation, ***Hao Shen****, Li Fan, Leo Tom Varghese, Daniel E. Leaird, Andrew M. Weiner, Minghao Qi; Purdue Univ., USA.* A completely on-chip solution for radio-frequency arbitrary waveform generation (RFAWG) is proposed with silicon add-drop microring resonators and tunable all-pass microring delay lines. Preliminary results are shown for the pulse shaping effect.

CMS3 • 10:45 a.m.

CMOS-Compatible Temperature Insensitive Silicon Microring Resonators, ***Biswajeet Guha****, Bernardo B. C. Kyotoku, Michal Lipson; Cornell Univ., USA.* We propose a new class of resonant silicon optical devices which are passively temperature compensated based on tailoring optical mode confinement in waveguides. We demonstrate their operation over a wide temperature range of 80 degrees.

CMS4 • 11:00 a.m.

Free-Standing Silicon Ring Resonator for Low Power Optical Bistability, ***Peng Sun****, Ronald M. Reano; Ohio State Univ., USA.* We demonstrate low power optical bistability in a free-standing silicon ring resonator. The transmission exhibits hysteresis for 80 μW pump power, which is over an order of magnitude lower than similar unreleased ring resonators.

CMS5 • 11:15 a.m.

Eleven-Channel Second-Order Silicon Microring-Resonator Filterbank with Tunable Channel Spacing, ***Marcus S. Dahlem****, Charles W. Holzwarth, Anatol Khilo, Franz X. Kärtner, Henry I. Smith, Erich P. Ippen; MIT, USA.* A wideband eleven-channel second-order filterbank fabricated on an SOI platform is demonstrated with tunable channel spacing and 20 GHz single-channel bandwidths. The tuning efficiency is ~28 μW/GHz/ring.

10:15 a.m.–12:00 p.m. CMT • Cavity-Enhanced Sensing

Douglas J. Bamford; Physical Sciences Inc., USA, Presider

CMT1 • 10:15 a.m. Tutorial

Recent Advances in Cavity Ringdown Spectroscopy and Application to Medical Breath Analysis, ***Christopher S. Wood****; Precision Photonics Corp., USA.* A major goal of medicine is to catch disease early with methods that are non-invasive, sensitive, and highly specific. Optical breath analysis is a growing field that provides exactly this type of diagnosis.

Chris is currently Senior Research Scientist and Director of R&D at Precision Photonics Corporation. His specialties include tunable lasers, high-power lasers, electro-optics, quantum optics, and ultra-sensitive spectroscopy. His familiarity with cavity-enhanced absorption spectroscopy began as a graduate student at the University of Colorado-Boulder, studying extremely small parity-violating effects in atomic cesium, culminating in the *1998 award for Outstanding Doctoral Thesis in Atomic, Molecular, and Optical physics by the American Physical Society*. His post-doc work at NIST-Boulder involved multiple ultraviolet lasers to study Quantum Computation and fundamental tests of Quantum Mechanics, using trapped Be+ ions. Since then, his work has focused on industrial R&D efforts that lead to commercial product development. He has worked for universities, government labs, small family-owned tech companies, venture capital-funded start-ups, SBIR-based small companies, and a large aerospace prime contractor.

CMT2 • 11:15 a.m.

OPO Based Off-Axis Integrated Cavity Output Spectroscopy for Rapid Chemical Sensing, ***Denis D. Arslanov****[1], Frans J. M. Harren[1], Ian D. Lindsay[2], Klaus J. Boller[3]; [1]Radboud Univ., Netherlands, [2]Univ. of Bristol, UK, [3]Univ. of Twente, Netherlands.* We presented rapid and sensitive trace gas detector based on a high power and fast scanning cw OPO in combination with off-axis integrated cavity output spectroscopy. A detection limit of 2×10^{-9} cm^{-1} $Hz^{-1/2}$ was obtained.

CMK • Pulse Measurement—Continued

CMK6 • 11:30 a.m.
Ultrafast, Single-Shot Phase and Amplitude Measurement via a Temporal Imaging Approach, *Daniel H. Broaddus*[1], *Mark A. Foster*[1], *Onur Kuzucu*[1], *Karl W. Koch*[2], *Alexander L. Gaeta*[1]; [1]*Cornell Univ., USA,* [2]*Corning, Inc., USA.* We demonstrate single-shot measurement of the phase and amplitude of an ultrafast waveform using time-magnification and heterodyning with simple external clock synchronization.

CMK7 • 11:45 a.m.
Ultrafast Temporal Phase Detection Using Thick Nonlinear Crystals, *Hsiang-Nan Cheng*[1], *Chi-Cheng Chen*[1], *Shang-Da Yang*[1], *Carsten Langrock*[2], *Martin M. Fejer*[2]; [1]*Inst. of Photonics Technologies, Natl. Tsing Hua Univ., Taiwan,* [2]*E. L. Ginzton Lab, Stanford Univ., USA.* We experimentally demonstrated that second-harmonic generation yield due to a thick nonlinear crystal is sensitive to temporal phase of ultrashort pulses, which could be useful in temporal chirp monitoring and ultrafast coherent communications.

CML • CLEO Symposium on Photonics for Advanced Energy Technology: Photonics for Power Generation and Delivery—Continued

CML5 • 11:45 a.m.
Intersubband Thermophotovoltaic Detectors, *Jian Yin, Roberto Paiella; Boston Univ., USA.* High-efficiency multiple-junction detectors for thermophotovoltaic energy conversion are designed based on the series combination of different quantum cascade structures. Numerical simulations indicate that these devices can outperform existing interband solutions.

CMM • Non-Silica Fiber—Continued

CMM6 • 11:45 a.m.
Broadband Low Power Super-Continuum Generation in As_2S_3 Chalcogenide Glass Fiber Nanotapers, *Stephen A. Dekker*[1], *Chunle Xiong*[1], *Eric Magi*[1], *Alexander C. Judge*[1], *Jasbinder S. Sanghera*[2], *L. Brandon Shaw*[2], *Ishwar D. Aggarwal*[2], *David J. Moss*[1], *Benjamin J. Eggleton*[1]; [1]*CUDOS, Australia,* [2]*NRL, USA.* We demonstrate broadband low power supercontinuum generation in arsenic sulphide (As_2S_3) tapered fiber nanowires with an effective area ~ 0.8 μm^2 and nonlinearity gamma = 15,300 /W/km. Simulations showed good agreement between theory and experiment.

CMN • Frequency Combs I—Continued

CMN5 • 11:30 a.m.
Dual Frequency Combs at 3.4 μm with Subhertz Residual Linewidths, *Esther Baumann*, *Fabrizio R. Giorgetta, Ian Coddington, William C. Swann, Nathan R. Newbury; NIST, USA.* Two coherent 1.5μm frequency combs are transferred to 3.4μm by difference-frequency generation with a 1064nm cw laser. From a multi-heterodyne measurement, the residual linewidth between the comb teeth is resolution-limited at 200 mHz.

CMN6 • 11:45 a.m.
Octave-Spanning Supercontinuum Generation for an Er-Doped Fiber Laser Frequency Comb at a 1 GHz Repetition Rate, *David Chao*, *Guoqing Chang, Jonathan L. Morse, Franz X. Kärtner, Erich P. Ippen; MIT, USA.* We developed a 1 GHz Er-doped femtosecond fiber laser system providing 2nJ pulses at ~100fs durations and demonstrated octave-spanning supercontinuum generation from 1μm - 2.4μm that is suitable for 1f-2f stabilizing the frequency comb.

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

NOTES

Room A5	Room A6	Room A7
QELS	CLEO	QELS

QMC • Novel Phenomena II—Continued

QMC6 • 11:30 a.m.
Optical Multi-Hysteresises and "Rogue Waves" in Nonlinear Plasma, ***Alexander E. Kaplan****; Johns Hopkins Univ., USA.* An intense irradiation of an overdense plasma can induce standing "rogue waves" and highly-multiple hysteresises due to a relativistic electron mass-effect. Those waves can be sustained by a radiation intensity much lower their peak intensity.

QMC7 • 11:45 a.m.
Richtmyer-Meshkov Instability in Nonlinear Optics, ***Shu Jia****[1], Laura I. Huntley[2], Jason W. Fleischer[1]; [1]Princeton Univ., USA, [2]Stanford Univ., USA.* We experimentally demonstrate an all-optical Richtmyer-Meshkov instability, in which a shock wave is incident on an intensity interface. Intensity fingering and shear-generated vortices are observed for both 1-D and 2-D shock-wave impulses.

CMO • VCSEL II—Continued

CMO6 • 11:30 a.m.
Multiwavelength High Contrast Grating VCSEL Array With 200nm Spectral Range, ***Vadim Karagodsky****[1], Bala Pesala[1], Christopher Chase[1], Werner Hofmann[1], Fumio Koyama[2], Connie J. Chang-Hasnain[1]; [1]Dept. of Electrical Engineering and Computer Sciences, Univ. of California at Berkeley, USA, [2]Tokyo Inst. of Technology, Japan.* We propose a new multi-wavelength high contrast grating VCSEL array, with an ultrabroad spectral range. The simple fabrication flow of this array is fully epitaxy compatible and requires no extra steps beyond a single-VCSEL process.

CMO7 • 11:45 a.m.
Analysis of Coupled Vertical-Cavity Surface-Emitting Laser Arrays, ***Dominic F. Siriani****, Ann C. Lehman Harren, P. Scott Carney, Kent D. Choquette; Univ. of Illinois at Urbana-Champaign, USA.* Coupling properties of vertical-cavity surface-emitting laser (VCSEL) arrays are analyzed using a new stochastic coupled mode theory. Comparisons between theory and experiment reveal important details about the coupling and coherence of VCSEL arrays.

QMD • Surface Plasmon Polaritons—Continued

QMD5 • 11:30 a.m.
Versatile Excitation of Localized Surface Plasmon Polaritons via Spatially Modulated Polarized Focus, ***Tzu-Hsiang Lan****, Jan-Ya He, Chung-Hao Tien; Natl. Chiao Tung Univ., Taiwan.* We proposed a method to generate a versatile localized surface plasmon with the capability of beam steering and shaping by using collinear Kretchmann configuration in conjunction with spatially inhomogeneous polarized beam.

QMD6 • 11:45 a.m.
Sub-Wavelength Plasmon Solitons in 1-D Arrays of Coupled Metallic Nanowires, *Fangwei Ye[1], Bambi Hu[1], Dumitru Mihalache[2],* ***Nicolae C. Panoiu****[3]; [1]Hong Kong Baptist Univ., China, [2]"Horia Hulubei" Natl. Inst. for Physics and Nuclear Engineering, Romania, [3]Univ. College London, UK.* We present the first theoretical study of sub-wavelength plasmon solitons formed in arrays of metallic nanowires. We demonstrate that the plasmonic arrays support unstaggered and staggered solitons, which can be effectively excited from Gaussian beams.

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

NOTES

Room A8	Room C1&2	Room C3&4	San Jose Ballroom IV (San Jose Marriott)
CLEO			JOINT

CMP • Intense THz Phenomena—Continued

CMP5 • 11:30 a.m.
THz Nonlinearity of Water Observed with Intense THz Pulses, ***Masaya Nagai***[1,2]*, Koichiro Tanaka*[1,3,4]*;* [1]*Dept. of Physics, Kyoto Univ., Japan,* [2]*PRESTO, JST, Japan,* [3]*iCeMS, Kyoto Univ., Japan,* [4]*CREST, JST, Japan.* We reveal THz nonlinearity of liquid water using intense monocycle THz pulse. Single THz pulse response and THz pump-probe spectroscopy show the breaking and recovering of hydrogen bonding network in water molecules.

CMP6 • 11:45 a.m.
Anisotropy of Hot Electron Effective Mass in n-Doped InGaAs Revealed by Nonlinear THz-Pump/THz-Probe Spectroscopy, ***Francois Blanchard***[1,2,3]*, Fuhai Su*[2]*, Luca Razzari*[1]*, Gargi Sharma*[1]*, Roberto Morandotti*[1]*, Tsuneyuki Ozaki*[1]*, Matt Reid*[3]*, Frank Hegmann*[2]*;* [1]*INRS, Canada,* [2]*Univ. of Alberta, Canada,* [3]*Univ. of Northern British Columbia, Canada.* We study ultrafast hot electron transport in n-doped InGaAs using polarization-sensitive nonlinear THz-pump/THz-probe spectroscopy. We observe an anisotropic effective mass for hot electrons due to the nonparabolicity of the conduction band.

CMQ • Waveguides—Continued

CMQ6 • 11:30 a.m.
Characterization of Nd-Doped Polymer Waveguide Amplifiers near 1060 and 870 nm, *Jing Yang, Mart B. J. Diemeer, Gabriël Sengo,* ***Markus Pollnau****, Alfred Driessen; Univ. of Twente, Netherlands.* Nd^{3+}-complex-doped polymer channel waveguide amplifiers with various lengths and Nd^{3+} concentrations were fabricated by a simple procedure. Internal net gain of 5.7 dB/cm at 1064 nm and 2.0 dB/cm at 873 nm was obtained.

CMQ7 • 11:45 a.m.
Micro-Luminescence and Micro-Raman Mapping of Ultrafast Laser Inscribed Yb:KGd$(WO_4)_2$ and Yb:KY$(WO_4)_2$ Channel Waveguides, ***Fiona M. Bain***[1]*, Alexander A. Lagatsky*[1]*, Wagner F. Silva*[2]*, Daniel Jaque*[3]*, Robert R. Thomson*[4]*, Nicholas D. Psaila*[4]*, Ajoy K. Kar*[4]*, Wilson Sibbett*[1]*, C. T. A. Brown*[1]*;* [1]*School of Physics and Astronomy, Univ. of St. Andrews, UK,* [2]*Inst. de Fisica, Univ. Federal de Alagoas, Brazil,* [3]*Dept. de Fisica de Materials C-IV, Univ. Autónoma de Madrid, Spain,* [4]*School of Engineering and Physical Sciences, Heriot-Watt Univ., UK.* Micro-luminescence and micro-Raman mapping has been performed on ultrafast laser inscribed channel Yb:KGd$(WO_4)_2$ and Yb:KY$(WO_4)_2$ waveguides. Correlation can be seen between guiding regions and shifts in micro-luminescence and micro-Raman peaks when compared to the bulk.

CMR • Laser Nanostructuring—Continued

CMR3 • 11:30 a.m.
Laser-Induced Periodic Nanostructures on ZnO Surfaces with a Patterned Beam in Water Environment, ***Susanta K. Das****, Martin Bock, Arkadi Rosenfeld, Ruediger Grunwald; Max-Born-Inst. for Nonlinear Optics and Short Pulse Spectroscopy, Germany.* Periodic surface structures were induced in ZnO in water with a focused femtosecond laser beam working in Fresnel region. A circular diffraction pattern transferred into the material is superimposed by sub-200 nm features.

CMR4 • 11:45 a.m.
Femtosecond Laser-Induced TiO_2 Nanostructures on Titanium, ***Bulent Oktem****, Hamit Kalaycioglu, F. Ömer Ilday; Bilkent Univ., Turkey.* We report formation of polarization-dependent nanostructures (nanolines, nanocircles) by high repetition-rate femtosecond laser pulses on titanium surface through a novel mechanism, converting Ti to TiO_2. Arbitrarily large-area patterns are created by self-stitching of these patterns.

JMB • Joint CLEO/QELS Symposium on Optomechanics for Physical and Biological Sciences II: Physics—Continued

JMB5 • 11:45 a.m.
Optical Probing and Actuation of Microwave Frequency Phononic Crystal Resonators without Clamping Losses, ***Matt Eichenfield****, Jasper Chan, Amir H. Safavi-Naeini, Oskar J. Painter; Caltech, USA.* We demonstrate microwave-frequency mechanical modes of optomechanical crystals having arbitrarily small clamping losses. The optomechanical crystals are connected to the substrate via a phononic bandgap structure, simultaneously isolating and rigidly supporting the optomechanical resonator.

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

NOTES

AMB • Microscopy and Endoscopy—Continued

AMB3 • 11:30 a.m.
OPO-Based Multimodal Nonlinear Optical Microscopy, ***Mikhail N. Slipchenko****, Ji-Xin Cheng; Purdue Univ., USA.* We report on a femtosecond OPO based multimodal nonlinear optical microscope that permits multiphoton fluorescence, SHG, THG, CARS, and stimulated Raman scattering imaging on the same platform.

AMB4 • 11:45 a.m.
Lensfree Polarization Microscopy on a Chip Using Incoherent Digital Holography, ***Chulwoo Oh****[1], Serhan Isikman[1], Aydogan Ozcan[1,2]; [1]Univ. of California at Los Angeles, USA, [2]California NanoSystems Inst., USA.* We demonstrate an on-chip polarization microscope based on incoherent lensfree holography. Placed between two polarizers, a birefringent sample creates in-line holograms that can be digitally reconstructed to create lensfree polarization images over a large field-of-view.

