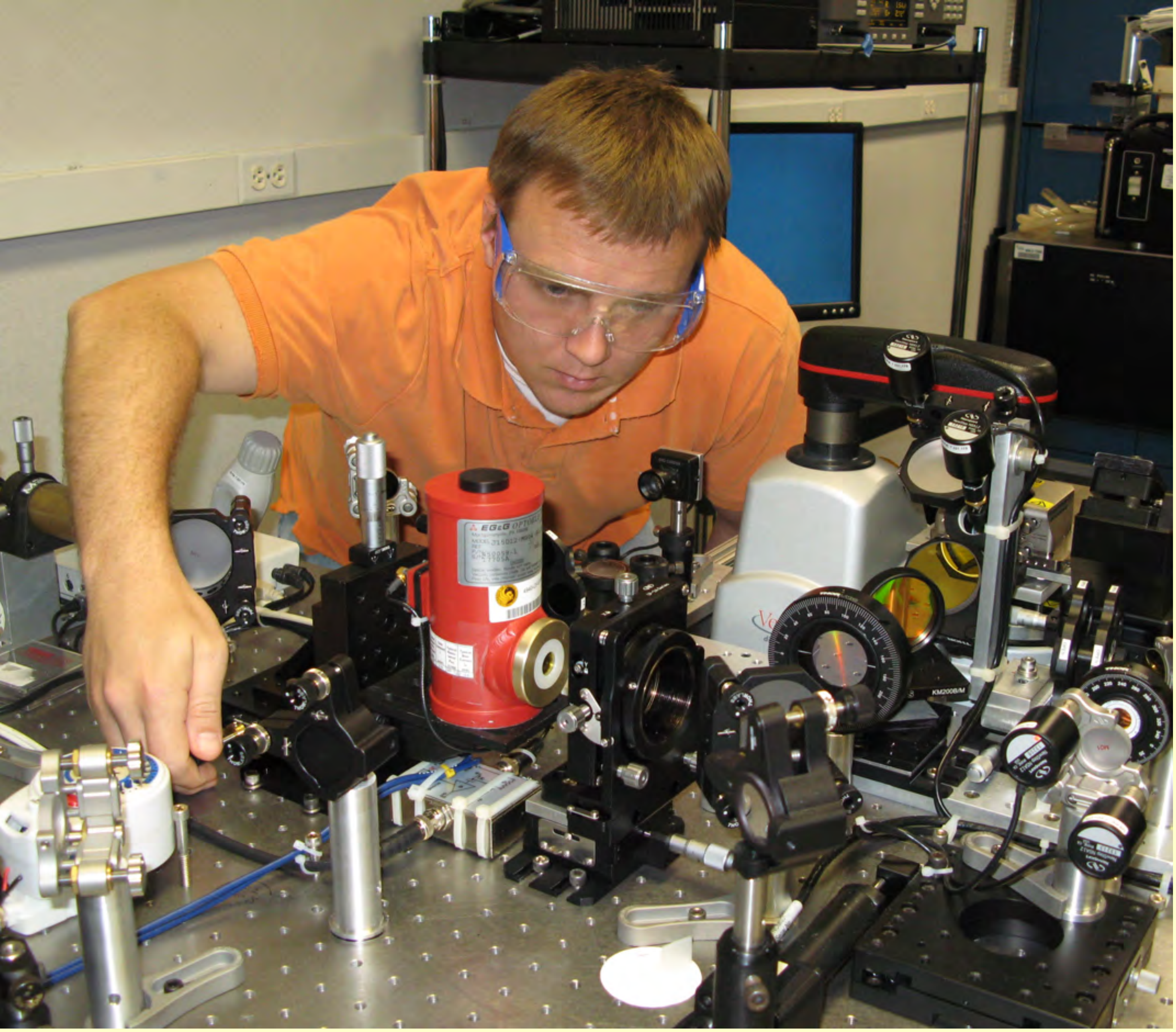


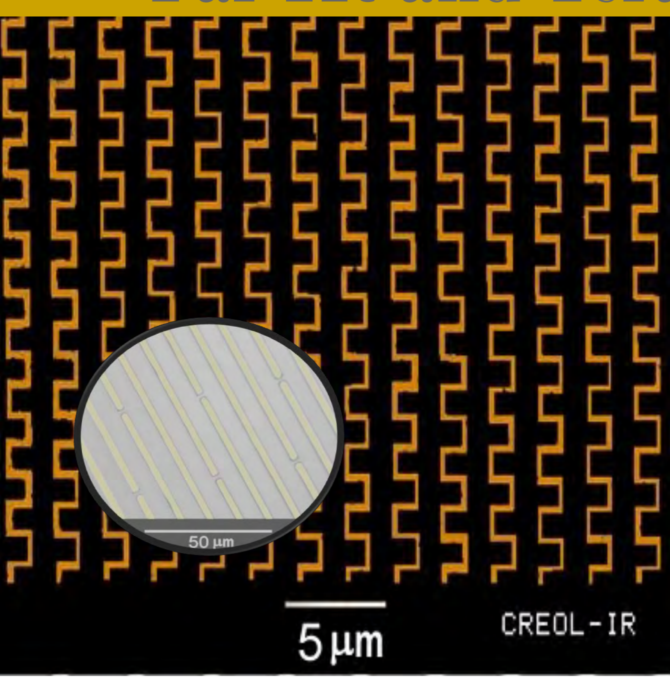
Industrial Affiliates Day

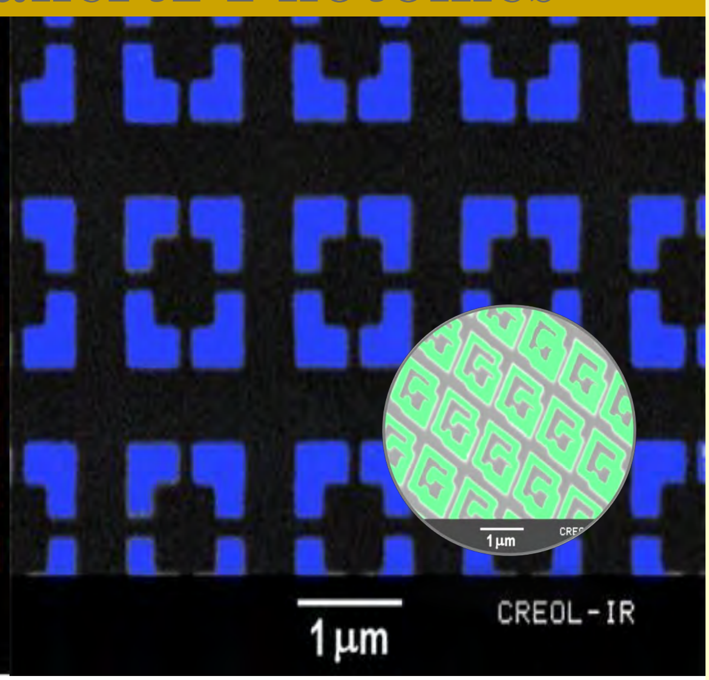
University of Central Florida

CREOL – The College of Optics and Photonics

2011

Far IR and Terahertz Photonics





UNIVERSITY OF CENTRAL FLORIDA

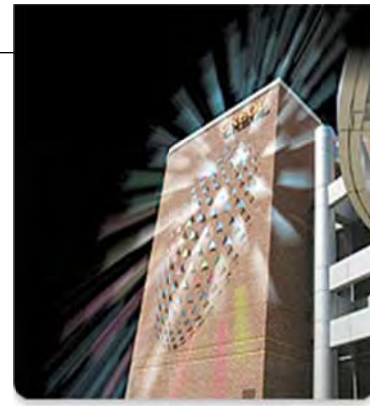
CREOL, THE COLLEGE OF OPTICS & PHOTONICS

Industrial Affiliates Day

April 29, 2011

Content page

Program Guide



UCF Alumni Center

8:00 **Continental Breakfast and Walk-in Registrations**
Tabletop Exhibits – Alumni Center Lobby

8:30	Welcoming Remarks	Tony Waldrop MJ Soileau	UCF Provost & Vice President UCF Vice-President for Research
8:50	CREOL, The College of Optics and Photonics –Overview	Bahaa Saleh	Dean & Director, CREOL, The College of Optics & Photonics

Symposium on
Far IR and Terahertz Photonics

9:20	Quantum Cascade Lasers: widely tailorable light source from the mid-infrared to TeraHertz	Federico Capasso	Harvard School of Engineering and Applied Optics

9:55 **Break** & **Exhibit**

10:10	Novel nano architectural concepts for THz/IR based bio-sensing	Dwight Woolard	Army Research Laboratory
10:35	Far IR and Terahertz Technology – at the Turning Point of Change!	Michael Dudzik	Lockheed Martin Corp.

11:00 **Break** & **Exhibit**

11:15	Infrared Imaging in the Military: Status and Challenges	Ronald Driggers	Optical Sciences Division Naval Research Laboratory
11:40	Open Questions		

12:00 **Lunch Served –UCF Alumni Center**

Tabletop Exhibits – Alumni Center Lobby

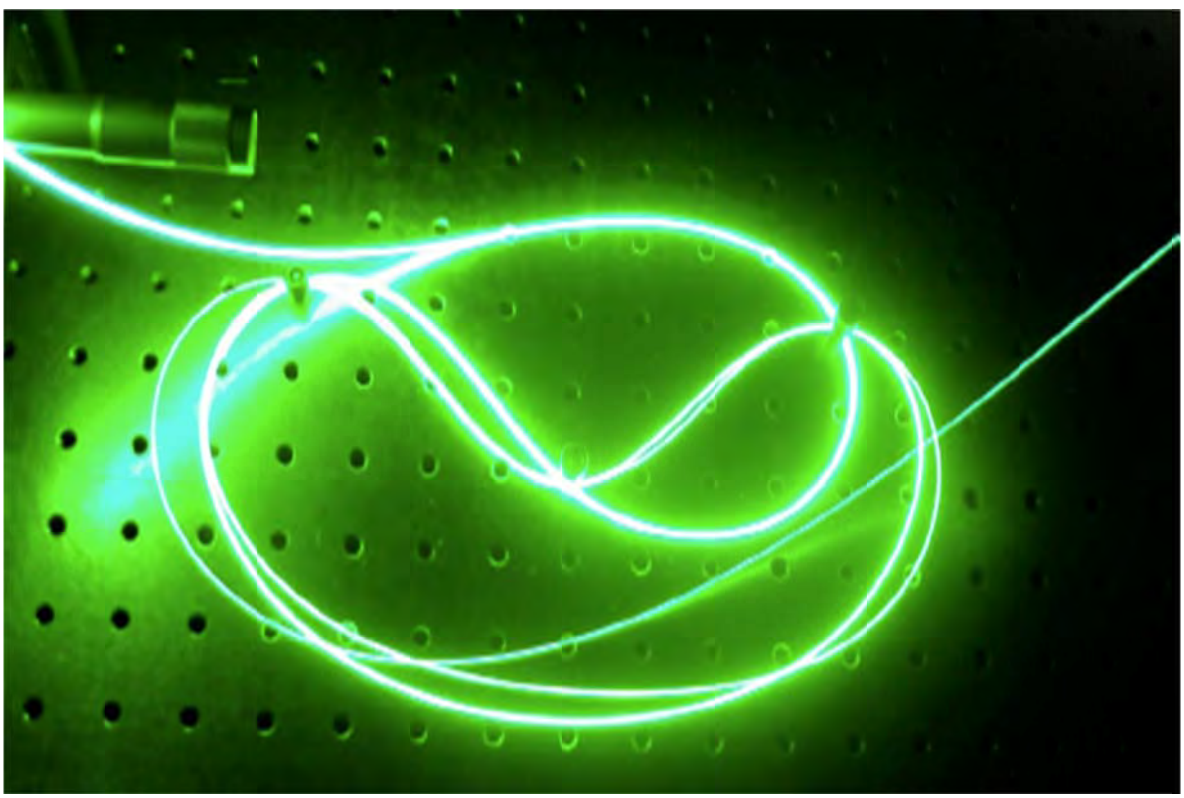
1:00	Next generation optical fibers for IR applications	Axel Schülzgen	CREOL, The College of Optics & Photonics
1:25	Infrared Antennas and Frequency Selective Surfaces	Glenn Boreman	CREOL, The College of Optics & Photonics

Student of the Year Talk

1:50	A low noise chirped pulse laser with an intra-cavity Fabry-Pérot etalon and high precision etalon characterization	Dimitrios Mandridis	Graduate Student CREOL, The College of Optics and

2:05 Walk to the CREOL Building

2:20	**Poster Sessions** **Lab Tours** **Table-Top Exhibits**	Graduate Students	CREOL rooms 102 & 103; Tours start from lobby CREOL Lobby
4:00 – 5:30	**Poster award presentation Reception**	Bahaa Saleh	CREOL Lobby



Invited Talks

Quantum Cascade Lasers: widely tailorable light source from the mid-infrared to TeraHertz

Federico Capasso
Robert L. Wallace Professor of Applied Physics
Harvard University
School of Engineering and Applied Sciences

Abstract
Quantum Cascade Lasers (QCLs) represent a radical departure from diode lasers in that they don't rely on the bandgap for light emission. This freedom from bandgap slavery has many far reaching implications that will be fully explored in this talk. I will trace the path from invention to exciting advances in the physics and applications of these revolutionary lasers which cover the mid- and far-ir spectrum and are broadly impacting sensing, spectroscopy, and sub-wavelength photonics. The unipolar nature of QCLs combined with the capabilities of electronic band structure engineering leads to unprecedented design flexibility and functionality compared to other lasers. Topics to be discusses also include: high power and room temperature CW operation in the Mid-IR, room temperature QCL based Terahertz, QCL with broadband lasing properties. QCLs have been used as a platform to demonstrate new plasmonic device concepts raging form resonant optical antenna, collimator and polarizers. The talk will conclude with applications to chemical sensing and trace gas analysis along with the ongoing commercialization of this technology.

Federico Capasso is the Robert Wallace Professor of Applied Physics at Harvard University, which he joined in 2003 after a 27 years career at Bell Labs where he did research, became Bell Labs Fellow and held several management positions including Vice President for Physical Research. His research has spanned a broad range of topics from applications to basic science in the areas of electronics, photonics, nanoscale science and technology including plasmonics and the Casimir effect. He is a co-inventor of the quantum cascade laser. He is a member of the National Academy of Sciences, the National Academy of Engineering and a fellow of the American Academy of Arts and Sciences, His many awards include the King Faisal Prize for Science, the Berthold Leibinger Zukunftspreis (the future prize), the Julius Springer Prize for Applied Physics, the APS Arthur Schawlow Prize and the IEEE Edison Medal.