CMS • Microring Resonator Optical and RF Processing—Continued

CMS6 • 11:30 a.m.
Efficient Coupler between Silicon and Polymer Waveguides, ***Jie Shu****, Qianfan Xu; Rice Univ., USA.* We propose an efficient optical coupler between sub-micron sized silicon waveguides on chip and multi-micron wide polymer waveguides on board. We show low coupling loss < 0.4 dB with high tolerance to misalignment.

CMS7 • 11:45 a.m.
"Magic Radius" Phenomenon in Thin-Ridge SOI Ring Resonators: Theory and Preliminary Observation, ***Thach G. Nguyen****[1], Ravi S. Tummidi[2], Robert M. Pafchek[2], Thomas L. Koch[2], Arnan Mitchell[1]; [1]School of Electrical and Computer Engineering, RMIT Univ., Australia, [2]Ctr. for Optical Technologies, Dept. of Electrical and Computer Engineering, Lehigh Univ., USA.* The lateral leakage loss mechanism of the TM-like mode in thin-ridge SOI ring resonators is significantly impacted by the ring radius and waveguide width. This behavior is analyzed using rigorous modeling techniques and verified experimentally.

CMT • Cavity-Enhanced Sensing—Continued

CMT3 • 11:30 a.m.
Optical Loss Characterization of CaF_2 in the Ultraviolet Region for Prism Retroreflectors, ***Brian Lee****[1], Azer Yalin[1], Kevin Lehmann[2]; [1]Colorado State Univ., USA, [2]Univ. of Virginia, USA.* We report optical loss measurements of calcium fluoride samples at 249 and 403 nm. Contributions of birefringence are investigated. Calcium fluoride prism retroreflectors are of interest for cavity-enhanced absorption spectroscopy in the ultraviolet region.

CMT4 • 11:45 a.m.
Intracavity Phase Interferometry for Magnetic Field Sensing, ***Andreas Schmitt-Sody****, Koji Masuda, Andreas Velten, Jean-Claude Diels; Dept. of Physics and Astronomy, Univ. of New Mexico, USA.* Application of a phase to frequency conversion is demonstrated to measure small magnetic fields with a sensitivity of 10nT corresponding to a polarization rotation of $2x10^{-9}$ rad.

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

NOTES

1:30 p.m.–3:15 p.m.
CMU • Pulse Measurement and Propagation
Rick Trebino; Georgia Tech, USA, Presider

CMU1 • 1:30 p.m.
Experimental Demonstration of Airy-Bessel 3-D Linear Light Bullets, *Andy Chong*[1], *William H. Renninger*[1], *Frank W. Wise*[1], *Demetrios N. Christodoulides*[2]; [1]*Cornell Univ., USA,* [2]*Univ. of Central Florida, USA.* We demonstrate for the first time a versatile class of Airy-Bessel linear light bullets. The main lobe of the Airy-Bessel wave packet was sustained for many dispersion and diffraction lengths of propagation.

CMU2 • 1:45 p.m.
On the Origin of Negative Dispersion Contributions in Filamentary Propagation, *Carsten Brée*[1,2], *Jens Bethge*[2], *Ayhan Demircan*[1], *Erik T. J. Nibbering*[2], *Günter Steinmeyer*[2]; [1]*Weierstraß-Inst. für Angewandte Analysis und Stochastik, Germany,* [2]*Max-Born-Inst., Germany.* We experimentally show that the windows frequently used for filament cells have a decisive influence on nonlinear pulse shaping, determining the group-delay-dispersion of the self-compressed pulses.

CMU3 • 2:00 p.m.
Phase Retrieval and the Measurement of the Complete Spatiotemporal Electric Field of Ultrashort Pulses, *Pamela R. Bowlan*[1,2], *Rick Trebino*[1,2]; [1]*School of Physics, Georgia Tech, USA,* [2]*Swamp Optics LLC, USA.* The technique, SEA TADPOLE, measures the complete spatiotemporal intensity and phase of arbitrary ultrashort pulses, but device instability blurs the spatial component of the phase. We show that a simple phase-retrieval algorithm recovers it.

CMU4 • 2:15 p.m.
Frequency-Domain Streak Camera for Ultrafast Imaging of Evolving Light-Velocity Objects, *Zhengyan Li*, *Rafal Zgadzaj*, *Xiaoming Wang*, *Steve Reed*, *Yang Zhao*, *Michael C. Downer*; *Dept. of Physics, Univ. of Texas at Austin, USA.* We report the extension of Frequency-domain Holography to a Frequency-Domain Streak Camera capable of capturing the evolution of refractive index structures propagating at luminal speeds. Possibility of extension to Frequency-Domain Tomography is demonstrated.

1:30 p.m.–3:15 p.m.
CMV • Detectors and All-Optical Switching
William Green; IBM Res., USA, Presider

CMV1 • 1:30 p.m. Invited
Ultrafast Graphene Photodetector, *Fengnian Xia*[1], *Thomas Mueller*[2], *Yu-ming Lin*[1], *Phaedon Avouris*[1]; [1]*IBM T.J. Watson Res., USA,* [2]*Vienna Univ. of Technology, Austria.* We demonstrate ultrafast transistor-based photodetectors made from single- and few-layer graphene. The photoresponse does not degrade for optical intensity modulations up to 40GHz, and further analysis suggests that the intrinsic bandwidth may exceed 500GHz.

CMV2 • 2:00 p.m.
Waveguide-Integrated Low-Noise Germanium Avalanche Photodetector with 6dB Sensitivity Improvement, *Solomon Assefa*, *Fengnian Xia*, *Yurii Vlasov*; *IBM T.J. Watson Res. Ctr., USA.* A waveguide-integrated Germanium avalanche photodetector with 6dB sensitivity improvement and excess noise with keff~0.1 was demonstrated while operating with 12dB gain at around 3V bias voltage. The photodetector was monolithically integrated into front-end CMOS.

CMV3 • 2:15 p.m.
Cavity-Enhanced Photocurrent Generation in a p-i-n Diode Integrated Silicon Microring Resonator Matrix, *Shaoqi Feng*, *Hui Chen*, *Xianshu Luo*, *Andrew W. Poon*; *Hong Kong Univ. of Science and Technology, Hong Kong.* We report cavity-enhanced photocurrent generation in the 1.55-μm wavelength range in a p-i-n diode integrated silicon microring resonator matrix. We demonstrate photocurrent of ~10 nA at microring resonance wavelengths and cavity enhancement exceeding 11-fold.

1:30 p.m.–3:15 p.m.
CMW • Novel Fiber Sources
Robert Jopson; Bell Labs, Alcatel-Lucent, USA, Presider

CMW1 • 1:30 p.m.
375 kW Peak Power Sub-Nanosecond Passively Q-Switched Ytterbium Doped Fiber Laser, *Lei Pan*[1], *Ilya Utkin*[1], *Ruijun Lan*[1,2], *Yogesh Godwal*[1], *Robert Fedosejevs*[1]; [1]*Univ. of Alberta, Canada,* [2]*Shandong Univ., China.* We demonstrate a passively Q-switched ytterbium doped fiber laser with Cr^{4+}:YAG and stimulated Brillouin backscattering. Linearly polarized output with ~ 375 kW peak power and pulse duration as short as 490 ps have been obtained.

CMW2 • 1:45 p.m.
Q-Switching a Fiber Laser with an Electrically Controlled Microstructured Fiber, *Zhangwei Yu*[1,2], *Walter Margulis*[1], *Walter Margulis*[2], *Mikael Malmström*[1,2], *Oleksandr Tarasenko*[2], *Fredrik Laurell*[1]; [1]*Royal Inst. of Technology, Sweden,* [2]*Acreo AB, Sweden.* A monolithic fiber laser incorporating an electrically driven microstructured fiber is Q-switched exploiting nanosecond polarization rotation and multi-pass amplification. All components are in-fiber, simplifying fabrication and improving robustness.

CMW3 • 2:00 p.m.
Dispersion Variation of a Thulium-Doped Stretched-Pulse Fiber Laser with Spectral Filtering, *Frithjof Haxsen*[1,2], *Dieter Wandt*[1,2], *Uwe Morgner*[1,2,3], *Dietmar Kracht*[1,2], *Jörg Neumann*[1,2]; [1]*Laser Zentrum Hannover e.V., Germany,* [2]*Ctr. for Quantum-Engineering and Space-Time Res. – QUEST, Germany,* [3]*Leibniz Univ. Hannover, Germany.* We report on stretched-pulse operation of a thulium-doped fiber laser with spectral filtering emitting at 1.98 μm. Cavity dispersion was varied from -0.044 ps^2 to 0.049 ps^2. The experimental results are compared with numerical simulations.

CMW4 • 2:15 p.m.
Efficient Intracavity Frequency Doubling of an Yb-Doped Fiber Laser Using an Internal Resonant Enhancement Cavity, *Rafal Cieslak*, *Jayanta K. Sahu*, *William A. Clarkson*; *Optoelectronics Res. Ctr., Univ. of Southampton, UK.* We describe a simple approach for efficient generation of visible light in high-power continuous-wave fiber lasers via second harmonic generation in an internal resonant cavity. Preliminary results for a cladding-pumped Yb fiber laser are presented.

1:30 p.m.–3:15 p.m.
CMX • Frequency Combs II
Scott Diddams; NIST, USA, Presider

CMX1 • 1:30 p.m.
All-Fiber-Based Frequency Comb with an Intra-Cavity Waveguide Electro-Optic Modulator, *Yoshiaki Nakajima*[1,2], *Hajime Inaba*[1], *Kazumoto Hosaka*[1], *Kana Iwakuni*[1,3], *Atsushi Onae*[1], *Kaoru Minoshima*[1], *Feng-Lei Hong*[1]; [1]*AIST, Japan,* [2]*Univ. of Fukui, Japan,* [3]*Keio Univ., Japan.* We develop an all-fiber-based frequency comb with an intra-cavity waveguide electro-optic modulator. A comb mode is successfully phase-locked to an optical reference without frequency division. The servo bandwidth of repetition rate is approximately 400 kHz.

CMX2 • 1:45 p.m.
A Simple Implementation of Spectral Shearing Interferometry for Self-Referenced Amplitude and Phase Characterization of Optical Frequency Comb Sources, *V. R. Supradeepa*, *Christopher M. Long*, *Daniel E. Leaird*, *Andrew M. Weiner*; *Purdue Univ., USA.* We demonstrate a simple scheme which uses only an intensity modulator and an OSA to achieve low-power (~100nW, 10aJ/pulse at 10GHz), self-referenced, amplitude and phase characterization of high repetition rate optical frequency comb sources.

CMX3 • 2:00 p.m.
Carrier Envelope Offset Stabilization of an Optical Parametric Oscillator Without f-2f Self-Referencing, *Teresa I. Ferreiro*, *Jinghua Sun*, *Derryck T. Reid*; *Heriot-Watt Univ., UK.* Signal pulses from a femtosecond optical parametric oscillator were carrier-envelope-offset stabilized for ~10 minutes with a bandwidth of <2 kHz and a cumulative phase error over 1 second of 2.05 radians, without f-2f self-referencing.

CMX4 • 2:15 p.m.
All-Fiber Carbon Nanotube Based Mode-Locked Laser System for Generation of Stable fs Frequency Combs, *Khanh Kieu*, *Tsung-Han Wu*, *N. Peyghambarian*, *Jason Jones*; *College of Optical Sciences, Univ. of Arizona, USA.* We report on a simplified all-fiber octave spanning femtosecond laser system based on a tapered fiber carbon nanotube saturable absorber capable of generating a stabilized frequency comb structure.

Room A5

QELS

1:30 p.m.–3:15 p.m.
QME • Scattering and Emission by Aperiodic Media
Viktor A. Podolskiy; Univ. of Massachusetts at Lowell, USA, Presider

QME1 • 1:30 p.m.
Temporal Coupled-Mode Theory for the Fano Resonance in Light Scattering and Its Applications, *Zhichao Ruan,* *Shanhui Fan; Ginzton Lab, Dept. of Electrical Engineering, Stanford Univ., USA.* We present a temporal coupled-mode theory for the Fano resonance in light scattering by individual obstacle. As an application, we design a structure that exhibits strong absorption and weak scattering properties at the same frequency.

QME2 • 1:45 p.m.
Disorder-Enhanced Transport in Photonic Quasi-Crystals: Anderson Localization and Delocalization, *Liad Levi*[1], *Mikael Rechtsman*[2], *Barak Freedman*[1], *Tal Schwartz*[1], *Ofer Manela*[1], *Moti Segev*[1]; [1]*Technion - Israel Inst. of Technology, Israel,* [2]*Courant Inst. of Mathematical Sciences, New York Univ., USA.* We demonstrate experimentally that disorder enhances transport of waves in Penrose-type photonic quasicrystals. Increasing disorder gives rise to a transition from "bumpy ride" to diffusive transport.

QME3 • 2:00 p.m.
Reflection of Subdiffusive Light from 3-D Disordered Photonic Crystals, *Kyle M. Douglass*[1], *Takashi Suezaki*[2], *Geoffrey A. Ozin*[2], *Sajeev John*[2], *Aristide Dogariu*[1]; [1]*Univ. of Central Florida, USA,* [2]*Univ. of Toronto, Canada.* Two different transport regimes of light are observed in the same medium and are explained by the scaling theory of localization. Our results constitute the first demonstration of continuous renormalization of the optical diffusion coefficient.

QME4 • 2:15 p.m.
Double Scattering of Light from Biophotonic Nanostructures with Short-Range Order, *Heeso Noh,* *Seng Fatt Liew, Vinodkumar Saranathan, Richard O. Prum, Eric R. Dufresne, Simon G. J. Mochrie, Hui Cao; Yale Univ., USA.* We investigate the mechanism for coloration of isotropic nanostructures with short-range order in bird feather barbs. While the primary spectral peak originates from single scattering, double scattering of light contributes additional spectral features.

Room A6

CLEO

1:30 p.m.–3:15 p.m.
CMY • Short Pulse Lasers
A. Catrina Bryce; Univ. of Glasgow, UK, Presider

CMY1 • 1:30 p.m.
Mode-Locking Build-Up Measurements: Probing the Modelocking Mechanisms in Vertical-External-Cavity Surface-Emitting Lasers, *Keith G. Wilcox,* *Adrian H. Quarterman, Stewart Carswell, Zakaria Mihoubi, Vasilis Apostolopoulos, Aaron Chung, Anne Tropper; School of Physics and Astronomy, Univ. of Southampton, UK.* The pulse evolution from onset to steady state in a mode-locked vertical-external-cavity surface-emitting laser producing femtosecond and picosecond pulses was studied. A 40-times reduction in pulse shortening rate from picosecond to femtosecond regime was observed.

CMY2 • 1:45 p.m.
Superradiant Emission from a Tapered Quantum-Dot Semiconductor Diode Emitter, *Mo Xia*[1], *Richard V. Penty*[1], *Ian H. White*[1], *Peter P. Vasil'ev*[2]; [1]*Univ. of Cambridge, UK,* [2]*PN Lebedev Physical Inst., Russian Federation.* Superradiant emission pulses from a quantum-dot tapered device are generated on demand at repetition rates of up to 5 MHz. The pulses have durations as short as 320 fs at a wavelength of 1270 nm.

CMY3 • 2:00 p.m.
Bistable Wavelength Switching in a Two-Section Quantum-Dot Mode-Locked Diode Laser, *Mingming Feng*[1], *Richard P. Mirin*[1], *Kevin L. Silverman*[1], *Steven T. Cundiff*[2]; [1]*NIST, USA,* [2]*JILA ,NIST, Univ. of Colorado, USA.* We investigate the wavelength-switching property of a bistable two-section quantum-dot diode laser. The switching time between the two stable wavelengths is about 150 ps, which is about two round trips time of the laser.

CMY4 • 2:15 p.m.
Gain Saturation in 60-fs Mode-Locked Semiconductor Laser, *Adrian H. Quarterman*[1], *Keith G. Wilcox*[1], *Vasilis Apostolopoulos*[1], *Zakaria Mihoubi*[1], *Mark Barnes*[1], *Ian Farrer*[2], *Dave A. Richie*[2], *Anne Tropper*[1]; [1]*School of Physics and Astronomy, Univ. of Southampton, UK,* [2]*Cavendish Lab, Univ. of Cambridge, UK.* A passively mode-locked optically-pumped InGaAs/GaAs quantum well laser with an intracavity semiconductor saturable absorber mirror emits sub-100-fs pulses. Pulse energy declines steeply as pulse duration is reduced below 100 fs due to gain saturation.

Room A7

QELS

1:30 p.m.–3:15 p.m.
QMF • Plasmonic Waveguides
Peter Catrysse; Stanford Univ., USA, Presider

QMF1 • 1:30 p.m.
Excitation of Gap Plasmonic Waveguides by Nano Antennas, *Jing Wen*[1,2], *Peter Banzer*[1,2,3], *Daniel Ploss*[1,2], *Arian Kriesch*[1,2], *Bernhard Schmauss*[4], *Ulf Peschel*[1,2,3]; [1]*Inst. of Optics, Information and Photonics, Univ. Erlangen-Nuremberg, Germany,* [2]*Max-Planck-Inst. for the Science of Light, Germany,* [3]*Cluster of Excellence 'Engineering of Advanced Materials', Univ. of Erlangen-Nuremberg, Germany,* [4]*Chair for High Frequency Technology, Univ. Erlangen-Nuremberg, Germany.* We experimentally demonstrate the excitation of plasmonic gap waveguides by nano antennas. The excitation is shown to be both spatially and spectrally dependent which can potentially be used for the selective excitation of plasmonic nanostructures.

QMF2 • 1:45 p.m.
Experimental Realization of Sub-Wavelength Plasmonic Slot Waveguides and Couplers on Silicon-on-Insulator, *Zhanghua Han,* *Abdul Y. Elezzabi, Vien Van; Dept. of Electrical and Computer Engineering, Univ. of Alberta, Canada.* Sub-wavelength plasmonic slot waveguides and broadband couplers were monolithically integrated with Si waveguides on SOI. Plasmonic waveguide propagation length of 6λ was achieved along with a 30% coupling efficiency between the Si and plasmonic waveguides.

QMF3 • 2:00 p.m.
Passive Building Blocks for Plasmonics Nanocircuits with Three-Dimensional Slot Waveguides, *Wenshan Cai,* *Mark L. Brongersma; Stanford Univ., USA.* We present the analysis and optimization of several basic elements for three-dimensional plasmonic slot waveguides. These elements are key building blocks for efficient routing of light that can be used in on-chip optical links.

QMF4 • 2:15 p.m.
High Performances of Planar Hybrid Plasmonic Waveguide-Based Structures, *Hong-Son Chu,* *Ping Bai, Er-Ping Li; Advanced Photonics and Plasmonics Group, A*STAR Inst. of High Performance Computing, Singapore.* We report a novel planar hybrid plasmonic waveguide which provides low propagation loss, strong mode confinement, high power and intensity in the nano-gap. The 90°-waveguide bends and couplers based on proposed waveguides are also discussed.

Room A8	Room C1&2	Room C3&4	San Jose Ballroom IV (San Jose Marriott)
CLEO	CLEO	CLEO	JOINT

1:30 p.m.–3:15 p.m.
CMZ • THz Domain Spectroscopy
Susumu Komiyama; Univ. of Tokyo, Japan, Presider

CMZ1 • 1:30 p.m.
Terahertz Dielectric and Magnetic Response Near Magnetic Phase Transition in a Multiferroic Hexagonal $YMnO_3$, *Christelle Kadlec*[1], *Petr Kuzel*[1], *Stanislav Kamba*[1], *Roman V. Pisarev*[2]; [1]*Inst. of Physics, Acad. of Sciences of the Czech Republic, Czech Republic,* [2]*Ioffe Physical Technical Inst., Russian Academy of Sciences, Russian Federation.* Time-domain THz spectroscopy is used to extract simultaneously dielectric and magnetic properties of hexagonal $YMnO_3$. A magnon in antiferromagnetic phase and possible electromagnon in paramagnetic phase were first observed.

CMZ2 • 1:45 p.m.
Resolution of the THz Vibrational Modes of Tris (hydroxymethyl) aminomethane (TRIS) Using Waveguide THz-TDS, *Sree H. Srikantaiah*, *Daniel R. Grischkowsky; Oklahoma State Univ., USA.* High resolution THz vibrational spectrum of TRIS is measured using waveguide THz-TDS. 12 highly resolved spectral features for the drop-cast film and 11 features for sublimated film are observed at 13.6K.

CMZ3 • 2:00 p.m.
A Terahertz Plastic Wire Based Evanescent Field Sensor for High Sensitivity Liquid Detection, *Ja-Yu Lu*[1], *Borwen You*[1], *Ci-Ling Pan*[2], *Tze-An Liu*[3], *Jin-Long Peng*[3]; [1]*Inst. of Electro-Optical Science and Engineering, National Cheng Kung Univ., Taiwan,* [2]*Dept. of Photonics and Inst. of Electro-Optical Engineering, National Chiao Tung Univ., Taiwan,* [3]*Ctr. for Measurement Standards, Industrial Technology Res. Inst., Taiwan.* A highly sensitive detection method based on the evanescent wave of a terahertz subwavelength plastic wire was demonstrated for liquid sensing. A 20ppm melamine alcohol solution is successfully identified with refractive-index sensitivity of 0.01.

CMZ4 • 2:15 p.m.
Anisotropic Terahertz Conductivity of One-Dimensional Electrons in Single-Walled Carbon Nanotubes, *Lei Ren*[1], *Takashi Arikawa*[1], *Junichiro Kono*[1], *Cary L. Pint*[2], *Robert H. Hauge*[2], *Aleksander K. Wojcik*[3], *Alexey A. Belyanin*[3], *Yoshiaki Takemoto*[4], *Kei Takeya*[4], *Iwao Kawayama*[4], *Masayoshi Tonouchi*[4]; [1]*Dept. of Electrical and Computer Engineering, Rice Univ., USA,* [2] *Dept. of Chemistry, Rice Univ., USA,* [3] *Dept. of Physics, Texas A&M Univ., USA,* [4] *Inst. of Laser Engineering, Osaka Univ., Japan.* Terahertz time-domain spectroscopy of a highly-aligned single-walled carbon nanotube film reveals strongly anisotropic responses. The deduced complex dynamic conductivity clearly showed a non-Drude-like frequency dependence, with real part showing a peak at ~ 4 THz.

1:30 p.m.–3:15 p.m.
CMAA • Advanced Concepts in Photovoltaics
Sarah Kurtz; Natl. Renewable Energy Lab, USA, Presider

CMAA1 • 1:30 p.m. Invited
Thin Film Silicon Solar Cell Fabricated at 100oC by High Density Plasma for Flexible Photovoltaic Application, *Chang-Hong Shen*[1], ***Jia-Min Shieh***[1,2], *Hao-Chung Kuo*[2], *Jung Y. Huang*[2], *Wen-Chien Yu*[1], *Wen-Hsien Huang*[1], *Chao-Kei Wang*[1], *Chih-Wei Hsu*[2], *Yu-Hsin Lin*[2], *Hung-Yu Chiu*[2], *Bau-Tong Dai*[1], *Fu-Liang Yang*[1]; [1]*Natl. Nano Device Labs, Taiwan,* [2]*Inst. of Electro-Optical Engineering, Natl. Chiao Tung Univ., Taiwan.* Record fabrication temperature, 100°C, of a single junction amorphous Si solar cell was demonstrated by a high-density plasma method. Present solar cell revealed conversion efficiency of 7.4% at 200°C (4.1% at 135°C).

CMAA2 • 2:00 p.m.
Plasmonic Back Structures Designed for Efficiency Enhancement of Thin Film Solar Cells, *Wenli Bai*[1,2], *Qiaoqiang Gan*[1], *Filbert Bartoli*[1], *Guofeng Song*[2]; [1]*Electrical and Computer Engineering Dept., Lehigh Univ., USA,* [2]*Inst. of Semiconductors, Chinese Acad. of Sciences, China.*** Metallic back structures with one-dimensional periodic nanoridges attached to thin-film amorphous silicon (a-Si) solar cell are proposed to enhance the cell efficiency in a wide near-IR range.

CMAA3 • 2:15 p.m.
Nanovoid Plasmonic-Enhanced Low-Cost Photovoltaics, *Niraj N. Lal*[1], *Fumin M. Huang*[1], *Bruno F. Soares*[1], *Sumeet Mahajan*[1], *Jatin K. Sinha*[2], *Phil N. Bartlett*[2], *Jeremy J. Baumberg*[1]; [1]*Univ. of Cambridge, UK,* [2]*Univ. of Southampton, UK.*** Gold and silver nanovoid structures generate localised plasmon modes which are harnessed to enhance organic and amorphous silicon solar cell performance. Higher absorption at plasmonic resonant wavelengths indicates significant potential for enhanced photocurrent and efficiency.

1:30 p.m.–3:15 p.m.
CMBB • Advanced Beam Shaping for Laser Processing
Yves Bellouard; Technische Univ. Eindhoven, Netherlands, Presider

CMBB1 • 1:30 p.m.
Holographic Fabrication of Three-Dimensional Penrose-Type Photonic Quasi-Crystal Using a Lab-Made Phase Mask, *Faraon Torres*[1], *Yuankun Lin*[1], *Ahmad Harb*[1], *Kris Ohlinger*[1], *Karen Lozano*[1], *Di Xu*[2], *Kevin P. Chen*[2]; [1]*College of Science and Engineering, Univ. of Texas-Pan American, USA,* [2]*Dept. of Electrical and Computer Engineering, Univ. of Pittsburgh, USA.*** Penrose-type photonic quasi-periodic crystals are fabricated through 5 or 6 beam holographic lithography using a lab-made phase mask. The quasi-crystal structure is confirmed through diffraction patterns showing ten-fold symmetry.

CMBB2 • 1:45 p.m.
Adaptive Optics for Direct Writing in Three-Dimensional Nano-Fabrication, *Alexander Jesacher, Richard Simmonds, Tony Wilson,* ***Martin Booth****; Univ. of Oxford, UK.* Aberrations affect the focal spot quality in direct laser write applications when focusing through a refractive index mismatch. We develop adaptive optics to correct aberrations and demonstrate improved fabrication depth in several substrates.

CMBB3 • 2:00 p.m.
Femtosecond Bessel Filaments for High Aspect-Ratio and Taper-Free Micromachining of Dielectrics, *Francois Courvoisier*[1], *Manoj K. Bhuyan*[1], *Maxime Jacquot*[1], *Pierre-Ambroise Lacourt*[1], *Luca Furfaro*[1], *Michael J. Withford*[2], *John M. Dudley*[1]; [1]*Univ. de Franche-Comté, France,* [2]*MacQuarie Univ., Australia.*** Femtosecond Bessel beams are demonstrated for high aspect ratio machining in the filamentation regime with water assistance. Taper-free microchannels and micro-trenches are demonstrated with aspect ratio up to 40 and diameters down to 2 µm.

CMBB4 • 2:15 p.m.
1-ns Reconfiguration Direct Space-to-Time Pulse Shaping, *Albert Vega,* *Daniel E. Leaird, Andrew M. Weiner; Purdue Univ., USA.* In this paper we demonstrate high-speed direct space-to-time pulse shaping with waveform reconfigurations down to 1ns. Our pulse shaper implementation incorporates a modified arrayed-waveguide grating structure and an array of optoelectronic reflection modulators.

1:30 p.m.–3:15 p.m.
JMC • Joint CLEO/QELS Symposium on Optomechanics for Physical and Biological Sciences III: Technology
Seok-Hyun (Andy) Yun; Harvard Univ., USA, Presider

JMC1 • 1:30 p.m.
Sensitive Phonon Detection in a Spiderweb Optomechanical Resonator, *Jessie Rosenberg,* *Qiang Lin, Oskar Painter; Caltech, USA.* We report position-squared coupling six orders of magnitude larger than previously demonstrated, allowing measurement of as few as 652 phonons and presenting a practical route toward probing of single-phonon jumps and characterization of phonon statistics.

JMC2 • 1:45 p.m.
Ultra-High Q Crystalline Microresonators for Cavity Optomechanics, *Johannes Hofer*[1], *Albert Schliesser*[1], *Tobias Kippenberg*[1,2]; [1]*Max-Planck-Inst. für Quantenoptik, Germany,* [2]*École Polytechnique Fédérale de Lausanne, Switzerland.*** We report on optomechanical coupling in crystalline whispering-gallery-mode resonators possessing ultra-high optical ($> 10^{10}$) and mechanical ($> 10^5$) Q-factors. Microdiscs reveal high frequency mechanical radial modes (> 20 MHz) and unprecedented sideband factors (> 100).

JMC3 • 2:00 p.m.
Positive and Negative Mechanical Kerr Nonlinearities in Periodically-patterned Silicon Waveguides, *Jing Ma,* *Michelle Povinelli; Univ. of Southern California, USA.* We design periodic silicon waveguides with mechanical Kerr coefficients of positive or negative sign. The mechanical Kerr coefficient is > 3 orders of magnitude larger than the Kerr coefficient of silicon for suspended lengths ~30µm.

JMC4 • 2:15 p.m.
Nanoparticle Manipulation with Optical Forces from Surface Plasmon Polaritons on Gold Stripes, *Kai Wang,* *Ethan Schonbrun, Kenneth Crozier; School of Engineering and Applied Science, Harvard Univ., USA.* We experimentally demonstrate enhanced propulsion of polystyrene and gold particles by surface plasmon polaritons on gold stripes. The largest propulsion velocity enhancement, relative to total internal reflection, is measured to be 5 for polystyrene particles.

Room B2-B3

CLEO: Applications

1:30 p.m.–3:15 p.m.
AMC • Sensing and Imaging
Javier A. Jo; Texas A&M Univ., USA, Presider

AMC1 • 1:30 p.m.
Fluorescence Correlation Spectroscopy in an Optical Trap, *H. Daniel Ou-Yang*, *Yi Hu, Joseph Junio, Xuanhong Cheng; Lehigh Univ., USA.* We have combined optical trapping and fluorescence correlation spectroscopy (FCS) to determine the trapping energy and concentration of nanoparticles in suspension by analyzing the elongated dwell time and enhanced concentration in the optical trap.

AMC2 • 1:45 p.m.
**Evanescent-Wave Cavity Enhanced Spectroscopy as a Tool in Label-Free Biosensing, *Lineke S. van der Sneppen*[1], *Grant Ritchie*[1], *Gus Hancock*[1], *Freek Ariese*[2], *Cees Gooijer*[2], *Wim Ubachs*[2], *Rob Haselberg*[3], *Govert W. Somsen*[3], *Gerhardus J. de Jong*[3]; [1]*Univ. of Oxford, UK,* [2]*Vrije Univ. Amsterdam, Netherlands,* [3]*Univ. Utrecht, Netherlands.* A variety of evanescent-wave cavity-enhanced techniques is used in studying interfacial kinetics as well as the performance of anti-biofouling coatings, demonstrating the potential of these techniques in label-free biosensing.

AMC3 • 2:00 p.m. Invited
Innovative Combined Sensing and Imaging Approaches in Biophotonics, *Ilko K. Ilev;* *Food and Drug Administration (FDA), USA.* Using simple fiber-optic based approaches, we have developed some advanced biophotonics and nanobiophotonics combined imaging and sensing techniques that can be exploited for high-resolution bioimaging and biosensing at cellular, intracellular and bulk tissue level.

San Jose Salon I & II (San Jose Marriott)

CLEO

1:30 p.m.–3:15 p.m.
CMCC • General Aspects of Nonlinear Optics
Narasimha S. Prasad; NASA Langley Res. Ctr., USA, Presider

CMCC1 • 1:30 p.m. Tutorial
Historical Perspective on Nonlinear Optics and Its Applications, *Y. Ron Shen;* *Univ. of California at Berkeley, USA.* Nonlinear optics in the past 60 years has been full of excitement and created tremendous impact in many disciplines. New laser technology has been the prime motive force behind the advances of the field.

Y. Ron Shen received his Ph.D. from Harvard University in 1963. He joined the Physics faculty of the University of California at Berkeley in 1964 where he has been ever since. His research interest is in the broad area of interaction of light with matter. He was involved in the early development of nonlinear optics, searching for basic understanding of various nonlinear optical phenomena. He is the author of the text "The Principles of Nonlinear Optics".

San Jose Salon III (San Jose Marriott)

1:30 p.m.–3:15 p.m.
CMDD • Mid-IR
Dietmar Kracht; Laser Zentrum Hannover e.V., Germany, Presider

CMDD1 • 1:30 p.m.
High Power Diode Pumped 2 µm Laser Operation of Tm:Lu_2O_3, *Philipp Koopmann*[1,2], *Samir Lamrini*[2], *Karsten Scholle*[2], *Peter Fuhrberg*[2], *Klaus Petermann*[1], *Günter Huber*[1]; [1]*Insitute of Laser-Physics, Germany,* [2]*LISA Laser Products, Germany.* We report the first diode pumped laser operation of Tm:Lu_2O_3 at 2 µm with more than 40 W of output power and slope efficiencies of up to 42% at room temperature.

CMDD2 • 1:45 p.m.
Resonantly Pumped 2.1-µm Ho:Y_2O_3 Ceramic Laser, *George Alex Newburgh*[1], *Akil Word-Daniels*[1], *Akio Ikesue*[2], *Mark Dubinskii*[1]; [1]*US ARL, USA,* [2]*World Lab Co., Ltd., Japan.* We report the first Ho:Y_2O_3 ceramic laser operating at 2.085µm with 29% slope efficiency as resonantly diode-pumped at 1.93 µm. Pertinent spectroscopic data are also presented.