Novel nanoarchitectural concepts for THz/IR based Bio-Sensing Applications

Dwight Woolard
US Army Research Office

Abstract

Very long-wavelength spectroscopic science and technology has long been a research area of emphasis due to the fact that many biological and chemical molecules possess unique spectral fingerprints in the very far-infrared (far-IR) and terahertz (THz) frequency (~ 3.0-0.3 millimeters) regimes. Furthermore, since long-wavelength spectral absorption is known to be closely linked to the structural detail of molecules, electronic/photonics interactions in this regime are very importance for many fundamental research areas (e.g., chemistry, biological, material science, etc.) and for many important application areas (e.g., threat agent detection, medical diagnostics, etc.). While these facts suggest that long-wavelength spectroscopy should be an effective sensing and characterization tool, practical problems (e.g., weak sig-natures, limited number of discernable features, and sensitivity to environmental factors) often reduce their effective-ness in practice. These general issues motivate one to consider the concept of engineering special nanoscale architectures that would allow for the enhanced extraction and controllable multiplication of the spectral signatures associated with specific target molecules that have been strategically included into these architectures. Here, the basic idea is to define DNA-based nano-assemblies (i.e., either materials or structural devices) that incorporate the functionality of the target organic and/or biological molecules such that they effect highly predictable and controllable changes into the electro-optical properties of the resulting superstructures. The first example to be reported on here is the use of long-chain organic molecular switches (OMSs) that utilize multiple molecular-ring structures to achieve conductivity proper-ties that are dependent on exposures to the 3-D polarizations of other molecules. As will be discussed, with these types of OMS components it is possible to envision artificially engineered smart materials that exhibit a dielectric tensor response upon exposure to polar gases, which is useful for defining THz/IR based sensors. A second example to be report-ed on here is the use of biological molecular switches (BMSs) such as DNA-derivatives that can be shown to possess multiple metastable states and light-induced multiple-coordinate transition paths. As will be discussed, these types of properties can be used to define material systems and associated devices with measurable macroscopic THz/IR electro-optical properties that reveal the underlying states and vibration dynamics of the constituent BMSs. The results from recent modeling and simulation studies will be used illustrate the physical properties of these OMS and BMS as well as their use in realizing functional electronic materials and devices in the context of THz/IR spectral sensing and characterization.

Dr. Dwight L. Woolard manages the U.S. Army Research Laboratory (ARL) – U.S. Army Research Office (ARO) Program on Solid-State & High-Frequency Electronics which emphasizes: (1) THz-Frequency Science & Technology, (2) Nanoelectronics & Molecular Electronics, and (3) Advanced Solid-State Device Concepts. Dr. Woolard presently leads one of the largest U.S. Research Program in THz-Frequency Science & Technology and pioneered the development of THz Spectroscopy for biological agent sensing. Dr. Woolard has been active in the research areas of THz-Frequency Bio-Sensing Science, THz-Frequency Oscillations in Solid-State Tunneling Devices and Novel Nanoscale/Molecular Device Concepts since joining the ARL in 1993. Dr. Woolard is a graduate of North Carolina State University – Raleigh, Ph.D. Electrical and Computer Engineering, was elected to IEEE Fellow in 2004 "for leadership in the discovery and development of novel sensing methodologies and advanced electronic devices at terahertz frequencies," and was the recipient of the 2008 IEEE-USA Harry Diamond Award "for contributions and leadership in the discovery and development of novel electronic and optoelectronic devices and systems with emphasis on terahertz frequencies."

Far IR and Terahertz Technology – at the Turning Point of Change!

Michael Dudzik
VP, Science and Technology
Lockheed Martin Corp.
Micheal.c.dudzik@lmco.com

Abstract

The far IR and Terahertz regions of the electro-magnetic spectrum offer the potential for new imaging and communications capabilities. However, these regions have not been exploited to the same degree as classical electro-optical and radar technology. Enabled by the recent advances in modeling, device development and systems engineering, there is a turning point of change occurring in the quest for new applications of far IR and Terahertz technology.. This presentation will address technical and translation issues associated with this segment of the spectrum from ideation to "killer" applications.

Michael Dudzik is Vice President, Science & Technology, Washington Operations. Lockheed Martin Corporation. In this capacity he leads the corporation's efforts in building a network of business & technical relation-ships within the Federal science, engineering, and technology communities. Focusing on mid-term & long term research initiatives (i.e. fundamental research, discovery, and system concept invention), he is responsible for identifying emerging technologies and opportunities within the university, small business and Federally funded research and development centers. Further, he is responsible for assessing the market environments of the emerging technology-based programs, designing strategies to effectively penetrate new markets, driving strategy implementation and ensuring closure on development activities.

Infrared Imaging in the Military: Status and Challenges

Ronald G. Driggers
Superintendent, Optical Sciences Division
Naval Research Laboratory

Abstract
A review of the military's primary imaging modes including target acquisition, intelligence, surveillance, and reconnaissance, and the new mode of persistent surveillance is discussed. Army, Air Force, and Navy imaging technology contributions are described and some future challenges are provided.

Ronald G. Driggers received a doctorate in electrical engineering from the University of Memphis in 1990. He was appointed to the Senior Executive Service as the Superintendent of the Optical Sciences Division at the Naval Research Laboratory in 2008. Previously, he was the Director of the Modeling and Simulation Division at the U.S. Army's Night Vision and Electronic Sensors Directorate (NVESD) and a brief period as the Chief of the Electro-Optics and Photonics Division at the Army Research Laboratory. Dr. Driggers is the author of four books on Infrared and Electro-Optics Systems and has published over 100 research papers. He was Editor-in-Chief of the Encyclopedia of Optical Engineering (Taylor and Francis). He was selected as the 2002 Army Materiel Command's Engineer of the Year, 2001 CERDEC Technical Employee of the Year, and 2001 NVESD Technical Employee of the Year. He is a U.S. Naval Reserve Officer and was selected as the 2001 Naval Engineering Duty Officer of the Year (William Kastner Award). He is also a Fellow of the International Society for Optical Engineering, the Optical Society of America, and the Military Sensing Symposium. In January 2010, he took over duties as Editor-in-Chief of SPIE's flagship journal, Optical Engineering.

Next generation optical fibers for IR applications: novel materials and nano-scale textures

Axel Schülzgen
Professor of Optics
CREOL, The College of Optics & Photonics
& Townes Laser Institute
University of Central Florida

Abstract

Fiber optics is one of the fastest developing fields of modern optics with broad impact on many area including communications, lasers, sensing, and biophotonics. To continue this success and expand th impact of fiber optics, materials science and optical fiber fabrication technology have to be combined t create novel components and devices that are suitable for all ranges of the electromagnetic spectrur including infrared wavelengths. Thanks to heavy investments, driven for the most part by optica communications, the fiber optics tool box is rapidly expanding and state-of-the-art fibers are ofte complex structures containing special glasses and cross-sectional features much smaller than th wavelength of light. This talk will focus on the design, fabrication, and applications of next-generatio optical fiber that feature novel fiber materials and utilize our capability to create nanometer scale fibe textures.

Axel Schülzgen received the Diplomphysiker (M.S.) degree and the Dr. rer. nat. (Ph.D.) degree from Humboldt-University Berlin in 1988 and 1992, respectively. In 1993 he was awarded with a Habilitation fellowship from the German Research Foundation. After being a visiting researcher at the Trinity College in Dublin, Ireland, in 1995, he joined the College of Optical Sciences of the University of Arizona in 1996 and became a Research Professor in 2006. In 2009, Dr. Schülzgen joined the College of Optics and Photonics, CREOL and the Townes Laser Institute at the University of Central Florida as a Professor of Optics. Dr. Schülzgen's research area is experimental physics with a specialization in spectroscopy, optics, and photonics. His current research focuses on fiber optics including fiber lasers, novel fiber materials, and design and fabrication of micro- and nanostructured optical fiber. Dr. Schülzgen's resume includes over 70 peer reviewed journal papers and 40 invited presentations at international conferences. He is an Associate Editor of Applied Optics in the area of ultrafast lasers and optics. Dr. Schülzgen's honors include the Carl-Ramsauer-Award from AEG Corporation and the Heinrich-Gustav-Magnus-Award from Humboldt-University Berlin.