CMDD3 • 2:00 p.m.
Continuous-Wave Lasing of Monoclinic Ho:$KLu(WO_4)_2$ under in-Band Excitation by a Diode-Pumped Tm:$KLu(WO_4)_2$ Laser, *Xavier Mateos*[1], *Venkatesan Jambunathan*[1], *Maria Cinta Pujol*[1], *Joan Josep Carvajal*[1], *Magdalena Aguilo*[1], *Francesc Diaz*[1], *Uwe Griebner*[2], ***Valentin Petrov***[2]; [1]*Univ. Rovira i Virgili, Spain,* [2]*Max-Born-Inst., Germany.* We present the first cw Ho:KLuW laser operating at room temperature. It is resonantly pumped by a diode-pumped Tm:KLuW laser and emits at 2060 nm in E//N_m polarization with a slope efficiency of 22%.

CMDD4 • 2:15 p.m.
Efficient Ho:$LuLiF_4$ Laser in-Band Pumped by a Tm Fiber Laser, *Ji Won Kim*[1], *J.I. Mackenzie*[1], *W.A. Clarkson*[1], *D. Parisi*[2], *S. Veronesi*[2], *M. Tonelli*[2]; [1]*Optoelectronics Res. Ctr., Univ. of Southampton, UK,* [2]*Natl. Enterprise for Nano Science and Technology, Dept. di Fisica, Univ. di Pisa, Italy.* A Ho:$LuLiF_4$ laser with an output power of 5.4W and slope efficiency of 76% at 2.1µm in-band pumped by a Tm fiber laser at 1.94µm is reported. Strategies for further increasing output power are considered.

CMU • Pulse Measurement and Propagation—Continued

CMU5 • 2:30 p.m.
Photonic Fiber for Flexible Sub-20-fs Pulse Delivery, ***Jens Bethge***[1]*, Tuan Le*[2]*, Julia Skibina*[3,4]*, Andreas Sting*[2]*, Günter Steinmeyer*[1]*;* [1]*Max-Born-Inst., Germany,* [2]*Femtolasers Produktions GmbH, Austria,* [3]*Saratov State Univ., Russian Federation,* [4]*Nanostructured Glass Technology Co., Russian Federation.* Delivery of sub-20-fs pulses with a spectrally flat phase through 80 cm chirped photonic crystal fiber with chirped-mirror precompensation is experimentally demonstrated. This sets a new record for fiber-based femtosecond pulse delivery.

CMU6 • 2:45 p.m.
Dispersion-Free Ultrashort and Ultrabroadband Polarization Vortex Pulse Generation, *Yu Tokizane, Kazuhiko Oka,* ***Ryuji Morita****; Dept. of Applied Physics, Hokkaido Univ., Japan.* Ultrabroadband polarization vortex generation ranging ~600 to ~800 nm without polarization dispersion was demonstrated using a photonic-crystal radial polarizer. It enables us to investigate closed-loop coherence in the ultrashort temporal and/or ultrabroad spectral region(s).

CMU7 • 3:00 p.m.
Spatiotemporal Dynamics of Cross-Polarized Wave Generation, ***Daniel E. Adams***[1]*, Thomas A. Planchon*[2]*, Jeff A. Squier*[1]*, Charles G. Durfee*[1]*;* [1]*Colorado School of Mines, USA,* [2]*Howard Hughes Medical Inst., USA.* We use Spatially and Spectrally Resolved Interferometry (SSRI) to investigate cross-polarized wave (XPW) generation. We find that the XPW pulse is $\sqrt{3}$ smaller than the input in the spatiotemporal domain regardless of input chirp.

CMV • Detectors and All-Optical Switching—Continued

CMV4 • 2:30 p.m.
All-Optical Computing Circuits Based on Bacteriorhodopsin Protein Coated Microcavity Switches, ***Sukhdev Roy***[1]*, Mohit Prasad*[1]*, Juraj Topolancik*[2]*, Frank Vollmer*[3]*;* [1]*Dayalbagh Educational Inst., India,* [2]*Northeastern Univ., USA,* [3]*Rowland Inst., Harvard Univ., USA.* We present designs of all-optical MUX/DEMUX and half-adder/subtractor circuits based on switching of an infrared laser beam at 1310 nm in bacteriorhodopsin protein coated silica microsphere using low power (<200 μW) pump beams.

CMV5 • 2:45 p.m.
All-Optical Switch Involving Fano Resonance in Ultrasmall Photonic Crystal Nanocavities, ***Kengo Nozaki***[1]*, Takasumi Tanabe*[1]*, Akihiko Shinya*[1]*, Shinji Matsuo*[2]*, Tomonari Sato*[2]*, Hideaki Taniyama*[1]*, Masaya Notomi*[1]*;* [1]*NTT Basic Res. Labs, Japan,* [2]*NTT Photonics Labs, Japan.* We demonstrate a Fano scheme consisting of ultrasmall photonic crystal nanocavities, and observe the asymmetric transmission spectrum. All-optical switching with a 1 fJ pump energy and an 18 ps time window is also successfully estimated.

CMV6 • 3:00 p.m.
All-Optical Fiber-Coupled Ultrafast Switching in 2-D InP-Based Photonic Crystal Nanocavity, ***Maia Brunstein***[1]*, Alejandro Yacomotti*[1]*, Remy Braive*[1]*, Isabelle Sagnes*[1]*, Laurent Bigot*[2]*, Ariel Levenson*[1]*;* [1]*CNRS, France,* [2]*Univ. des Sciences et Technologies de Lille, France.* Ultrafast optical switching capabilities of an InP-based photonic crystal cavity are studied using a tapered fiber-assisted coupling scheme. Overall switching times as short as 25ps were measured with a femtosecond pump and probe technique.

CMW • Novel Fiber Sources—Continued

CMW5 • 2:30 p.m.
Tunable Pulse Width, Short Pulse High Power Green Laser, *Pratheepan Madasamy, Lynsi Coressel, Donald R. Jander,* ***Eric C. Honea****; Lockheed Martin Aculight, USA.* We report the demonstration of a short pulse high power IR (98W) and green (43W) laser with 50ps pulse-width, 700MHz repetition-rate and near-diffraction-limited beam quality (M^2<1.1). The pulse-width was electro-optically tunable from 10ps to 50ps.

CMW6 • 2:45 p.m.
Optically-Driven Fast and Widely Wavelength-Swept Fiber Laser Based on Dispersion Tuning, ***Osamu Kusakari****, Shinji Yamashita; Dept. of Electrical Engineering and Information Systems, Univ. of Tokyo, Japan.* We demonstrate optically-driven fast and wide wavelength-swept laser based on dispersion tuning via cross gain modulation of the SOA. We achieved the tuning range of 87.9 nm and the tuning rate of 200 kHz.

CMW7 • 3:00 p.m.
Linewidth Optimization of Fourier Domain Mode-Locked Lasers, ***Sebastian Todor***[1]*, Christian Jirauschek*[1]*, Benjamin Biedermann*[2]*, Robert Huber*[2]*;* [1]*Emmy Noether Res. Group "Modeling of Quantum Cascade Devices" at the Inst. for Nanoelectronics, Technische Univ. München, Germany,* [2]*Lehrstuhl für BioMolekulare Optik, Fakultät für Physik, Ludwig-Maximilians-Univ. München, Germany.* We theoretically and experimentally investigate the instantaneous linewidth of Fourier domain mode-locked lasers, yielding good agreement. Based on simulations, strategies are discussed to drastically reduce the laser linewidth.

CMX • Frequency Combs II—Continued

CMX5 • 2:30 p.m.
First Fully Stabilized Frequency Comb from a SESAM-Modelocked 1.5-μm Solid-State Oscillator, ***Max C. Stumpf***[1]*, Selina Pekarek*[1]*, Andreas E. H. Oehler*[1]*, Thomas Südmeyer*[1]*, John M. Dudley*[2]*, Ursula Keller*[1]*;* [1]*ETH Zurich, Switzerland,* [2]*Univ. de Franche-Comté, France.* A diode-pumped 170-fs, 110-mW Er:Yb:glass-laser generates an octave-spanning supercontinuum without amplification in an optimized PM-HNLF. The CEO frequency is self-referenced and stabilized by feedback on the diode current. Cavity length control stabilizes the repetition rate.

CMX6 • 2:45 p.m.
All-Fiber Single Optical Frequency Generation from an Er-Doped Fiber Frequency Comb, ***Young-Jin Kim****, Yunseok Kim, Byung Jae Chun, Sangwon Hyun, Seung-Woo Kim; KAIST, Republic of Korea.* We demonstrate an all-fiber-based apparatus built to generate near-infrared frequencies directly from an Er-doped fiber frequency comb. The amplified final output signal yields a frequency stability of 2×10^{-15} with a linewidth less than 1 Hz.

CMX7 • 3:00 p.m.
Noise-Insensitive Self-Referencing Inteferometer for Carrier-Envelope Offset Frequency Stabilization of a Ti:sapphire Laser, ***Veronika Tsatourian***[1,2]*, Helen S. Margolis*[1]*, Giuseppe Marra*[1]*, Derryck T. Reid*[2]*, Patrick Gill*[1]*;* [1]*Natl. Physical Lab, UK,* [2]*Heriot-Watt Univ., UK.* A novel design of f:2f self-referencing interferometer employing Wollaston prisms for group-delay dispersion compensation exhibits up to 15 dB reduction in phase noise in specific frequency bands compared to a Michelson interferometer arrangement.

3:15 p.m.–3:45 p.m. Coffee Break, *San Jose McEnery Convention Center, Concourse Level*

NOTES

Room A5	Room A6	Room A7
QELS	CLEO	QELS

QME • Scattering and Emission by Aperiodic Media—Continued

QME5 • 2:30 p.m.
Super-Resolution of Images Using Incoherent Light, ***Yoav Shechtman***[1]*, Alexander Szameit*[2]*, Yonina C. Eldar*[1]*, Mordechai Segev*[2]*;* [1]*Dept. of Electrical Engineering,Technion-Israel Inst. of Technology, Israel,* [2]*Dept. of Physics and Solid State Inst., Technion-Israel Inst. of Technology, Israel.* We present a method for reconstrucing images beyond the cutoff spatial-frequency using incoherent light. Our approach is noise-robust and can be used for reconstructing sub-wavelength information through measurments taken in the optical far-field.

QME6 • 2:45 p.m.
Measuring and Exploiting the Transmission Matrix in Optics, *Sebastien M. Popoff, Geoffroy Lerosey, Rémi Carminati, Mathias Fink, Albert C. Boccara,* ***Sylvain Gigan****; Inst. Langevin, CNRS, France.* We introduce a method to measure the transmission matrix of a complex medium. This matrix exhibits statistical properties in good agreement with random matrix theory and allows light focusing and imaging through the random medium.

QME7 • 3:00 p.m.
Circularly-Polarized Light Emission from Semiconductor Planar Chiral Photonic Crystals, ***Kuniaki Konishi****, Masahiro Nomura, Naoto Kumagai, Satoshi Iwamoto, Yasuhiko Arakawa, Makoto Kuwata-Gonokami; Univ. of Tokyo, Japan.* Circular anisotropy of vacuum filed modes is induced in on-waveguide semiconductor chiral photonic crystals. Quantum dots embedded in the waveguide layer emit circularly polarized light with 25% of circular degree of polarization.

CMY • Short Pulse Lasers —Continued

CMY5 • 2:30 p.m.
Simulation, Design, and Characterization of Electrically-Pumped VECSELs for Future Passive Modelocking, ***Martin Hoffmann***[1]*, Yohan Barbarin*[1]*, Wolfgang P. Pallmann*[1]*, Deran J. H. C. Maas*[1]*, Philipp Kreuter*[1]*, Bernd Witzigmann*[2]*, Matthias Golling*[1]*, Thomas Südmeyer*[1]*, Ursula Keller*[1]*;* [1]*ETH Zurich, Switzerland,* [2]*Univ. of Kassel, Germany.* An ultrafast electrically-pumped VECSEL design requires an acceptable trade-off in cw output power. Validating our design guidelines and simulations 120 mW cw output power are generated. Homogenous current injection is even achieved for large devices.

CMY6 • 2:45 p.m.
Modelocked Integrated External-Cavity Surface Emitting Laser (MIXSEL) with Output Power up to 660 mW and Repetition Rate up to 10 GHz, ***Benjamin Rudin****, Valentin J. Wittwer, Deran J. H. Maas, Yohan Barbarin, Matthias Golling, Thomas Südmeyer, Ursula Keller; ETH Zurich, Switzerland.* We present an advanced MIXSEL, a VECSEL with integrated saturable absorber. Improved thermal management by substrate removal substantially increased the power. The novel antiresonant design is growth-error tolerant, enables shorter pulses and higher repetition rates.

CMY7 • 3:00 p.m.
Large Signal Analysis of AlGaInAs/InP Laser Transistor, ***Mizuki Shirao****, Nobuhiko Nishiyama, SeungHun Lee, Shigehisa Arai; Tokyo Inst. of Technology, Japan.* A large signal analysis of a laser transistor based on AlGaInAs/InP long wavelength material system is carried out. Better eye diagrams over 40-Gbps modulation speed are obtained in laser transistors than that in laser diodes.

QMF • Plasmonic Waveguides—Continued

QMF5 • 2:30 p.m.
Evolution of Beaming Pattern in Corrugated Mid-IR Plasmonic Structures, ***Sukosin Thongrattanasiri***[1]*, David Adams*[2]*, Daniel Wasserman*[2]*, Viktor A. Podolskiy*[1,2]*;* [1]*Oregon State Univ., USA,* [2]*Univ. of Massachusetts at Lowell, USA.* We consider the formation of highly directional beams from a subwavelength aperture surrounded by surface corrugations through a high-index superstrate and show that the beaming pattern strongly depends on the distance to the aperture.

QMF6 • 2:45 p.m.
Plasmonic Solar Cells with Broadband Absorption Enhancements, ***Ragip Pala****, Edward Barnard, Justin White, Mark Brongersma; Geballe Lab for Advanced Materials, Stanford Univ., USA.* A combined computational-experimental study optimizing plasmon-enhanced absorption in thin film solar cells is presented. We investigate the effect of different geometries where 2-dimensional periodic-aperiodic arrays of metal nanostructures sit above or below the active material.

QMF7 • 3:00 p.m.
Numerical Evidence of Exalted Nonreciprocal Dichroic Propagation in a Waveguide Coupled Magnetoplasmonic Chain of Ferromagnetic Metal Stripes, ***Mathias Vanwolleghem****, Liubov Magdenko, Philippe Gogol, Pierre Beauvillain, Béatrice Dagens; CNRS, France.* Patterning the metal layer of a ferromagnetic metal-clad III-V waveguide into a chain of coupled magnetoplasmonic nanostripes enhances optical non-reciprocity by two orders. Simulations show how non-reciprocal magnetoplasmonic chain modes couple resonantly to the waveguide.

3:15 p.m.–3:45 p.m. **Coffee Break,** *San Jose McEnery Convention Center, Concourse Level*

NOTES

Room A8	Room C1&2	Room C3&4	San Jose Ballroom IV (San Jose Marriott)
CLEO	CLEO	CLEO	JOINT

CMZ • THz Domain Spectroscopy—Continued

CMZ5 • 2:30 p.m.
Observation of Terahertz Frequency Comb by Fiber-Based, Asynchronous-Optical-Sampling THz-TDS, *Takeshi Yasui*[1], *Masaki Nose*[1], *Kohji Kawamoto*[1], *Shuko Yokoyama*[1], *Hajime Inaba*[2], *Kaoru Minoshima*[2], *Tsutomu Araki*[1]; [1]*Osaka Univ., Japan,* [2]*AIST, Japan.* We developed a fiber-based, asynchronous-optical-sampling THz-TDS system by combination of mode-locked Er-fiber lasers and photoconductive antennas. Detail structure of the THz comb was clearly observed with a spectral resolution of 5.6 MHz.

CMZ6 • 2:45 p.m.
THz Time-Domain Spectrometer Based on Asynchronous Optical Sampling with a Femtosecond Semiconductor Disk Laser, *Raphael Gebs*[1], *Peter Klopp*[2], *Gregor Klatt*[1], *Thomas Dekorsy*[1], *Uwe Griebner*[2], *Albrecht Bartels*[1]; [1]*Univ. of Konstanz, Germany,* [2]*Max-Born-Inst., Germany.* We combine high-speed asynchronous optical sampling with semiconductor disk femtosecond laser technology and realize a high-resolution THz time-domain spectrometer without mechanical delay. The system has great potential for size and cost reduction of existing systems.

CMZ7 • 3:00 p.m.
Multi-Mode Continuous Wave Terahertz Systems - Quasi Time Domain Spectroscopy, *Maik Scheller*[1,2], *Martin Koch*[2]; [1]*Inst. für Hochfrequenztechnik, Technische Univ. Braunschweig, Germany,* [2]*Fachbereich Physik, Philipps Univ. Marburg, Germany.* We present broadband terahertz spectroscopy systems based on continuous wave multi-mode laser diodes. By using commercial lasers with equidistant mode spacing we obtain signals similar to that of conventional time domain spectrometers.

CMAA • Advanced Concepts in Photovoltaics—Continued

CMAA4 • 2:30 p.m.
Absorption Enhancement of an Amorphous Si Solar Cell through Localized Surface Plasmon-Induced Scattering with Metal Nanoparticles, *Fu-Ji Tsai, Jyh-Yang Wang, Yean-Woei Kiang,* *C. C. Yang;* *Natl. Taiwan Univ., Taiwan.* Absorption enhancement of an amorphous Si solar cell is numerically demonstrated by placing metal nanoparticles on the device top, including periodical and non-periodical distributions, to induce localized surface plasmon for effectively generating forward scattering.

CMAA5 • 2:45 p.m.
Grating-Induced Surface Plasmon-Polaritons for Enhancing Photon Absorption in Organic Photovoltaic Devices, *Yifen Liu,* *Jaeyoun Kim; Iowa State Univ., USA.* We present a grating electrode that launches laterally propagating surface plasmon-polaritons along the active layers of organic photovoltaic devices. The resulting standing wave effectively increases the device thickness and enhances the photon absorption by 19.8%.

CMAA6 • 3:00 p.m.
Inverted Polymer Solar Cells with Paired Metal Oxide Modifications through Solution Processing, *Jing-Shun Huang, Yu-Hong Lin, Chen-Yu Chou, Guo-Dong Huang, Wei-Fang Su,* *Ching-Fuh Lin;* *Natl. Taiwan Univ., Taiwan.* A pair of solution-processed metal oxides is introduced near the electrodes to improve the inverted polymer solar cells. With the paired metal oxides, the conversion efficiency is notably enhanced to above 5%.

CMBB • Advanced Beam Shaping for Laser Processing—Continued

CMBB5 • 2:30 p.m.
Spatially Chirped Pulses for High Aspect Ratio Micromachining by Femtosecond Laser Ablation, *Dawn N. Vitek*[1], *Daniel Adams*[1], *Adrea Johnson*[1], *David Kleinfeld*[2], *Sterling Backus*[3], *Charles G. Durfee*[1], *Jeff Squier*[1]; [1]*Colorado School of Mines, USA,* [2]*Univ. of California at San Diego, USA,* [3]*Kapteyn-Murnane Labs, Inc., USA.* We demonstrate that spatially chirped femtosecond laser pulses overcome previous limitations for the machining of high-aspect ratio features with low numerical aperture beams in optically transparent materials.

CMBB6 • 2:45 p.m.
Material Processing Using Ultrashort Light Pulses with Tilted Front, *Peter G. Kazansky*[1], *Yasuhiko Shimotsuma*[2], *Martynas Beresna*[1], *Masaaki Sakakura*[2], *Jianrong Qiu*[3], *Selcuk Akturk*[4], *Yuri Svirko*[5], *Kiyotaka Miura*[2], *Kazuyuki Hirao*[2]; [1]*Optoelectronics Res. Ctr., Univ. of Southampton, UK,* [2]*Kyoto Univ., Japan,* [3]*Zhejiang Univ., China,* [4]*Istanbul Technical Univ., Turkey,* [5]*Univ. of Joensuu, Finland.* Femtosecond laser writing in glass is controlled by the polarization plane azimuth and intensity front tilt of light pulse. Polarization dependent distribution of extraordinary modifications along the light propagation direction is observed.

CMBB7 • 3:00 p.m.
Time-Resolved Observation of Energy Deposition in Fused Silica by Ultrashort Laser Pulses in Single and Cumulative Regime, *Cyril Mauclair*[1,2], *Konstantin Mishchik*[1], *Alexandre Mermillod-Blondin*[2], *Jörn Bonse*[2], *Arkadi Rosenfeld*[2], *Ingolf V. Hertel*[2,3], *Eric Audouard*[1], *Razvan Stoian*[1]; [1]*Lab Hubert Curien, Univ. de Lyon, France,* [2]*Max-Born-Inst., Germany,* [3]*Freie Univ. Berlin, Germany.* We present time-resolved phase-contrast microscopy investigations of femtosecond-laser bulk-excitation of a-SiO_2 for various temporal shapes with their consequences on the energy transfer to the lattice estimated from the absorptive electronic cloud and the pressure wave.

JMC • Joint CLEO/QELS Symposium on Optomechanics for Physical and Biological Sciences III: Technology—Continued

JMC5 • 2:30 p.m. Invited
Sound, Light and Particles in Photonic Crystal Fibres, *Philip Russell,* *A. Brenn, T. G. Euser, M. K. Garbos, M. S. Kang, A. Nazarkin; Max-Planck-Inst. for the Science of Light, Germany.* Keeping light tightly guided, over metre-long distances, in both nanoscale solid glass cores and hollow cores allows enhanced and highly reproducible control of linear and nonlinear interactions between light, acoustic vibrations and trapped particles.

JMC6 • 3:00 p.m.
High Throughput Photoporation of Mammalian Cells Using Microfluidic Cell Delivery, *Robert F. Marchington,* *Yoshihiko Arita, David J. Stevenson, Frank J. Gunn-Moore, Kishan Dholakia; Univ. of St. Andrews, UK.* Photoporation (optical injection) of mammalian cells using a tightly focused femtosecond laser beam is demonstrated within a microfluidic chip, providing delivery of cells to the beam and thus automating the system for high cell throughput.

3:15 p.m.–3:45 p.m. Coffee Break, *San Jose McEnery Convention Center, Concourse Level*

NOTES

CLEO: Applications

CLEO

AMC • Sensing and Imaging—Continued

AMC4 • 2:30 p.m.
Waveguide Biosensor with Integrated Photodetector Array for Tuberculosis Serology, ***Rongjin Yan****, N Scott Lynn, Luke C. Kingry, David S. Dandy, Richard A. Slayden, Kevin L. Lear; Colorado State Univ., USA.* The first demonstration of a label-free LEAC biosensor immunoassay is reported. CMOS chips with integrated detection arrays detected tuberculosis related antibodies and 18kDa protein antigens. The limit of detection for thickness change was 120 pm.

AMC5 • 2:45 p.m.
Wide Field-of-View Lensless Imaging of Caenorhabditis Elegans on a Chip, ***Serhan O. Isikman****, Ikbal Sencan, Onur Mudanyali, Waheb Bishara, Cetin Oztoprak, Aydogan Ozcan; Univ. of California at Los Angeles, USA.* Wide field-of-view lensfree on-chip imaging of C. Elegans samples is demonstrated using incoherent lensless in-line holography. Digital reconstruction of these lensless holograms rapidly creates the C. Elegans images over a field-of-view of >24mm².

AMC6 • 3:00 p.m.
Development of a Quantum Cascade Laser-Based Sensor for Non-Invasive CO_2 Monitoring, ***Anna P. M. Michel****[1], Tina P. Chen[1], Tiffany S. Ko[2], Nevin V. Raj[3], Meyeneobong E. Inyang[1], Bryan T. Bosworth[4], Matthew D. Escarra[1], Claire F. Gmachl[1]; [1]Princeton Univ., USA, [2]MIT Lincoln Lab, USA, [3]Harvard Univ., USA, [4]Albert-Ludwigs-Univ., Germany.* A novel device is proposed for the non-invasive measurement of CO_2 utilizing reflectance of the skin surface by a mid-infrared quantum cascade laser. We demonstrate CO_2 detection in a polymer at levels of biological importance.

CMCC • General Aspects of Nonlinear Optics—Continued

CMCC2 • 2:30 p.m.
Heralded Single Photon Partial Coherence, ***P. Ben Dixon****, Gregory Howland, Mehul Malik, David J. Starling, Robert W. Boyd, Emil Wolf, John C. Howell; Univ. of Rochester, USA.* We study partial transverse spatial coherence of localized single photon states. We demonstrate non-local control over its spatial coherence, which can be used for quantum image steganography, and provide theoretical framework from quantum coherence theory.

CMCC3 • 2:45 p.m.
Loophole-Free Bell Inequality Test via Preselected Macro-Qubit Entanglement, ***Magdalena Stobinska****[1,2,3], Pawel Horodecki[3,4], Ravindra Chhajlany[4,5,6], Ryszard Horodecki[3,4]; [1]Erlangen-Nürnberg Univ., Germany, [2]Max-Planck-Inst. for the Science of Light, Germany, [3]Univ. of Gdańsk, Poland, [4]Natl. Quantum Information Ctr. of Gdańsk, Poland, [5]Gdańsk Univ. of Technology, Poland, [6]Adam Mickiewicz Univ., Poland.* We present optical macro-entanglement beamsplitter-based preselection as a tool for loophole-free Bell test. Applied to experimentally feasible macro-qubits removes inefficiency of detection and dark counts. It constitutes novel polarization entanglement type.

CMCC4 • 3:00 p.m.
Increased Field of View via Nonlinear Digital Holography, ***Christopher Barsi****, Jason W. Fleischer; Princeton Univ., USA.* All imaging systems have limitations to their field of view. Here, we experimentally demonstrate that wave mixing due to spatial nonlinearity can increase this parameter.

CMDD • Mid-IR—Continued

CMDD5 • 2:30 p.m.
High-Power, Widely Tunable Cr^{2+}:ZnSe Laser, ***Patrick A. Berry****, Kenneth Schepler; AFRL, USA.* We demonstrate high-power (4 W), widely-tunable (400 nm) polycrystalline Cr^{2+}:ZnSe CW laser system utilizing an astigmatically-compensated Littrow-configuration cavity design. Using an etalon, linewidths as low as 2 nm were achieved.

CMDD6 • 2:45 p.m.
Efficient Cryo-Cooled 2.7-µm Er^{3+}-Doped Y_2O_3 Ceramic Laser Diode-Pumped at 974 nm, *Tigran Sanamyan, Jed F. Simmons,* ***Mark Dubinskii****; US ARL, USA.* Reported here is the first cryogenically-cooled diode-pumped performance of Er^{3+}:Y_2O_3 laser based on $^4I_{11/2} \Rightarrow {}^4I_{13/2}$ transitions. Pump-limited CW power of over 1.6 W at ~2.7 µm was achieved with the 27.5% slope efficiency.

CMDD7 • 3:00 p.m.
Dynamics of an Erbium Mid-IR Laser, ***Steven R. Bowman****, Nicholas J. Condon, Shawn O'Connor; NRL, USA.* A room temperature 4.5µm laser is reported in Er:KPb_2Cl_5 crystals using 0.8µm diode excitation. Long fluorescent lifetimes lead to important ETU and ESA processes. The impact of these excitation channels on laser performance is assessed.

3:15 p.m.–3:45 p.m. Coffee Break, *San Jose McEnery Convention Center, Concourse Level*

NOTES

3:45 p.m.–5:30 p.m.
CMEE • Pulse Shaping
Charles G. Durfee; Colorado School of Mines, USA, Presider

CMEE1 • 3:45 p.m. Tutorial

Ultrafast Pulse Shaping and Applications, ***Andrew Weiner****; Purdue Univ., USA.* Programmable optical pulse shaping, allowing generation of nearly arbitrarily shaped ultrafast optical waveforms, is reviewed. After outlining the fundamentals, new directions in pulse shaping and selected applications are discussed.

Andrew Weiner, the Scifres Distinguished Professor of Electrical and Computer Engineering at Purdue University, is especially well known for his pioneering work in the field of femtosecond pulse shaping. Prof. Weiner is a Fellow of both OSA and IEEE, is a member of the U.S. National Academy of Engineering, and has won numerous awards for his research. In 2009 he was selected by the Department of Defense as a National Security Science and Engineering Faculty Fellow. Prof. Weiner is author of over 230 journal articles and 400 conference papers as well as the recently published textbook Ultrafast Optics.

3:45 p.m.–5:30 p.m.
CMFF • Quantum Emitter Photonic Devices
Won Park; Univ. of Colorado, USA, Presider

CMFF1 • 3:45 p.m.

LO-Phonon Scattering of Cavity Polaritons in an Electroluminescent Device, ***Aymeric Delteil****[1], Angela Vasanelli[1], David Barate[1,2], Pierre Jouy[1], Jan Devenson[2], Roland Teissier[2], Alexei Baranov[2], Carlo Sirtori[1]; [1]MPQ Univ. Paris Diderot, France, [2]IES, Inst. d'Electronique du Sud, Univ. de Montpellier, France.* Emission of longitudinal optical phonons between the upper and the lower polariton branches has been observed in an intersubband electroluminescent device, operating in the strong coupling regime.

CMFF2 • 4:00 p.m.

Highly Efficient Electrically Driven Quantum Dot Micropillar Single Photon Sources, ***Stephan Reitzenstein****, Tobias Heindel, Christian Schneider, Matthias Lermer, Sven Hofling, Lukas Worschech, Alfred Forchel; Technische Physik, Univ. Würzburg, Germany.* We report on highly efficient electrically pumped quantum dot-micropillar single photon sources. The triggered sources show record high efficiency (34%) and single photon emission rates of up to 35 MHz under pulsed electrical excitation.

CMFF3 • 4:15 p.m.

Top-Down Fabricated Hybrid Diamond-Plasmon Nanoparticles, ***Birgit J. M. Hausmann****[1], Irfan Bulu[1], Tom Babinec[1], Mughees Khan[1], Phil R. Hemmer[2], Marko Loncar[1]; [1]Harvard Univ., USA, [2]Texas A&M Univ., USA.* We theoretically describe a hybrid diamond-plasmon particle device containing individual NV centers for QIP and quantum cryptography applications. Fabrication includes using E-beam lithography, ICP RIE and E-beam evaporation to define diamond nanoparticles embedded in gold.

CMFF4 • 4:30 p.m.

Fiber-Coupled Waveguides for Strong Resonant Interactions with Single Semiconductor Quantum Dots, ***Marcelo I. Davanco****[1], Matthew T. Rakher[1], Antonio Badolato[2], Kartik Srinivasan[1]; [1]NIST, USA, [2]Univ. of Rochester, USA.* We investigate fiber-coupled waveguides engineered for efficient interaction with single semiconductor quantum dots, with calculated fluorescence collection 70% and 15dB transmission contrast upon resonant excitation. Characterization of passive waveguides and preliminary photoluminescence measurements are presented.

3:45 p.m.–5:15 p.m.
CMGG • Photo-Darkening and Speciality Fibers
Liang Dong; IMRA America Inc., USA, Presider

CMGG1 • 3:45 p.m. Invited

Photo Darkening of Ytterbium Fiber Lasers and Amplifiers, ***Kent E. Mattsson****; Crystal Fibre, Denmark.* Photo darkening (PD) of ytterbium co-doped silica fibers in lasers and amplifiers is experimentally investigated and a numeric model for PD is proposed. Relaxation to well-defined equilibrium state of core PD is observed.

CMGG2 • 4:15 p.m.

Kilowatt-Level Peak Power Monolithic Fiber Amplifier for Single-Mode, Narrow Linewidth 100 ns Pulses, ***Wei Shi****[1], Eliot B. Peterse[1,2], Dan T. Nguyen[1], Jie Zong[1], Zhidong Yao[1], Mark A. Stephen[3], Arturo Chavez-Pirson[1], Nasser Peyghambarian[1]; [1]NP Photonics, Inc., USA, [2]Univ. of Arizona, USA, [3]NASA-GSFC, USA.* We have achieved a peak power of 1.2 kW for 105 ns pulses at 1530nm with transform-limited linewidth by using a single-mode 25μm-core phosphate fiber in the power amplifier stage of a monolithic MOPA system.

CMGG3 • 4:30 p.m.

Zero-Dispersion Wavelength Decreasing Tellurite Microstructured Fiber for Wide and Flattened Supercontinuum Generation, *Guanshi Qin,* ***Yasutake Ohishi****; Optical Functional Materials Lab, Japan.* We demonstrate wide and flattened supercontinuum generation in zero-dispersion wavelength decreasing tellurite microstructured fibers fabricated by using the tapering method.

3:45 p.m.–5:30 p.m.
CMHH • Multi-GHz Combs and Astronomical Applications
Franz X. Kärtner; MIT, USA, Presider

CMHH1 • 3:45 p.m.

A 12.5 GHz-Spaced Optical Frequency Comb Spanning >400 nm for Astronomical Spectrograph Calibration, ***Franklyn J. Quinlan****[1], Gabe Ycas[1,2], Steve Osterman[3], Scott Diddams[1]; [1]NIST, USA, [2] Physics Dept., Univ. of Colorado, USA, [3] Ctr. for Astrophysics and Space Astronomy, Univ. of Colorado, USA.* A 12.5 GHz-spaced optical frequency comb spanning 1380 nm to 1820 nm is generated via filtering and nonlinearly broadening a 250 MHz-spaced comb. Sidemode suppression from 1380 nm to 1630 nm has been measured.