Infrared Antennas & Frequency Selective Surfaces

Glenn D. Boreman
Trustee Chair Professor of Optics
CREOL, The College of Optics & Photonics
University of Central Florida

Abstract
Radiofrequency components such as antennas, transmission lines, phased arrays, frequency-selective surfaces, reflectarrays and meanderline waveplates are demonstrated in the infrared. Usual design methodologies apply, providing that IR material properties are used in the computations. We fabricate nanoscale antenna structures resonant at infrared (IR) frequencies using direct-write electron-beam lithography. Antennas facilitate electromagnetic coupling to sub-wavelength sized sensors (e.g., metal-oxide-metal tunnel diodes), with resulting spectral and polarization response determined by the dimensions and arrangement of the antenna arms. Along with single-element antennas, we have demonstrated both incoherent and coherent antenna arrays, with co-phased response verified by measurements of the angular reception patterns. In phased-array configurations, beam shifting and beam narrowing are noted, in agreement with classical antenna theory. Dual-dipole antennas can also be used to measure the magnitude of the spatial coherence of the incoming radiation, at the location of the two antennas. Frequency selective surfaces (FSS) are two-dimensional arrays of metallic antennas with subwavelength periodicity. Depending upon the geometry of the antenna arrangement, these have been demonstrated as spectral reflectance or transmittance filters in the IR and THz. They have also been configured as selective absorbers, to control the IR spectral emissivity of a surface by means of Kirchhoff's law. One extension of the IR FSS concept is the reflect array, which is a quasi-periodic array of antennas for which the phase shift on reflection depends on the local unit-cell geometry. Varying the antenna dimensions across the surface of an array can be used to produce a flat surface with optical focusing power. We have demonstrated these in the IR, at wavelengths as short as 1.5 micrometers. Another extension of FSS technology is the meanderline waveplate. These have been demonstrated in the 3-5 and 8-12 micrometer IR bands, and allow implementation of a quarter-wave, half-wave, or arbitrary retarder. Unlike the usual crystalline waveplates, the meanderline device has a thin aspect ratio and significant angular and spectral bandwidths. In the design of these devices, accounting for the spectral variation of the real and imaginary parts of the permittivity is crucial to obtain accurate agreement between numerical models and measured results. This is particularly important for thin (typically 100 nm) metallic films, for which inadequate tabular data are available in the literature. Material properties are measured as a function of frequency with an IR variable-angle spectroscopic ellipsometer, and then imported into full-wave electromagnetic models for design and analysis.

Glenn D. Boreman is Trustee Chair Professor of Optics at University of Central Florida, CREOL. He received a BS in optics from the University of Rochester, and a PhD in optics from the University of Arizona. Prof. Boreman served six years as the Editor-in-Chief of Applied Optics; is presently an associate editor of Optics Express and is the editor of the Wiley Series in Pure & Applied Optics. He is coauthor of Infrared Detectors and Systems, and author of Modulation Transfer Function in Optical and Electro-Optical Systems, and Basic Electro-Optics for Electrical Engineers. He is a Fellow of the Military Sensing Symposium, OSA, and SPIE. His main research area is the extension of radiofrequency concepts to the infrared spectrum using electron-beam lithography.

Exhibitors

Alumni Center

Analog Modules, Inc.
126 Baywood Ave.
Longwood, FL 32750
407-339-4355
www.analogmodules.com

LightPath Technologies Inc.
2603 Challenger Tech CT, Suite 100
Orlando, FL 32826
407-382-4007
www.lightpath.com

HORIBA Jobin Yvon, Inc.
3880 Park Ave.
Edison, NJ 08820
732-494-8660
www.horiba.com/us

OptiGrate Corp.
3267 Progress Drive
Orlando, FL 32826
www.optigrate.com

QPC Lasers
15632 Roxford St
Sylmar, California 91342
818-833-4566
www.qpclasers.com

The International Society for Optics and Photonics
P.O. Box 10
Bellingham, WA 98227
360-676-3290
www.spie.com

Yokogawa Corp. of America
2 Dart Road
Newnan, GA 30265
478-225-2859
www.yokogawa.com/us

CREOL Building

Agilent Technologies
3501 Stevens Creek Blvd.
Santa Clara, CA 95051
408-345-8886
www.us@agilent.com

Coherent, Inc.
5100 Patrick Henry Dr.
Santa Clara, CA 95054
408-764-4000
www.coherent.com

Gooch & Housego, LLC
4632 36th Street
Orlando, FL 32811
www.gooch@housego.com

Imagine Optic
1 Broadway, 14th floor
Cambridge, MA 02142
617-401-2198
www.imagine-optic.com

L3 Communications
2500 N. Orange Blossom Trail
Orlando, Florida 32804
407-295-5878
www.L-3com.com

Newport Corp.
1791 Deere Ave.
Irvine, CA 92606
877-835-9620
www.newport.com

Northrop Grumman
Cutting Edge Optronics
20 Point West Blvd.
St. Charles, MO 63301
www.NorthropGrumman.com

NKT photonics
1400 Campus Dr. West
Morganville, New Jersey 07551
732-972-9937
www.nktphotonics.com

Ophir-Spiricon
60 West 1000 North
Logan, Utah 84321
435-753-3729
www.ophir-spiricon.com

Optimax system, Inc.
6367 Dean Parkway
Ontario, New York 14519
877-396-7846
www.optimaxsi.com

Photonics online
Horsham, Pennsylvania
www.photonicsonline.com

Photonics Sepctra
Pittsfield, Massachusetts
www.photonics.com

Laser Institute of America
13501 Ingenuity Drive, Suite 128
Orlando, FL 32826
407-380-1553
www.LaserInstitute.com

Princeton Instruments
3660 Quakerbridge Rd.
Trenton, NJ 08619
609-587-9797
www.princetoninstruments.com

Society for Information Display
145 South Bascom Ave. Ste. 114
Campbell, CA 95008
408-879-3901
www.sid.org

Tektronix
14200 SW Karl Braun Dr.
Beaverton, OR 97077
800-835-9433
www.tek.com

The Optical Society
2010 Massachusetts Ave, NW
Washington, DC 20036
202-223-8130
www.osa.org

Teledyne ODI, Inc.
1026 N. Williamson Blvd.
Daytona Beach, FL 32114
386-236-0780
www.teledyne.com

Thorlabs
435 Route 206
Newton, New Jersey 07860
973-579-7227
www.thorlabs.com

Student of the Year Presentation

A low noise chirped pulse laser with an intra-cavity Fabry-Pérot etalon and high precision etalon characterization

Dimitrios Mandridis
CREOL, The College of Optics and Photonics
University of Central Florida

Abstract
The talk will present an extensive investigation of a chirped-pulse semiconductor-based Theta cavity design laser with an intra-cavity Fabry-Pérot etalon operating at 100 MHz repetition rate. A fiberized Fabry-Pérot periodic filter inserted within the Theta laser cavity mitigates the contribution of the supermode noise to the pulse-to-pulse energy variance by >10 times. Long-term stability is attained by referencing the cavity length to the etalon using a modified intra-cavity Hänsch-Couillaud locking scheme. Moreover, the high precision characterization of the etalon used in the Theta laser will be presented. A narrow linewidth laser source is used in conjunction with an acousto-optic modulator resulting in 10 parts per billion precision. The Theta laser can be used in photonic ADC and optical coherence tomography among other applications.