CMHH2 • 4:00 p.m.

Tunable Blue Astro-Comb, ***Guoqing Chang****[1], Andrew J. Benedick[1], Jonathan R. Birge[1], Alexander Glenday[2], Chi-Hao Li[2], David F. Phillips[2], Ronald L. Walsworth[2], Franz X. Kärtner[1]; [1]MIT, USA, [2]Harvard-Smithsonian Ctr. for Astrophysics, USA.* We developed a tunable, visible frequency comb near 420nm with 22GHz mode spacing and 20nm spectral width, which is able to calibrate astronomical spectrographs to search Earth-like exoplanets orbiting around stars similar to the Sun.

CMHH3 • 4:15 p.m.

High Precision Calibration of Spectrographs in Astronomy, ***Tobias Wilken****[1], Theodor W. Haensch[1], Thomas Udem[1], Tilo Steinmetz[1,2], Ronald Holzwarth[1,2], Antonio Manescau[3], Gaspare Lo Curto[3], Luca Pasquini[3], Christophe Lovis[4]; [1]Max-Planck-Inst. of Quantum Optics, Germany, [2]Menlosystems GmbH, Germany, [3]European Southern Observatory, Germany, [4]Observatoire de l'Univ. de Genève, Switzerland.* An Yb-fiber frequency comb was developed and employed to calibrate an astronomical spectrograph. The repeatability was photon noise limited at 300kHz. Absolute accuracy was improved by a factor of 20 compared to traditional calibration sources.

CMHH4 • 4:30 p.m.

Broadband Astro-Combs and the Impact of Nonlinear Spectral Broadening on Sidemode Suppression, ***Guoqing Chang****[1], Chi-Hao Li[2], David F. Phillips[2], Ronald L. Walsworth[2], Franz X. Kärtner[1]; [1]MIT, USA, [2]Harvard-Smithsonian Ctr. for Astrophysics, USA.* We propose and analyze an approach to generating broadband astro-combs with 1 cm/s (~10 kHz) calibration accuracy on astrophysical spectrographs. Implementation of these astro-combs requires a side-mode suppression of 60 dB before nonlinear spectral broadening.

Room A5

QELS

3:45 p.m.–5:30 p.m.
QMG • Localization and Propagation in Disordered Media
Zheng Wang; MIT, USA, Presider

QMG1 • 3:45 p.m. Invited
Band Gaps in Amorphous Photonic Lattices, ***Mikael Rechtsman***[1]*, Alexander Szameit*[2]*, Felix Dreisow*[3]*, Matthias Heinrich*[3]*, Robert Keil*[3]*, Stefan Nolte*[3]*, Mordechai Segev*[2]*;* [1]*Courant Inst. of Mathematical Sciences, New York Univ., USA,* [2]*Physics Dept. and Solid State Inst., Technion-Israel Inst. of Technology, Israel,* [3]*Inst. of Applied Physics, Friedrich-Schiller-Univ. Jena, Germany.* We present, theoretically and experimentally, amorphous photonic lattices exhibiting a band gap and negative effective mass, without Bragg diffraction. Bands are Anderson states, but defect states residing in the gap are always more localized.

QMG2 • 4:15 p.m.
Threshold Lasing Modes of a Random Laser: From the Localised to the Ballistic Regime, ***Ara A. Asatryan***[1]*, Lindsay C. Botten*[1]*, Michael A. Byrne*[1]*, Patrick Sebbah*[2]*, Christian Vanneste*[2]*, Laurent Labonte*[2]*, Hui Cao*[3]*;* [1]*Univ. of Technology, Sydney, Australia,* [2]*Univ. of Nice, France,* [3]*Yale Univ., USA.* We use the rigorous multipole method to calculate lasing and quasi-bound states from localised to diffusive regimes and show these coincide in the former regime but differ in the latter.

QMG3 • 4:30 p.m.
Spatial Photon Correlations in Multiple Scattering Media, ***Stephan Smolka***[1]*, Otto Muskens*[2]*, Ad Lagendijk*[3]*, Peter Lodahl*[1]*;* [1]*Dept. of Photonics Engineering, DTU Fotonik, Denmark,* [2]*School of Physics and Astronomy, Univ. of Southampton, United Kingdom,* [3]*Ctr. for Nanophotonics, FOM-Inst. AMOLF, Netherlands.* We present the first angle-resolved measurements of spatial photon correlations that are induced by multiple scattering of light. The correlation relates multiple scattered photons at different spatial positions and depends on incident photon fluctuations.

Room A6

CLEO

3:45 p.m.–5:30 p.m.
CMII • Modelocked Lasers
Richard Mirin; NIST, USA, Presider

CMII1 • 3:45 p.m. Invited
Reconfigurable, Multi-Section Quantum Dot Mode-Locked Lasers, ***Luke F. Lester****, C.-y. Lin, Y. Li, J. H. Kim, C. G. Christodoulou; Univ. of New Mexico, USA.* The optical characterization and applications of quantum dot mode-locked lasers constructed using a reconfigurable, unit-cell approach are discussed including diverse waveform generation, optical to RF signal conversion, and optimal laser layout design.

CMII2 • 4:15 p.m.
GaAs/AlGaAs Colliding Pulse Mode-Locked Lasers with Non-Absorbing Mirrors, ***Giuseppe Tandoi***[1]*, Charles N. Ironside*[1]*, A. Catrina Bryce*[1]*, Stewart D. McDougall*[2]*;* [1]*Univ. of Glasgow, UK,* [2]*Intense Ltd, UK.* We use quantum well intermixing to monolithically integrate non-absorbing mirrors in 3.7mm long GaAs/AlGaAs colliding-pulse mode-locked lasers and improve their output power by 40% by increasing the threshold for catastrophic optical mirror damage.

CMII3 • 4:30 p.m.
Monolithic 40 GHz Passively Mode Locked AlGaInAs/InP 1.55 μm MQW Laser with Surface-Etched Bragg Gratings, ***Lianping Hou***[1]*, Moss Haji*[1]*, Rafal Dylewicz*[1]*, Piotr Stolarz*[1]*, Anthony kelly*[1]*, John Arnold*[1]*, John Marsh*[1]*, Richard De la Rue*[1]*, Marc Sorel*[1]*, Catrina Bryce*[1]*, Bocang Qiu*[2]*;* [1]*Univ. of Glasgow, UK,* [2]*Intense Ltd., UK.* We fabricated 40 GHz passively mode-locked AlGaInAs/InP 1.55 μm lasers integrated with surface-etched distributed Bragg mirrors. Numerically optimized gratings provide low loss and accurate wavelength control. The lasers produce 10-ps Gaussian-pulses with TBP of 0.75.

Room A7

QELS

3:45 p.m.–5:30 p.m.
QMH • Plasmonic Antennas
Oscar Painter; Caltech, USA, Presider

QMH1 • 3:45 p.m.
Effects of Nanodots on Surface Plasmons and Electric Field Enhancement in Nano-Pillar Antenna Array, ***Jonathan Hu****, Wen-Di Li, Fei Ding, Stephen Y. Chou; Princeton Univ., USA.* We study effects of nanodots on surface plasmons and field enhancement in nano-pillar antenna array. The NPA's nanodots have slight effect on surface plasmon resonance wavelength, but increase field enhancement by two orders of magnitude.

QMH2 • 4:00 p.m.
Imaging the 3-D Scattering Pattern of Plasmonic Nanoantennas by Heterodyne Numerical Holography, ***Sarah Y. Suck***[1]*, Stéphane Collin*[2]*, Nathalie Bardou*[2]*, Yannick De Wilde*[1]*, Gilles Tessier*[1]*;* [1]*Inst. Langevin, Lab d'Optique, CNRS, France,* [2]*Lab de Photonique et de Nanostructures, CNRS, France.* Optical nanoantennas are studied by full field heterodyne numerical holography in total internal reflection. After a spectroscopic characterization, the 3-D scattering pattern of gold nanodisc chains was measured for wavelengths in and out of resonance.

QMH3 • 4:15 p.m. Invited
Lithographically Fabricated Optical Antennas with Sub-10nm Gaps Formed by a Sacrifical Layer, ***Wenqi Zhu****, Mohamad G. Banaee, Kenneth B. Crozier; Harvard Univ., USA.* We lithographically fabricate arrays of optical antennas with ~6nm gaps. The enhancement factor from surface-enhanced Raman scattering measurement is ~5 times larger than the same structure with ~18nm gaps.

Room A8	Room C1&2	Room C3&4	San Jose Ballroom IV (San Jose Marriott)
CLEO	CLEO	CLEO	JOINT

3:45 p.m.–5:30 p.m.
CMJJ • THz Ultrafast Generation
Jianming Dai; Rensselaer Polytechnic Inst., USA, Presider

CMJJ1 • 3:45 p.m.
THz Generation from Monoclinic Centrosymmetric GaTe Crystals Pumped across Bandgap Due to Carrier Unidirectional Diffusion, *Guibao Xu*[1], *Guan Sun*[1], *Yujie J. Ding*[1], *Ioulia B. Zotova*[2], *Krishna C. Mandal*[3], *Alket Mertiri*[3], *Gary Pabst*[3], *Nils Fernelius*[4]; [1]*Lehigh Univ., USA,* [2]*ArkLight, USA,* [3]*EIC Labs, Inc., USA,* [4]*AFRL, USA.* We have observed unique polarization and azimuth-angle characteristics of THz waves, generated from anisotropic monoclinic GaTe when pump photon energy is below and above its bandgap, due to carrier unidirectional diffusion.

CMJJ2 • 4:00 p.m.
Intense Terahertz Generation Based on the Photo-Dember Effect, *Gregor Klatt*[1], *Florian Hilser*[1], *Wenchao Qiao*[1], *Raphael Gebs*[1], *Albrecht Bartels*[1], *Klaus Huska*[2], *Uli Lemmer*[2], *Georg Bastian*[3], *Michael B. Johnston*[4], *Milan Fischer*[5], *Jérôme Faist*[5], *Thomas Dekorsy*[1]; [1]*Univ. of Konstanz, Germany,* [2]*Univ. Karlsruhe, Germany,* [3]*Univ. of Applied Sciences Trier, Germany,* [4]*Univ. of Oxford, UK,* [5]*ETH Zürich, Switzerland.* We demonstrate a new scheme for generating THz radiation based on the photo-Dember effect in lateral geometry. By micro-structuring a semiconductor surface we achieve strongly enhanced THz emission comparable to high-efficiency externally biased photoconductive emitters.

CMJJ3 • 4:15 p.m.
Evidence of Constructive Interference of THz Waves Emitted by Randomly-Distributed InN Nanoantennas, *Guibao Xu*[1], *Guan Sun*[1], *Yujie J. Ding*[1], *Ioulia B. Zotova*[2], *Muhammad Jamil*[3], *Ian T. Ferguson*[3]; [1]*Lehigh Univ., USA,* [2]*ArkLight, USA,* [3]*Georgia Tech, USA.* We demonstrate that THz radiation beams generated by an array of the randomly-distributed InN nanopyramids can be used to enhance the THz output power by two orders of magnitude due to strong constructive interference.

CMJJ4 • 4:30 p.m.
Terahertz Emission of Magnesium Doped Indium Nitride, *Yi-Jou Yeh*[1], *Hyeyoung Ahn*[1], *Yu-Liang Hong*[2], *Shangjr Gwo*[2]; [1]*Dept. of Photonics and Inst. of Electro-Optical Engineering, Natl. Chiao Tung Univ., Taiwan,* [2]*Dept. of Physics, Natl. Tsing-Hua Univ., Taiwan.* Significant THz power enhancement and polarity reversal were observed from Mg-doped InN. The carrier concentration-dependent THz polarity-reversal reflects the interplay between surface-electric-field and photo-Dember field for THz emission from InN:Mg.

3:45 p.m.–5:30 p.m.
CMKK • Efficiency in Solid-State Lighting
Asif Khan; Univ. of South Carolina, USA, Presider

CMKK1 • 3:45 p.m. Invited
Efficiency Droop in GaInN Solid-State Lighting Devices, *E. Fred Schubert*, *Martin F. Schubert; Rensselaer Polytechnic Inst., USA.* The efficiency droop in GaInN light-emitting diodes (LEDs) is an impediment for the introduction of solid-state lighting technology. The origin of the droop will be discussed along with measures that mitigate the droop.

CMKK2 • 4:15 p.m.
Investigation of Efficiency Droop in Blue InGaN/GaN Light-Emitting Diodes with Different Well Widths, *Chao-Hsun Wang*, *Ching-Hua Chiu, Jun-Rong Chen, Hao-Chung Kuo, Tien-Chang Lu, Shing-Chung Wang; Dept. of Photonic and Inst. of Electro-Optical Engineering, Natl. Chiao Tung Univ., Taiwan.* Temperature-dependent electroluminescence efficiency of blue light-emitting diodes with different well widths is investigated. The efficiency droop phenomenon for LEDs at low temperature is dependent with electron overflow and non-uniform hole distribution within MQW region.

CMKK3 • 4:30 p.m.
Reduction of the Efficiency Droop Effect of a Light-Emitting Diode through Surface Plasmon Coupling, *Chih-Feng Lu*, *Che-Hao Liao, Chih-Yen Chen, Chieh Hsieh, C. C. Yang; Natl. Taiwan Univ., Taiwan.* The efficiency droop effect of a light-emitting diode is significantly reduced through the coherent coupling of its emitting quantum wells with the surface plasmons generated on the fabricated Ag structure on the device top surface.

3:45 p.m.–5:30 p.m.
CMLL • Laser Structuring of Optical Materials
Richard Haglund; Vanderbilt Univ., USA, Presider

CMLL1 • 3:45 p.m. Invited
Micro- and Nano- Scale System Manufacturing Using Ultrafast Lasers, *Yves Bellouard*; *Technische Univ. Eindhoven, Netherlands.* Low-energy femtosecond laser pulses can be used to introduce various functionalities in fused silica that can be combined or distributed to form integrated micro- and nano-scale systems suitable for optofluidics and optomechanics applications.

CMLL2 • 4:15 p.m.
Single-Sweep Production of Complex 3-D-Waveguide Devices Produced by Adaptive Femtosecond Laser Writing, *Matthias Pospiech*[1], *Moritz Emons*[1], *Benjamin Väckenstedt*[1], *Uwe Morgner*[1,2]; [1]*Inst. of Quantum Optics, Leibniz Univ. Hannover, Germany,* [2]*Laser Zentrum Hannover e.V., Germany.* We report on the simultaneous creation of multiple waveguides in different depths in fused silica. A combination of beam shaping with femtosecond laser writing is used to write two waveguides with changing separation and depth.

CMLL3 • 4:30 p.m.
Sub Micron fs Inscribed Volume Bragg Gratings in Fused Silica, *Daniel Richter*, *Christian Voigtländer, Jens Thomas, Stefan Nolte, Andreas Tünnermann; Friedrich-Schiller-Univ. Jena, Germany.* We present femtosecond induced volume Bragg gratings (VBGs) using a phase mask technique. For the first time we could realize reflecting VBGs in fused silica with a high period stability and periods down to 537.5nm.

3:45 p.m.–5:30 p.m.
JMD • Joint CLEO/QELS Symposium on Optomechanics for Physical and Biological Sciences IV: Bio
Seok-Hyun (Andy) Yun; Harvard Univ., USA, Presider

JMD1 • 3:45 p.m. Invited
Light Takes Shape for Biophotonics: New Directions in Trapping and Cell Transfection, *Kishan Dholakia*; *Univ. of St. Andrews, UK.* We describe applications of optically sculpting the incident field for applications in optical trapping and controlled cell transfection.

JMD2 • 4:15 p.m.
Design and Experimental Demonstration of Optical Resonators for Nanotweezing, *Xavier Serey*[1], *Sudeep Mandal*[1], *David Erickson*[2]; [1]*School of Applied and Engineering Physics, Cornell Univ., USA,* [2]*Sibey School of Mechanical and Aerospace Engineering, Cornell Univ., USA.* Resonant silicon photonics has recently enabled the direct optical tweezing of nano-objects on chip. Here we present a comprehensive evaluation of different resonator designs and demonstrate one with a stiffness of 22.3 pN nm-1 W-1.

JMD3 • 4:30 p.m.
An Integrated Single Cell Optofluidic Platform Based on Phototransistor Optoelectronic Tweezers, *Arash Jamshidi*, *Justin K. Valley, Wilbur Lam, Hsan-Yin Hsu, Tiffany Dai, Sharmin Shekarchian, Steven L. Neale, Shao Ning Pei, Ming C. Wu; Univ. of California at Berkeley, USA.* We present a novel single cell manipulation platform based on phototransistor optoelectronic tweezers. This new platform integrates the functionalities of phOET for parallel cell manipulation in highly conductive culture media with a commercial microfluidic device.

Room B2-B3

CLEO: Applications

3:45 p.m.–5:30 p.m.
AMD • Spectroscopy and Imaging
Ilko K. Ilev; Food and Drug Administration (FDA), USA, Presider

AMD1 • 3:45 p.m. Invited
Optical Spectroscopy for the Diagnosis of Cancer, *Urs Utzinger;* *Univ. of Arizona, USA.* Abstract not available.

AMD2 • 4:15 p.m.
Multimodal Optical Coherence Tomography and Fluorescence Lifetime Imaging System for Simultaneous Anatomical and Biochemical Imaging of Biological Tissue, *Sebina Shresta, Jesung Park, Paritosh Pande, Fred Clubb, Brian E. Applegate,* ***Javier A. Jo****; Texas A&M Univ., USA.* We have developed a multimodal optical system for simultaneous optical coherence tomography (OCT) and fluorescence lifetime imaging microscopy (FLIM) imaging, and demonstrate its capability for high-speed co-registered micro-anatomical and biochemical tissue imaging.

AMD3 • 4:30 p.m.
Phase-Sensitive Motility Contrast Imaging of Tumor Response to Drugs, *Kwan Jeong[1],* ***David D. Nolte****[2], John Turek[2]; [1]Korean Military Acad., Republic of Korea, [2]Purdue Univ., USA.* We introduce phase-sensitive motility contrast imaging and present high-contrast time-course measurements of cytoskeletal anticancer drug effects on dynamic motion inside tumor spheroids obtained by digital holographic optical coherence imaging.

San Jose Salon I & II (San Jose Marriott)

CLEO

3:45 p.m.–5:30 p.m.
CMMM • Super Continuum and Multi-Wavelength Generation
Vladimir V. Shkunov; Raytheon Corp., USA, Presider

CMMM1 • 3:45 p.m.
Simultaneous Spectral Broadening and Amplification of a Laser Pulse in a Glass Plate, ***Jun Liu****[1,2], Takayoshi Kobayashi[1,2,3,4]; [1]Univ. of Electro-Communications, Japan, [2]JST, ICORP, Ultrashort Pulse Laser Project, Japan, [3]Natl. Chiao Tung Univ., Taiwan, [4]Osaka Univ., Japan.* We demonstrated a novel method of simultaneous spectral broadening and amplification of a laser pulse in a glass plate. A proof-of-principle experiment improved both the spectrum and the energy by a factor of about three.

CMMM2 • 4:00 p.m.
Supercontinuum Generation in an Integrated High-Index Glass Spiral Waveguide, ***David Duchesne****[1], Marco Peccianti[1,2], Michael R. E. Lamont[3], Marcello Ferrera[1], Luca Razzari[1,4], François Légaré[1], Roberto Morandotti[1], Sai T. Chu[5], Brent E. Little[5], David J. Moss[3]; [1]INRS-EMT, Canada, [2]Res. Ctr. SOFT INFM-CNR, "Sapienza" Univ., Italy, [3]CUDOS, Univ. of Sydney, Australia, [4]Dept. di Elettronica, Univ. di Pavia, Italy, [5]Infinera Corp., USA.* A supercontinuum spectrum of more than 300nm is obtained at 1550nm and 1290nm using doped-silica glass, 45cm long, integrated spiral waveguides. Different dynamics near two distinct zero dispersion wavelengths are observed and explained theoretically.

CMMM3 • 4:15 p.m.
Mid-Infrared Supercontinuum Generation in Lead-Bismuth-Gallium Oxide Glass Photonic Crystal Fiber, ***Nicolas Ducros****[1], Alexis Labruyère[1], Sébastien Février[1], Franck Morin[2], Frédéric Druon[2], Marc Hanna[2], Patrick Georges[2], Ryszard Buczynski[3], Dariusz Pysz[4], Ryszard Stepien[4]; [1]Xlim, Univ. of Limoges, France, [2]Lab Charles Fabry de l'Inst. d'Optique, Univ. Paris-Sud, France, [3]Faculty of Physics, Univ. of Warsaw, Poland, [4]Inst. of Electronic Materials Technology, Poland.* Supercontinuum generation from visible up to 2.8 μm is demonstrated in a highly nonlinear heavy metal oxide glass photonic crystal fiber. Numerical modelling shows that the supercontinuum may be extended to 4 μm.

CMMM4 • 4:30 p.m.
Two-Octave Supercontinuum Generation in a Liquid-Core Photonic Crystal Fiber, ***Jens Bethge****[1], Anton Husakou[1], Fedor Mitschke[2], Frank Noack[1], Uwe Griebner[1], Günter Steinmeyer[2], Joachim Herrmann[1]; [1]Max-Born-Inst. für Nichtlineare Optik und Kurzzeitspektroskpie, Germany, [2]Univ. Rostock, Germany.* We observe the generation of supercontinua from a hollow-core photonic crystal fiber filled with water. The observed supercontinuum spans the spectral range from 410 to 1650 nm and has a high energy of 0.4 μJ.

San Jose Salon III (San Jose Marriott)

3:45 p.m.–5:30 p.m.
CMNN • Short Pulse
Joe Alford; Lockheed Martin, USA, Presider

CMNN1 • 3:45 p.m.
Modelocking of a Diode-Laser-Pumped Ti:Sapphire Laser, ***Peter W. Roth****, Alexander J. Maclean, David Burns, Alan J. Kemp; Inst. of Photonics, Univ. of Strathclyde, UK.* Modelocking of a directly diode-laser-pumped Ti:sapphire laser is demonstrated. Near transform-limited pulses of 116fs duration are measured for an output power of 9mW under pumping at 452nm with a 1W gallium nitride diode laser.

CMNN2 • 4:00 p.m.
Generation of Sub-150-fs, 100 nJ Pulses from a Low-Cost Cavity-Dumped Cr:LiSAF Laser, ***Umit Demirbas****, Kyung-Han Hong, James G. Fujimoto, Alphan Sennaroglu, Franz X. Kärtner; MIT, USA.* We report a low-cost, cavity dumped Cr:LiSAF laser, generating 135-fs pulses at 825 nm, with 105 nJ pulse energies and ~0.78 MW of peak power at 10 kHz, using only 600 mW of pump power.

CMNN3 • 4:15 p.m.
Nd:$GdVO_4$ Laser Passively Mode-Locked by Cascaded Nonlinearity in Periodically-Poled Lithium Tantalate, *Hristo Iliev[1], Dimitar Popmintchev[1], Ivan Buchvarov[1], Sunao Kurimura[2], Uwe Griebner[3],* ***Valentin Petrov****[3]; [1]Sofia Univ., Bulgaria, [2]Natl. Inst. for Materials Science, Japan, [3]Max-Born-Inst., Germany.* PPMgSLT is used for mode-locking of a diode-pumped Nd:$GdVO_4$ laser by intracavity SHG. Stable and self-starting operation is observed achieving output powers of up to 4.7 W and pulse durations as short as 3.2 ps.

CMNN4 • 4:30 p.m.
Diode-Pumped Mode-Locked Nd^{3+}-Doped $Ba(Zr,Mg,Ta)O_3$ Ceramic Laser, *Hiroaki Kurokawa[1], Masaki Tokurakawa[1],* ***Akira Shirakawa****[1], Ken-ichi Ueda[1], Alexander A. Kaminskii[2], Satoshi Kuretake[3], Nobuhiko Tanaka[3], Yuji Kintaka[3], Keisuke Kageyama[3]; [1]Inst. for Laser Science, Univ. of Electro-Communications, Japan, [2]Inst. of Crystallography, Russian Acad. of Sciences, Russian Federation, [3]Murata Manufacturing Co., Ltd., Japan.* Nd^{3+}-doped $Ba(Zr,Mg,Ta)O_3$ ceramic laser is reported. The broadband fluorescence profile can be tailored by the "disordered" perovskite structure and is suitable for ultrashort pulse lasers. Mode-locked laser operation was demonstrated for the first time.

CMEE • Pulse Shaping—Continued

CMEE2 • 4:45 p.m.
Line-by-Line Control towards 10-THz Repetition Rate Arbitrary Optical Waveform Generation, ***Kanaka Raju Pandiri***[1], *Takayuki Suzuki*[1], *Akira Suda*[2], *Katsumi Midorikawa*[2], *Masayuki Katsuragawa*[1]; [1]*Univ. of Electro-Communications, Japan,* [2]*RIKEN Advanced Science Inst., Japan.* We report the line-by-line control of 10-THz frequency spacing Raman sidebands produced through an adiabatic Raman process. We finely control the spectral phase of the sidebands to the target flat-relative-spectral phase.

CMEE3 • 5:00 p.m.
Direct Temporal Shaping of High Energy Picosecond UV Pulses with a UV AOPDF Device, ***Alexandre Trisorio****, Clemens Ruchert, Christoph Hauri; Paul Scherrer Inst., Switzerland.* We demonstrate arbitrary shaped UV picosecond pulses with energies up to 50 μJ at 272 nm. Temporal shaping is performed by a UV AOPDF allowing direct amplitude and spectral phase control.

CMEE4 • 5:15 p.m.
Ultrabroadband Pulse Shaping with Double Side Deformable Mirror, *Stefano Bonora*[1,2], *Daniele Brida*[2], ***Paolo Villoresi***[1], *Giulio Cerullo*[2]; [1]*Univ. of Padova, Italy,* [2]*Politecnico di Milano, Italy.* We achieved ultrabroadband pulse shaping by use of a novel designed electrostatic deformable mirror based on push-pull technology. We demonstrated multi-pulse formation with programmable delay and sub-pulse length of 20 fs at 1.3μm.

CMFF • Quantum Emitter Photonic Devices—Continued

CMFF5 • 4:45 p.m.
Highly Anisotropic Decay Rate of Single Quantum Dots in Photonic Crystal Membranes, ***Qin Wang***[1], *Søren Stobbe*[1], *Henri Thyrrestrup*[1], *Holger Hofmann*[2], *Martin Kamp*[2], *Benedikt Friess*[2], *Lukas Worschech*[2], *Thomas Schlereth*[2], *Sven Höfling*[2], *Peter Lodahl*[1]; [1] *Dept. of Photonics Engineering, DTU Fotonik, Denmark,* [2]*Technische Physik, Univ. Würzburg, Germany.* We measured the variation of spontaneous emission rates with polarization for self-assembled single quantum-dots in photonic crystal membranes, and obtained a maximum anisotropy factor of 6 between decay rates of the two nondegenerate bright states.

CMFF6 • 5:00 p.m.
InGaAs QW Nanopillar Light Emitting Diodes Monolithically Grown on a Si Substrate, ***Linus C. Chuang****, Roger Chen, Forrest G. Sedgwick, Wai Son Ko, Kar Wei Ng, Thai-Truong D. Tran, Connie Chang-Hasnain; Dept. of Electrical Engineering and Computer Sciences, Univ. of California at Berkeley, USA.* Room-temperature operation of InGaAs/GaAs QW nanopillar light emitting diodes grown on a (111) Si substrate by low temperature MOCVD (400C) and fabricated using conventional lithography and processing techniques are reported for the first time.

CMFF7 • 5:15 p.m.
Fiber-Based Spectroscopy of 1.55 μm PbS Quantum Dots Coupled to Si Microcavities, ***Matthew T. Rakher***[1], *Ranojoy Bose*[2], *Chee Wei Wong*[2], *Kartik Srinivasan*[1]; [1]*Ctr. for Nanoscale Science and Technology, NIST, USA,* [2]*Optical Nanostructures Lab, Ctr. for Integrated Science and Engineering, Solid-State Science and Engineering and Mechanical Engineering, Columbia Univ., USA.* We use a fiber-taper waveguide to measure the transmission, photoluminescence, photodarkening, and lifetime from a low density of near-infrared PbS quantum dots integrated with silicon photonic crystal cavities, microdisks, and the taper itself.

CMGG • Photo-Darkening and Speciality Fibers—Continued

CMGG4 • 4:45 p.m.
An All-Fiber Optical Faraday Mirror, ***Lei Sun***[1,2], *Shibin Jiang*[3], *John Marciante*[1,2]; [1]*Inst. of Optics, Univ. of Rochester, USA,* [2]*Lab for Laser Energetics, Univ. of Rochester, USA,* [3]*AdValue Photonics Inc., USA.* An all-fiber optical Faraday mirror is demonstrated. It consists of a fiber Faraday rotator (56-wt% terbium-doped fiber) and a fiber Bragg grating. The polarization state of the reflected light is rotated 89°±2°.

CMGG5 • 5:00 p.m.
Photodarkening and Photobleaching of Yb-Doped Fibers by Laser Diodes, *Noriyuki Inoue,* ***Akira Shirakawa****, Ken-ichi Ueda; Inst. for Laser Science, Univ. of Electro-Communications, Japan.* Photodarkening and photobleaching of Yb-doped germanosilicate and aluminosilicate fibers have been studied. We show violet laser diodes (407nm) can efficiently bleach photodarkening even with low-intensity cladding-irradiation. Coirradiation of pumping and bleaching lights was also investigated.

CMHH • Multi-GHz Combs and Astronomical Applications—Continued

CMHH5 • 4:45 p.m.
CMOS-Compatible Microresonator-Based Optical Frequency Comb, ***Mark A. Foster****, Jacob S. Levy, Onur Kuzucu, Kasturi Saha, Michal Lipson, Alexander L. Gaeta; Cornell Univ., USA.* We generate optical frequency combs spanning 75 THz with a 204-GHz spacing using parametric oscillation in an integrated silicon-nitride microring resonator. The comb spacing is uniform to better than 5.2×10^{-11} relative to the optical frequency.

CMHH6 • 5:00 p.m.
Octave-Spanning Tunable Frequency Combs on a Chip, ***Pascal Del'Haye***[1], *Tobias Herr*[1], *Emanuel Gavartin*[2], *Ronald Holzwarth*[1], *Tobias J. Kippenberg*[1,2]; [1]*Max-Planck-Inst. of Quantum Optics, Germany,* [2]*École Polytechnique Fédérale de Lausanne, Switzerland.* We demonstrate direct full-octave spanning frequency comb generation via four-wave mixing in continuous wave laser pumped microresonators for the first time. The generated comb lines are fully tunable over more than one free spectral range.

CMHH7 • 5:15 p.m.
Demonstration of Semiconductor Laser Tracking Frequency Distance Gauge, ***James D. Phillips****, Eugeniu M. Popescu, Robert D. Reasenberg, Emanuele Rocco, Rajesh Thapa; Smithsonian Astrophysical Observatory, USA.* We present results from the Semiconductor-Laser Tracking Frequency distance Gauge having Allan deviation of 5 pm. The simple and rugged SL-TFG will achieve sub-pm accuracy. It is required for space-based astronomical instruments and gravitational experiments.

5:30 p.m.–6:00 p.m. Break *(Civic Auditorium doors will open at 5:45 p.m. for the Plenary)*

6:00 p.m.–8:30 p.m. CLEO and CLEO: Applications Plenary Session, *Civic Auditorium*

NOTES

Room A5

QELS

QMG • Localization and Propagation in Disordered Media—Continued

QMG4 • 4:45 p.m.
Controlling Anderson Localization in Disordered Photonic Crystal Waveguides, *Stephan Smolka,* *Pedro D. Garcia, Søren Stobbe, Peter Lodahl; Dept. of Photonics Engineering, DTU Fotonik, Denmark.* We prove Anderson localization in the slow-light regime of a photonic crystal waveguide by measuring the ensemble-averaged localization length which is controlled by the dispersion of the disordered photonic crystal waveguide.

QMG5 • 5:00 p.m.
Photonic Band-Gap Evolution from Polycrystalline to Amorphous Photonic Structures, *Jin Kyu Yang,* *Heeso Noh, Seng Fatt Liew, Carl Schreck, Corey S. O'Hern, Hui Cao; Yale Univ., USA.* We map out a transition from polycrystalline to amorphous photonic structures with decreasing short-range order. The photonic band gap decreases once the individual domains of ordered structure become too small for the gap formation.

QMG6 • 5:15 p.m.
Symmetry-Breaking of Bound States in the Continuum, *Yonatan Plotnik,* *Or Peleg, Alexszameit, Nimrod Moiseyev, Moti Segev; Technion-Israel Inst. of Technology, Israel.* We present the first experimental observation of bound states in the continuum in optics, and how the bound state transforms into a leaky mode as symmetry is reduced.

Room A6

CLEO

CMII • Modelocked Lasers—Continued

CMII4 • 4:45 p.m.
Generation of Microwave Signal in a Mode-Locked InAs/InP Based Quantum Dash Laser with CW Optical Injection, *Ehsan Sooudi*[1,2], *Harendra N. J. Fernando[1], Stephen P. Hegarty[2,3], Guillaume Huyet[2,3], John G. McInerney[1,2], François Lelarge[4], Kamel Merghem[5], Anthony Martinez[5], Abderrahim Ramdane[5]; [1]Optoelectronics Group, Physics Dept., Univ. College Cork, Ireland, [2]Tyndall Natl. Inst., Ireland, [3]Cork Inst. of Technology, Ireland, [4]Alcatel-Thales III-V Lab, a Joint Lab of Alcatel Lucent Bell Labs and Thales Res. & Technology, France, [5]CNRS Lab for Photonics and Nanostructures, France.* We report microwave oscillation in CW optically injected InAs/InP quantum dash lasers emitting at 1.56 μm, at twice the lasers' self-mode-locked frequency. Narrow linewidths (≈140 kHz) with >200 MHz locking range has been observed.