Dimitrios Mandridis was born in Athens, Greece in 1981. He received his BS and MSc degrees in Applied Math and Physics with specialization in Optoelectronics and Material Science (2004) from the National Technical University of Athens (NTUA). In July 2005, he joined CREOL, the College of Optics & Photonics at the University of Central Florida, where he received the MS in Optics degree in 2007 while continuing his studies towards the PhD in Optics. Currently, he is a member of the Ultrafast Photonics Group at CREOL under the advisory of Peter J. Delfyett. His current research involves a blend of microwave photonics, metrology and laser development with a focus on ultra-low noise semiconductor-based lasers at low repetition rates for high-speed pho-tonic analog-to-digital conversion. Mr. Mandridis is an author and coauthor of more than 14 journal papers, 30 conference proceedings 2 media articles and 1 patent. He was the 2010 recipient of the IEEE Photonics Society Graduate Student Fellowship.

Posters

Poster 1

Mass spectrometry of laser-induced plasmas

CheonHa Jeon, Matthieu Baudelet*, Martin Richardson
CREOL, The College of Optics & Photonics, University of Central Florida
* Dr. Matthieu Baudelet: baudelet@creol.ucf.edu, (407) 823-6910

Abstract
Plasma generation by high intensity lasers is now a common technology that sees applications ranging from laser fusion, high photon energy radiation sources to low-temperature spectroscopic excitation sources. The fundamentals of the interaction between the electromagnetic field of the laser pulse and the matter are still under investigation in order to better engineer and control applications based on the laser-induced plasmas. Spectroscopic diagnostics have always been used for characterization of the early plasma charged constituents. But the need for different spectral ranges from extreme-ultraviolet to infrared, and as a consequence a large number of different spectrometers and detectors, can become a challenge for simultaneous diagnostics of single events. As an alternative, the mass spectrometry of laser-induced plasmas will provide information on the plasma state such as its ionization degree, its chemical composition and its energy to compare to fundamental models. This study shows the mass spectrometry of the first nanoseconds of laser-induced plasmas of different metals as well as the extension to liquid organic samples.

Poster 2

Raman tweezers for single cells diagnostics

Shima Fardad, Matthieu Baudelet*, Martin Richardson
CREOL, The College of Optics & Photonics, University of Central Florida
* baudelet@creol.ucf.edu, (407) 823-6910

Abstract
Since the first observation of optical trapping by Ashkin *et al.* [1], optical tweezers have shown an intense development for manipulation and interrogation of single cells in biology and physical sciences [2]. In the context of the Laser Spectroscopy and Sensing group in the Laser and Plasma Laboratory, optical tweezers have been built to address single particles and cells. In order to obtain spectroscopic information on the structure and composition of the trapped samples, Raman spectroscopy has been added to the system. This system allows then to trap, manipulate and characterize properties of micron-size particles with a single continuous laser beam at 532 nm. With our system, Raman spectra of single polystyrene beads and single biological cells such as yeast and red blood cells in aqueous media have been obtained.
[1] A. Ashkin, J. M. Dziedzic, J. E. Bjorkholm, and Steven Chu, "Observation of a single-beam gradient force optical trap for dielectric particles," Opt. Lett. **11**, 288-290 (1986)
[2] D. McGloin, "Optical Tweezers: Methods and Applications", Taylor and Francis (2009)

Poster 3

Compact Laser-based Spectroscopic Systems for Biological Analysis

Yuan Liu, Lionel Gigant†, Matthieu Baudelet*, Martin Richardson
CREOL, The College of Optics & Photonics, University of Central Florida
†*Université Bordeaux, Bordeaux, France*
* baudelet@creol.ucf.edu, (407) 823-6910

Abstract

Laser-Induced Breakdown Spectroscopy (LIBS) and Raman spectroscopy can provide composition information of the sample in the elemental and molecular aspect respectively. Due to the similarity of the LIBS and Raman spectroscopy setups, a compact laser-based spectroscopy system that is capable to perform these two types of measurements is possible, which generally leads to a more comprehensive understanding of the sample itself. The compact system requires compact components such as lasers, spectrometers and detectors, but laboratory components are usually cumbersome. In this study, the performance of such a compact laser spectroscopy system was evaluated based on laboratory equipment by analyzing the quality of food samples such as cheese. The pros and cons are compared between a compact system and a laboratory system. The trends and needs for developing the compact laser spectroscopy system are given.

Poster 4

Moiré Bragg Gratings in PTR Glass

Daniel Ott*, Sergiy Mokhov, Vasile Rotar, Julien Lumeau, Leonid Glebov, Vadim Smirnov[1]
CREOL, The College of Optics & Photonics, University of Central Florida
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* dott@creol.ucf.edu, 407-823-6907

Abstract

Phase-shifted fiber Bragg gratings are used as a common approach to generating narrow spectral line widths on the order of a few picometers. However, due to unavailability of appropriate bulk photosensitive materials, this class of filters has not been studied in free space. We present our approach to recording phase-shifted gratings in bulk photo-thermo-refractive (PTR) glass by multiplexing of volume Bragg gratings with slightly different periods to create a Moiré interference pattern, i.e. a high frequency refractive index modulation whose amplitude is modulated by a slowly varying sinusoidal envelope. The zeros of this envelope are equivalent to π phase shifts in the fundamental grating. The resultant grating is a bulk Fabry-Perot with mirrors and cavity formed by the two recorded Bragg gratings. An overview of the relevant theory, including simplified models based on Fabry-Perot theory, critical design parameters, fabrication tolerances, and preliminary experimental results are presented.

Poster 5

Scalable fabrication of micro- and nano-particles utilizing the Rayleigh instability in multi-material fibers

Joshua J. Kaufman, Soroush Shabahang, Guangming Tao, Esmaeil Banaei, and Ayman F. Abouraddy
CREOL, The College of Optics & Photonics, University of Central Florida

Abstract

We describe a novel fabrication method for producing polymer, glass, and metal micro- and nano-particles whose diameters range from 200 microns to under 50 nanometers. This method relies on the Rayleigh capillary instability in a multi-material fiber. The fiber core is made of the target material and has size close to the desired particle diameter embedded in a sacrificial polymer matrix. The fiber temperature is elevated to reduce the core viscosity and the Rayleigh instability results in the breakup of the core into a periodic string of spherical particles. Particles designed as fluorescent and nonlinear nano-probes are described.

Poster 6

Design and Optimization of a Fiber-based Luminescent Solar Concentrator

Esmaeil Banaei and Ayman F. Abouraddy
CREOL, The College of Optics & Photonics, University of Central Florida

Abstract
A design for fiber-based luminescent solar concentrators (FLSC) is presented. The proposed FLSC's incorporate luminescent molecules in the fiber core, and photovoltaic cells are attached to the end of bundled fibers for the optical-to-electric conversion of the concentrated solar energy. We report on the optimization of the FLSC performance over a wide range of parameters including fiber structure, shape and size as well as luminescence materials properties and concentration. Preliminary experimental progress in fabrication of FLSC's will also be presented. Results show the feasibility of low-cost, efficient solar light concentration using all-polymer flexible fibers

Poster 7

Multi-material chalcogenide glass fibers for mid-infrared optics

Guangming Tao, Soroush Shabahang, Joshua Kaufman, and Ayman F. Abouraddy
CREOL, The College of Optics & Photonics, University of Central Florida

Abstract
We review our progress in the emerging area of multi-material fibers. In particular, we will describe our efforts towards the fabrication of mid-infrared microstructured, all-chalcogenide glass fibers and fiber tapers. The fabrication process combines elements from multiple procedures: glass processing, thin-polymer-film processing, preform extrusion, and optical fiber drawing. The flexibility of our approach allows us to explore a wide variety of applications for chalcogenide glass fibers in the mid-infrared including optical power delivery and nonlinear mid-infrared optics.

Poster 8

Specialty fibers - design and testing

C. Jollivet Salvin*, C. Loussert, P. Hofmann, T. Tiess, T. Wang, H. Desirena, R. Amezcua Correa, A.Schülzgen
CREOL, The College of Optics & Photonics, University of Central Florida
* jollivet@creol.ucf.edu

Abstract
During the past decade, with new optical fiber fabrication techniques including growing abilities to fabricate high-performance photonic crystal structures, an increasing amount of research based on novel fiber designs has led to many new devices and application areas.
Our efforts to develop a fiber optics laboratory include creating fiber modeling and design capabilities, micro and nanostructured fiber fabrication with the new drawing tower to be installed in the near future, as well as advanced testing and characterization of drawn fibers. This poster presents some design examples of future fiber, e.g., annular core and large mode area designs. For fiber testing, an experimental set-up for a detailed analysis of the modal content of few-mode fibers will be shown and first results are discussed. As a fiber device example, an all-fiber mode field adapter is demonstrated including numerical modeling and experimental verification.

Poster 9

Electronically Tunable Silicon Photonic Delay Lines

Saeed Khan,[1,*] Mohammad Amin Baghban,[2] and Sasan Fathpour[1,2]
[1]*Department of Electrical Engineering and Computer Science, University of Central Florida*
[2]*CREOL, The College of Optics and Photonics, University of Central Florida*
* Saeed Khan: saeedk@creol.ucf.edu

Abstract
Electronically tunable optical true-time delay lines are proposed. The devices utilize the combination of apodised gratings and the free-carrier plasma effect to tune the enhanced delay of silicon waveguides at a fixed wavelength. Three variations of the proposed scheme are studied and compared. The compact and integrable devices can achieve tuning ranges as high as ~660 ps with a loss of < 2.2 dB when operated in the reflection mode of the gratings. A delay of ~40 ps with a loss of < 10 dB and an estimated operation bit rate of ~20 Gb/s can be achieved.

Poster 10

Scaling CPA and OPCPA lasers to beyond 10 TW level

Benjamin Webb*, Andreas Vaupel, Nathan Bodnar, Lawrence Shah, and Martin Richardson
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Abstract
We present the development of two new multi-TW laser systems for the Townes Laser Institute in CREOL. One will be a 20 TW Optical Parametric Chirped-Pulse Amplification (OPCPA) system, and the other is a Ti:Sapphire based Chirped-Pulse Amplification (CPA) laser system that will be upgraded to >10 TW.

Our new OPCPA laser system, PhaSTHEUS (PHAse-Stabilized, Terawatt, High-Energy, Ultrashort System), is designed to produce pulse energies up to 100 mJ with sub-2-cycle duration (< 5 fs) at 1 Hz, with full control of the Carrier-Envelope-Phase (CEP). Sub-5 fs pulses will be achieved using two-color pumping of multiple Non-colinear Optical Parametric Amplifiers (NOPA's) by a hybrid fiber/solid-state pump line.

Currently, our highest peak power system operates at 0.6 terawatts (30 mJ in 50 fs). This system will be upgraded into the Multi-Terawatt Femtosecond Laser (MTFL), which is anticipated to reach >10 TW with up to 400 mJ pulses with 35 fs pulse duration at 10 Hz. Improvements include an aberration free stretcher design, the development of new multi-pass amplifiers pumped by 3 J, and vacuum spatial filters to provide an excellent output beam profile. Design of a vacuum chamber for pulse compression must be implemented, since peak powers exceed the critical power for self-focusing in air.

A comparison of these two laser facilities outlines the differences between OPCPA and CPA for obtaining >10 TW peak powers, as well as the inherent difficulties involved in scaling these two types of lasers to high energies. With the advantage of both OPCPA and CPA operating at >10 TW level in a single laboratory, we will be capable of performing a wide array of high power laser experiments in such areas as filamentation and high energy High Harmonic Generation (HHG).

Poster 11

Wide Bandgap modulation of sol-gel synthesized amorphous Zn1-xMgxO (x=0-1) film for Ultraviolet Applications

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Abstract
Amorphous $Zn_{1-x}Mg_xO$ (⍰-$Zn_{1-x}Mg_xO$) ternary alloy thin films across the full compositional range were synthesized by a sol-gel method on quartz substrates. The amorphous property of the ⍰-$Zn_{1-x}Mg_xO$ films was verified by X-ray diffraction, and atomic force microscopy revealed an extremely smooth surface with sub-nanometer root-mean square roughness. By growing amorphous film, the phase segregation in crystalline $Zn_{1-x}Mg_xO$ with $38\%<x<75\%$ was completely eliminated. Optical transmission measurements showed high transmissivity of more than 90% in the visible and near infrared regions, with optical bandgap tunability from 3.3 eV to more than 6.5 eV by varying the Mg content. Sol-gel synthesized amorphous $Zn_{1-x}Mg_xO$ films are a promising candidate for simple and low-cost fabrication of amorphous-based optoelectronic devices such as solar-blind detectors.

Poster 12

Record Stress Test Results on Lithographic VCSELs for Size Scaling and High Reliability

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Abstract
A new lithographic vertical-cavity surface-emitting laser (VCSEL) technology is demonstrated, which produces simultaneous mode- and current-confinement only by lithography and epitaxial crystal growth. The devices are grown by solid source molecular beam epitaxy, and have lithographically defined sizes that vary from 3 μm to 20 μm. The lithographic process allows the devices to have high uniformity and scalability to very small size, and the thermal resistance is reduced due to the elimination of oxide aperture. The 3 μm device shows a threshold current of 310 μA, the slope efficiency of 0.81 W/A, and the maximum output power of more than 5 mW, it also shows single-mode single-polarization operation with over 25 dB side-mode-suppression-ratio up to 1 mW of output power. The devices are expected to have improved reliability due to removal of internal strain caused by the oxide, and smaller device may have higher reliability due to less volume strain caused by the thermal expansion of the active region. Stress test shows no degradation for the 3 μm device operating at very high injection current level of 142 kA/cm^2 for 1000 hours. The lithographic VCSEL technology can lead to manufacture of reliable small size laser diode, which will have application in large area 2-D arrays and low power sensors.

Poster 13

Development of an all-fiber thulium CPA System

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Abstract
In this presentation we will discuss our recent efforts in generation and amplification of ultrashort pulses in Tm doped fiber. We report a robust all-fiber oscillator using single-walled carbon nanotubes generating sub-500 fs pulses at 70 MHz. Using a Raman soliton amplifier these pulses were amplified to ~8 nJ with minimum pulse durations of 150 fs. We have explored further amplification of the 150 fs pulses in LMA fiber and will discuss the management of dispersion prior to amplification. The near term possibilities of scaling to GW peak powers and long term improvements for thulium CPA systems will be discussed.

Poster 14

Diffractive optical elements used for light management in photovoltaic modules

I. Mingareev*, R. Berlich, T.J. Eichelkraut, H. Herfurth, M.C. Richardson
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Abstract
Common solar cells used in photovoltaic modules feature metallic contacts which partially block the sunlight from reaching the semiconductor layer, and reduce the overall efficiency of the modules. Simple diffractive optical elements (DOE) have been generated in the bulk glass of a photovoltaic by ultrafast laser irradiation to direct light away from the contacts. Calculations of the planar electromagnetic wave diffraction and propagation have been performed using the rigorous coupled wave analysis technique taking multiple reflections of light from metallic contacts, semiconductor layer and glass surfaces into an account. The dependency of the efficiency enhancement on the design parameters of the DOE has been studied.