CMII5 • 5:00 p.m.
Stabilization of Quantum-Dot Mode-Locked Lasers via Optical Injection, *Tatiana Habruseva*[1], *Natalia Rebrova[1], Tomasz Piwonski[1], Jaroslaw Pulka[1], Stephen P. Hegarty[1], Douglas A. Reid[2], Liam P. Barry[2], Guillaume Huyet[1]; [1]Tyndall Natl. Inst., Ireland, [2]RINCE, Dublin City Univ., Ireland.* Waveform instability is theoretically found in quantum-dot mode-locked laser simulations using experimentally obtained device dynamical parameters. Stabilization via optical injection is numerically and experimentally shown.

CMII6 • 5:15 p.m.
Ultra-Low RF Linewidth in a Quantum Dot Mode-Locked Laser Under External Optical Feedback Stabilization, *Chang-Yi Lin*[1], *Frederic Grillot[1,2,3], Nader A. Naderi[1], Yan Li[1], Luke F. Lester[1]; [1]Ctr. for High Technology Materials, Univ. of New Mexico, USA, [2]CNRS FOTON-INSA, France, [3]CNRS FOTON-ENSSAT, France.* The effect of external optical feedback on quantum dot two-section passively mode-locked lasers is investigated. The RF linewidth narrows down from 8 KHz in the free-running situation to a very low value of 350 Hz.

Room A7

QELS

QMH • Plasmonic Antennas—Continued

QMH4 • 4:45 p.m.
Manipulating Nano-Scale Light Fields with the Asymmetric Bowtie Nano-Colorsorter, *P James Schuck*[1], *Zhaoyu Zhang[1,2], Alex Weber-Bargioni[1], Shiwei Wu[1], Scott Dhuey[1], Stefano Cabrini[1]; [1]Molecular Foundry, Lawrence Berekely Natl. Lab, USA, [2]Dept. of Chemistry, Univ. of California at Berkeley, USA.* We present a class of devices called Asymmetric Bowtie nano-Colorsorters. These devices have specifically engineered symmetries enabling them to capture, confine, spectrally filter and steer optical fields while maintaining nanoscale field distributions.

QMH5 • 5:00 p.m.
3-D Optical Yagi-Uda Nanoantenna Array, *Daniel Dregely,* *Richard Taubert, Harald Giessen; Univ. of Stuttgart, Germany.* We fabricated three-dimensional arrays of optical Yagi-Uda nanoantennas. Due to the high directivity of the array structure the incoming light is received efficiently at the resonant wavelength in the near-infrared (around 1.3 μm).

QMH6 • 5:15 p.m.
Ultra-Sensitive Infrared Spectroscopy of Proteins with Collective Excitations of Nanoplasmonic Arrays, *Ronen Adato*[1], *Ahmet A. Yanik[1], Jason J. Amsden[2], David L. Kaplan[2], Fiorenzo G. Omenetto[2], Mi K. Hong[1], Shyamsunder Erramilli[1], Hatice Altug[1]; [1]Boston Univ., USA, [2]Tufts Univ., USA.* Short interaction lengths limit the application of infrared absorption spectroscopy to the study monolayer thickness films. We employ periodic infrared antenna arrays to obtain 10^4-10^5 enhancement of protein absorption signals corresponding to zepto-mole sensitivity.

5:30 p.m.–6:00 p.m. Break *(Civic Auditorium doors will open at 5:45 p.m. for the Plenary)*

6:00 p.m.–8:30 p.m. CLEO and CLEO: Applications Plenary Session, *Civic Auditorium*

NOTES

Room A8	Room C1&2	Room C3&4	San Jose Ballroom IV (San Jose Marriott)
CLEO	CLEO	CLEO	JOINT

CMJJ • THz Ultrafast Generation—Continued

CMJJ5 • 4:45 p.m.
Generation and Frequency Control of THz Waves by Nanoscale Piezo-Engineering, *Hoonil Jeong*[1], *Jihoon Jeong*[1], *Christopher J. Stanton*[2], *Young-Dahl Jho*[1]; [1]*Gwangju Inst. of Science and Technology, Republic of Korea,* [2]*Univ. of Florida, USA.* We report a newly found terahertz generation mechanism, mediated via acoustic standing waves confined within GaN-based piezoelectric heterostructures and its spectral control by adapting the active layer thickness.

CMJJ6 • 5:00 p.m.
Mesa-Structured InGaAs/InAlAs Photoconductive Antennas for THz Time Domain Systems Operated at 1.5 µm, *Roman J. B. Dietz,* *Helmut Roehle, Hans-Jürgen Hensel, Jutta Boettcher, Harald Künzel, Dennis Stanze, Martin Schell, Bernd Sartorius; Fraunhofer Inst. for Telecommunications, Heinrich-Hertz-Inst., Germany.* Mesa-structuring of InGaAs/InAlAs photoconductive layers has been employed for improving THz antennas. The developed devices are evaluated in a time domain spectrometer operating at 1.5 µm wavelengths. Order-of-magnitude improvements versus planar antennas are demonstrated.

CMJJ7 • 5:15 p.m.
Ultrafast Terahertz Dynamics and Broadband Optical Conductivity of Few-Layer Epitaxial Graphene, *Hyunyong Choi*[1], *Ferenc Borondics*[1], *David A. Siegel*[1,2], *Shuyun Zhou*[1,2], *Michael C. Martin*[1], *Alessandra Lanzara*[1,2], *Robert A. Kaindl*[1]; [1]*Lawrence Berkeley Natl. Lab, USA,* [2]*Univ. of California at Berkeley, USA.* We report the ultrafast THz dynamics and broadband electromagnetic response of few-layer epitaxial graphene. Electrodynamics consistent with a dense Dirac electron plasma and a transient THz response dominated by recombination of excess holes is observed.

CMKK • Efficiency in Solid-State Lighting—Continued

CMKK4 • 4:45 p.m.
InGaN Light-Emitting Diodes with an Integrated Reflector Cup, *Ling Zhu,* *X. H. Wang, P. T. Lai, H. W. Choi; Dept. of Electrical and Electronic Engineering, Univ. of Hong Kong, Hong Kong.* An LED of truncated-conical geometry with an enhancement of 21.7% of upward intensity achieved by laser micromachining was reported. With the reflector surrounded the sidewall, the angular color uniformity of it was enhanced by 37%.

CMKK5 • 5:00 p.m.
Green Light Emitting Diodes with High Internal Quantum Efficiency in-Rich InGaN/GaN Self-Organized Quantum Dots Grown by RF-Plasma Assisted Molecular Beam Epitaxy, *Meng Zhang,* *Wei Guo, Animesh Banerjee, Pallab Bhattacharya; Univ. of Michigan, USA.* Self-Organized green InGaN/GaN quantum dots with high internal quantum efficiency have been grown by RF-Plasma Assisted Molecular Beam Epitaxy. Green light emitting diodes based on these dots were fabricated and electroluminescence spectra were measured.

CMKK6 • 5:15 p.m.
Study of Polarization Properties of Light Emitted from Tensile Strained InGaN/AlInN Quantum Well, *Po-Yuan Dang,* *Hung-Hsun Huang, Yuh-Renn Wu; Inst. of Photonics and Optoelectronics and Dept. of Electrical Engineering, Natl. Taiwan Univ., Taiwan.* This paper discusses the optical polarization anisotropic of c-plane tensile strained InGaN/AlInN QW. The results indicate that in particular alloy composition with the tensile strain, it can reduce QCSE and make a polarized light source.

CMLL • Laser Structuring of Optical Materials—Continued

CMLL4 • 4:45 p.m.
Ultrafast Laser Inscribed Nd-Doped Silicate Glass Waveguide Laser, *Euan Ramsay,* *Robert R. Thomson, Nicholas D. Psaila, Ajoy K. Kar, Derryck T. Reid; Heriot-Watt Univ., UK.* We report laser oscillation from waveguides inscribed in Nd-doped silicate glass. Laser action was observed at 1062nm for a pump of 808nm, with a slope efficiency of 15.0% and maximum output power of 7.5mW.

CMLL5 • 5:00 p.m.
Femtosecond Laser Induced Vortex Anisotropy, *Martynas Beresna,* *Peter G. Kazansky; Optoelectronics Res. Ctr., Univ. of Southampton, UK.* Anisotropic bubble chain structures are produced by ultrashort pulse laser irradiation in silica glass. Vortex anisotropy is observed in the irradiated volume.

CMLL6 • 5:15 p.m.
From Carrier Dynamics inside Fused Silica to Control of Multiphoton-Avalanche Ionization for Laser Machining, *Shuting Lei*[1], *David Grojo*[2], *Thomas Barillot*[2,3], *Marina Gertsvolf*[2,4], *Zenghu Chang*[1], *David M. Rayner*[2], *Paul B. Corkum*[2,4]; [1]*Kansas State Univ., USA,* [2]*Natl. Res. Council, Canada,* [3]*Univ. Claude Bernard Lyon 1, France,* [4]*Univ. of Ottawa, Canada.* Using pump-probe measurements, we characterize carrier decay time inside fused silica and measure deeply bound self-trapped excitons. With pump-probe delay, we also control free carrier injection and the subsequent avalanche process for laser machining applications.

JMD • Joint CLEO/QELS Symposium on Optomechanics for Physical and Biological Sciences IV: Bio—Continued

JMD4 • 4:45 p.m. Invited
Microrheology Measurements of the Mechanical Properties of Cells, *David Weitz;* *Harvard Univ., USA.* Abstract not available.

JMD5 • 5:15 p.m.
Brillouin Microscopy for Ocular Biomechanics, *Giuliano Scarcelli*[1,2], *Seok H. Yun*[1,2]; [1]*Harvard Medical School, Massachusetts General Hospital, USA,* [2]*Wellman Ctr. for Photomedicine, USA.* We present Brillouin confocal microscopy with high throughput and high extinction for non-invasive mechanical measurements of tissue and biomaterials. In particular, we demonstrate biomechanical characterization of crystalline lens and cornea.

5:30 p.m.–6:00 p.m. Break *(Civic Auditorium doors will open at 5:45 p.m. for the Plenary)*

6:00 p.m.–8:30 p.m. CLEO and CLEO: Applications Plenary Session, *Civic Auditorium*

NOTES

Room B2-B3

CLEO: Applications

AMD • Spectroscopy and Imaging—Continued

AMD4 • 4:45 p.m. Invited

Functional Imaging and Monitoring of Brain and Breast with Diffuse Light, ***Arjun Yodh****; Univ. of Pennsylvania, USA.* Diffuse optical spectroscopy and tomography of tissue is finding unique clinical niches. I will describe representative brain and breast functional imaging and monitoring results to illustrate the workings of these new tissue diagnostics.

AMD5 • 5:15 p.m.

Integrated Optoelectronics for Neural Stimulation and Recording in Freely Moving Animals, ***Jing Wang***[1]*, David Borton*[2]*, Jiayi Zhang*[1]*, Rick Van Wagenen*[3]*, Rebecca Burwell*[4]*, Barry Connors*[5]*, Arto Nurmikko*[1,2]*;* [1]*Dept. of Physics, Brown Univ., USA,* [2]*Div. of Engineering, Brown Univ., USA,* [3]*Blackrock Microsystems, USA,* [4]*Dept. of Psychology, Brown Univ., USA,* [5]*Dept. of Neuroscience, Brown Univ., USA.* Specific classes of neural cells in mammalian brain can be rendered light sensitive by genetic means. We combine the new 'optogenetics' approaches with simultaneous electrical recording in behaving animals by an integrated cortical-implanted optoelectronic device.

San Jose Salon I & II (San Jose Marriott)

San Jose Salon III (San Jose Marriott)

CLEO

CMMM • Super Continuum and Multi-Wavelength Generation—Continued

CMMM5 • 4:45 p.m.

Near-Diffraction-Limited Supercontinuum Generation in a Cladding-Pumped Nonlinear Fiber Converter, ***Junhua Ji****, Christophe A. Codemard, Andrew Webb, Jayanta K. Sahu, Johan Nilsson; Optoelectronics Res. Ctr., Univ. of Southampton, UK.* Through nonlinear scattering including stimulated Raman scattering and beam clean-up, a pulsed multimode pump beam is converted into a nearly diffraction-limited supercontinuum extending from 1 to 2 μm in a passive cladding-pumped nonlinear fiber converter.

CMMM6 • 5:00 p.m.

Enhanced Soliton Self-Frequency Shift and White-Light CW Supercontinuum Generation in Germanosilicate-Core PCFs, ***Benoit Barviau****, Alexandre Kudlinski, Yves Quiquempois, Arnaud Mussot; Univ. Lille 1, France.* We numerically investigate the mechanisms responsible for the enhancement of the soliton self-frequency-shift effect in germanoscilicate-core photonic crystal fibers. A direct consequence leads to the first experimental demonstration of a powerful white-light continuous-wave supercontinuum.

CMMM7 • 5:15 p.m.

Nonperiodic Optical Superlattice Optimized by Genetic Algorithm for Engineered Multi-wavelength Conversion, *Jui-Yu Lai*[1]*, Yi-Jhen Liu*[1]*, Hung-Yu Wu*[2]*, Yen-Hung Chen*[2]*,* ***Shang-Da Yang***[1]*;* [1]*Inst. of Photonics Technologies, Natl. Tsing Hua Univ., Taiwan,* [2]*Dept. of Optics and Photonics, Natl. Central Univ., Taiwan.* We experimentally demonstrate engineered multiwavelength conversion using nonperiodic optical superlattice optimized by genetic algorithm with two target functions. This scheme has better spectral shape fidelity and ~15% higher conversion efficiency compared to aperiodic optical superlattice.

CMNN • Short Pulse—Continued

CMNN5 • 4:45 p.m.

Carbon-Nanotube Mode-Locked Cr:YAG Laser, *Won Bae Cho*[1,2]*, Andreas Schmidt*[1]*, Sun Young Choi*[2]*, Valentin Petrov*[1]*, Uwe Griebner*[1]*, Guenter Steinmeyer*[1]*, Soonil Lee*[2]*, Dong-Il Yeom*[2]*,* ***Fabian Rotermund***[2]*;* [1]*Max-Born-Inst., Germany,* [2]*Ajou Univ., Republic of Korea.* Transmissive single-walled carbon nanotube saturable absorbers were used for passive mode-locking of a Cr:YAG laser, delivering tunable sub-100-fs pulses around 1.5 μm with output powers up to 110 mW at 84.6 MHz.

CMNN6 • 5:00 p.m.

A Femtosecond Cr^{4+}:forsterite Laser Generating 1.4W Output Power, ***Shih-Hsuan Chia***[1]*, Tzu-Ming Liu*[2]*, Anatoly A. Ivanov*[3]*, Aleksei M. Zheltikov*[4]*, Chi-Kuang Sun*[1,5]*;* [1]*Graduate Inst. of Photonics and Optoelectronics, Natl. Taiwan Univ., Taiwan,* [2]*Inst. of Biomedical Engineering, Natl. Taiwan Univ., Taiwan,* [3]*Photochemistry Ctr., Russian Acad. of Sciences, Russian Federation,* [4]*Dept. of Physics., Intl. Laser Ctr., M.V. Lomonosov Moscow State Univ., Russian Federation,* [5]*Res. Ctr. for Applied Sciences, Acad. Sinica, Taiwan.* By optimizing the thermal properties of crystals, we report a femtosecond Cr:forsterite laser with a highest ever 1.4W output power, which is desired for many applications, including biomedical imaging, studies of fibers, and photonic devices.

CMNN7 • 5:15 p.m.

Passive Mode-Locking of Diode-Pumped Tm:$GdLiF_4$ Laser, ***Nicola Coluccelli***[1]*, Gianluca Galzerano*[1]*, Alberto Di Lieto*[2]*, Mauro Tonelli*[2]*, Paolo Laporta*[1]*;* [1]*Inst. di Fotonica e Natotecnologie - CNR, Italy,* [2]*Dept. di Fisica, Univ. di Pisa, Italy.* We report on the first demonstration of passive mode-locking laser operation of a diode-pumped Tm:$GdLiF_4$ crystal. Pulse trains with 20-ps duration, average power of ~100 mW, and repetition rate of 75 MHz are obtained.

5:30 p.m.–6:00 p.m. Break *(Civic Auditorium doors will open at 5:45 p.m. for the Plenary)*

6:00 p.m.–8:30 p.m. CLEO and CLEO: Applications Plenary Session, *Civic Auditorium*

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