Poster 15

Development of Thin-Disk Lasers: Towards High Beam Quality at kW Level

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Abstract
Thin-disk and fiber laser architectures now dominate the field of high-power solid-state lasers. As such, the Townes Laser Institute has been expanding research into thin-disk laser systems and related materials. In the Laser Plasma Laboratory (LPL) we are working with the leading manufacturer of thin disk lasers, Trumpf GmbH, in a concerted effort towards further development of thin-disk laser systems. Our specific interests require high average power, high-energy nanosecond pulse, with near diffraction-limited beam quality. While considerably better than comparable rod-type systems in terms of heat removal and thermal management, thermal distortions in the thin-disk gain medium are still significant at kW-level average powers and there is still a great amount of room for improvement. Therefore our specific thrust in thin-disk laser development is towards improved thermal handling and characterization of thermal distortions. A Shack-Hartmann wavefront analysis facility has been developed for the characterization of wavefront distortions that occur under thermal loads. Various optical samples have been tested on transmission and a protocol for reflection testing is being developed for analysis of changes is disk curvature. Characterization of these thermally induced distortions in thin-disk lasers systems will lead to insights on how to improve the cooling and beam quality. As a further step, the application of laser ceramic host materials will also allow for dramatic improvements in beam quality.

Poster 16

Infrared Phased-Array Antennas

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Abstract
Infrared (IR) phased-array antenna-coupled metal-oxide-metal (MOM) tunnel diodes provide a versatile detection mechanism that allows for determination of the polarization, wavelength, angle of arrival, and degree of coherence of

an optical field. The wavelength and polarization of received IR radiaton are determined by varying the length and orientation of a single dipole antenna. Angle-of-arrival measurements are made with a pair of dipole antennas coupled to a MOM diode through a coplanar strip transmission line. The direction of maximum angular response is altered by varying the position of the MOM diode along the transmission line connecting the antenna elements. In addition, phased-array antennas can be used to measure the degree of coherence of a partially coherent IR field generated by a spatially incoherent source. For a two-element array, the degree of coherence is a measure of the correlation of electric fields received by the antennas as a function of the element separation. Antenna-coupled MOM diode devices are fabricated using electron beam lithography and thin-film deposition through a resist shadow mask. Measurements at 10.6 μm are substantiated by electromagnetic simulations and compared to analytic results.

Poster 17

Characterization of the Linear and Nonlinear Optical Response of Cascaded Plasmon Resonant Nanocomposites

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Abstract
The linear and nonlinear optical properties of cascaded plasmon resonant metallic-dielectric nanocomposites are investigated. We have previously shown that the nonlinear optical refraction and absorption of plasmon resonant nanocomposites can be optimized by modifying the spatial arrangement of silver nanoparticles in a nonlinear host material. Here we will discuss the nonlinear optical response enhancement of similar nanocomposites using cascaded plasmon resonances on coupled silver nanoparticles arrays. The arrays include chains of the silver nanoparticles with alternating sizes. The linear and nonlinear response of these structures was evaluated numerically as a function of the dissimilarity in the nanoparticle size. In successive simulations, the metal fill fraction was kept fixed while the relative size of particles was varied. It is found that the new coupled resonances that develop in these structures can produce further enhancement of the nonlinear optical response, which could lead to new optical switching devices. A new micro-z-scan setup for the experimental characterization of nanophotonic nonlinear optical structures is presented.

Poster 18

Two paths for OPCPA laser development: high average power vs. high energy

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Abstract
We present our two Optical Parametric Chirped-Pulse Amplification (OPCPA) laser facilites being developed at the Townes Laser Institute in CREOL. Our high-average power system HERACLES (High-Energy, Repetition rate-Adjustable, Carrier-Locked-to-Envelope System), currently provides optical pulses with few-cycle duration (sub-10-fs) at the 0.1 mJ-level. The OPCPA pump is generated by a hybrid fiber/solid-state amplifier design currently delivering 2.2 mJ at 1064 nm. After implementation of a booster amplifier stage, it will generate few-cycle pulses with 1 mJ energy at repetition rates up to 10 kHz corresponding to 0.1 TW. The system is designed to allow full control of the carrier-envelope phase (CEP).
Our new ultra high-intensity facility PhaSTHEUS (PHAse-Stabilized, Terawatt, High-Energy, Ultrashort System) is designed to provide a pulse energy of up to 100 mJ with sub-2-cycle duration (< 5fs) at low repetition rates. To achieve the necessary pump energy large aperture, flashlamp-pumped, solid-state amplifiers are employed which are currently providing 162 mJ pulse energy at 1 Hz repetition rate. Further extension with increasing rod diameter will permit amplification to the 2 J-level. Thus, the overall design foresees sub-2-cycle pulses with an intensity of 20 TW.

Poster 19

2 µm Propagation Studies, Issues Associated with High Power Mid-IR Beam Propagation

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Abstract
Thulium doped silica fiber can be used both as a broadband ASE source as well as a high power widely tunable 2 µm wavelength source owing to its large emission bandwidth (~200 nm). We have investigated the atmospheric propagation of high-power, narrow linewidth, tunable Tm:fiber Master Oscillator Power Amplifier (MOPA) system on a 1 km laser range at Merritt island. We will also investigate the propagation in the 2 µm wavelength regime in lab settings. In addition to the strong absorption features associated with water and CO_2 in this wavelength range, thermal lensing in materials such as silica glasses is also more severe than at 1 or 1.5 µm wavelengths due to higher absorption. We have performed thermal lensing measurements for silica based glasses and transmission characterization of chalcogenide glasses with Tm: doped fiber laser system. The oscillator for the above is a Tm doped Large Mode Area (LMA) fiber cladding pumped by 200 W, 793 nm diode laser which is capable of producing more than 50 W of output power.

Poster 20

Linear and nonlinear optical properties of gold and silver nanoparticles

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Abstract
Metallic nanoparticles have attracted considerable attention in nonlinear optical applications due to their proposed field enhancing properties. We are investigating the linear and nonlinear optical properties of gold nanorods (NRs) and of silver nanospheres (NSs) immersed in various host materials. Different NR alignment techniques are examined by linear spectroscopic analyses which show changes in the transverse and longitudinal plasmonic resonances. Z-scan measurements around the resonances reveal an optical bleaching behavior of the nanoparticles when irradiated with light of strong intensity. The bleaching is found to increase with linear absorption. A deeper analysis of the nanostructure electron dynamics by pump-probe experiments reveal an oscillatory modulation of the transmission signal which decays with the relaxation to the initial state. These results can be explained by an increase in the electron scattering rate by heat acceptance upon irradiation and an oscillatory change in the electron gas density due to rapid thermal expansion and contraction. Furthermore, the nanoparticles suggest potential for enhancing optical nonlinearities when suspended in a nonlinear host material. Silver NSs immersed in carbon disulfide (CS_2) show a combined signal of optical bleaching and increased two-photon absorption (2PA) relative to its magnitude in pure CS_2.

Poster 21

Spectral changes in single erythrocytes during the malaria parasite multiplication cycle probed by confocal absorption microscopy

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[2]Burnett School of Biomedical Sciences, UCF * sarora@knights.ucf.edu,
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Abstract
We have developed a novel approach to measure optical absorption spectra with spatial resolution at the micron scale. The setup employs a confocal microscope with a broadband white light excitation beam in transmission geometry.

The spatial resolution is found to be better than 1.5 microns in the lateral direction and 4 microns in the axial direction. Through measurements of the transmitted intensity in protein and dye nanoliter solutions at fixed path lengths, we establish that the absorbance varies linearly with concentration over the range from 0.1 to 7 mM. We present measurements of the absorption spectrum of single red blood cells (~ 7 microns diameter) under solution conditions. The spectra of cells infected with the malaria parasite show changes in peak positions and relative intensities in the Soret and �- and �- bands. These indicate hemoglobin degradation that can be correlated with the stages of the parasite multiplication cycle. Our approach enables measurements of spatial variations in the optical density of small samples and may find application in monitoring biological assemblies at the single cell level.

Poster 22

A single-photon CNOT gate using spatial-parity and polarization qubits

Kumel Kagalwala,[1] Giovanni Di Giuseppe,[1,2] Ayman F. Abouraddy,[1] and Bahaa Saleh[1,*]
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[2]School of Science and Technology, Physics Division, University of Camerino, 62032 Camerino (MC), Italy
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Abstract
We demonstrate a new and simple implementation of a quantum optical CNOT gate that relies on two degrees of freedom of a single photon: its polarization and its spatial parity. The control qubit is the photon polarization and the target qubit is the one-dimensional spatial parity. The CNOT operation is achieved using a polarization-sensitive spatial light modulator. The single-photon two-qubit state is then analyzed after the CNOT gate in the joint Hilbert space of polarization and spatial parity using a modified Mach-Zehnder interferometer, which projects onto the spatial-parity basis, followed by a polarization measurement. The truth-table for this two-qubit gate is validated. Furthermore, we test a Bell-like inequality using the two qubits corresponding to these two degrees of freedom.

Poster 23

Ultra High Density, High Radiance Spectral Beam Combining by Volume Bragg Gratings

[1]Derrek Drachenberg*, [1]Ivan Divliansky, [2]Vadim Smirnov, [1]George Venus, [1]Leon Glebov
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[2]OptiGrate Corporation

Abstract
Toward the goal of 100 kW level diffraction limited beams, we present high power, high spectral density beam combining by volume Bragg gratings of five 150 W beams with a spectral separation of 0.25 nm between beams, the narrowest to date for high power. Within 1 nm bandwidth, 750 W total power is combined with greater than 90 % efficiency. Each grating experiences a different thermal load resulting from different powers of the transmitted and reflected beams. The effect of thermal loading on the quality of the diffracted and transmitted beams is studied. A demultiplexing setup is demonstrated to measure and correct the lensing induced by laser heating of the VBGs and improvement in beam quality is observed resulting in the demonstration of an SBC system with the highest spectral radiance reported to date of 224 $\mathrm{TW/(sr * m^2)}$.

Lab Tours

Labs & Facilities

The main facilities of the College are housed in a state-of-the art 104,000 sq. ft. building dedicated to optics and photonics research and education.

Shared Facilities

Nanophotonics Systems Fabrication Facilities. A 3,000 ft^2 multi-user facility containing Class 100 and Class 1000 cleanrooms and a Leica 5000+ e-beam lithography instrument capable of 10-nm resolution. These facilities are used for fabrication and study of nanostructured materials and nanophotonic integrated circuits. The Laboratory is designed and operated as a multi-user facility, with availability to companies and other outside users. Rm 180.

Optoelectronic Fabrication Cleanroom. 800 sq. ft. multiuser facility consisting of class 100 and class 10,000 cleanrooms. Used in the development of optoelectronic semiconductor devices. The facility equipment includes a Suss MJB-3 aligner, a Plasma-Therm 790 RIE/PECVD, an Edwards thermal evaporator, along with a bonder, a scriber and microscope. Rm 211

Scanning Electron Microscope (SEM) Facility. Vega SBH system built by Tescan is a tungsten-filament scanning electron microscope. The system is designed with a fully electronic column and is capable of imaging from 1-30 keV with nanometer scale resolution. Additionally, the system is equipped with the state of the art sample positioning stage with 5 nm resolution and a full scale travel of 42 mm. The shared SEM is ideal for checking the fidelty of travel of 42 mm. The shared SEM is ideal for checking the fidelity of the microfabrication routinely performed in the CREOL cleanroom. Rm 176

Cary Spectra-Photometer and Microscope. Cary 500 is Spectrophotometer that is capable of measuring light absorption in both transmitted and reflected light in the UV, visible and near IR spectrum. Rm 159

Varian Cary 500 Scan UV-Vis-NIR Spectrophotometer. Rm 159

Olympus Nomarski Interference Microscope. Rm 159

Zygo Facility. Zygo New View 6300 Interferometer shared facility. Rm 211B. Martin Richardson.

Machine Shop. Has two modern Sharp LMV milling machines and a 16-50G lathe capable of achieving the tolerances required for the instruments used in CREOl. Classes are offered to qualify research scientists and students to safely modify and construct instruments critical to their research. Rm A106. Richard Zotti.

Faculty Laboratories

	Room
Ayman Abouraddy	
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Glenn Boreman

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David Hagan and Eric Van Stryland

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James Harvey

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Aravinda Kar

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Pieter Kik

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Stephen M. Kuebler

- Fabrication of 3D micro- and nano-scale structures — CHM 324

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- Quantum Well Optoelectronics — 220, 223

Jim Moharam

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Martin Richardson

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- Multi-TW Femtosecond Laser Interaction Facility; New Solid State Laser Development; Secure Laser Test Range SLTR — 140
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- Laser Spectroscopy & Sensing Lab — 140, 123 & 123A, 112- 117
- Fiber Laser Development Lab — 143
- X-ray microscopy — 123
- Laser Materials Processing — 141
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- Laser Tissue Interaction Lab — 262

Nabeel Riza

- Photonic Information Processing Systems — 251, 253

Bahaa Saleh

- Quantum Optics Lab — 204

Axel Schülzgen

- Fiber Optics Lab — 201

Winston Schoenfeld

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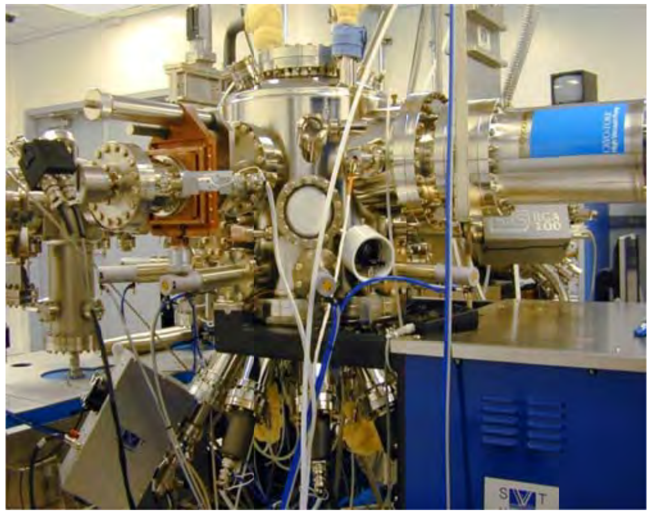
- Wide Band Gap Characterization Lab — A112
- Oxide MBE Lab — 180C

Eric Van Stryland (See Drs. Hagan and Van Stryland)

Nanophotonics Fabrication Facility



MBE Facility

Lab Tour Schedule

Guided tours start at **2:30 pm** and at **3.15pm** in the CREOL lobby and last about 40 minutes.

Be sure to look at the live video feed of the CREOL cleanroom showing the ebeam writer (screen located in the lobby), and at the monitors near several laboratories on the ground floor.

TOUR A Start times: 2.30pm and 3.15pm

A105 **Fiber Draw Tower**
Dr. Ayman Abouraddy

201 **Fiber Optics Lab** ★ **Featured in talk**
Dr. Axel Schulzgen

244A **Optical Signal Processing using Frequency Combs**
Dr. Peter Delfyett — http://up.creol.ucf.edu

TOUR B Start times: 2.30pm and 3.15pm

125 **Infrared Antennas & Frequency Selective Surfaces** ★ **Featured in talk**
Dr. Glenn Boreman — http://ir.creol.ucf.edu

130 **Nanoscale E-Field Mapper**
Dr. Glenn Boreman — http://ir.creol.ucf.edu

256 **Stabilized Optical Frequency Combs**
Dr. Peter Delfyett — http://up.creol.ucf.edu

115 **Laser Spectroscopy and Sensing**
Dr. Martin C. Richardson — http://lpl.creol.ucf.edu

TOUR C Start times: 2.30pm and 3.15pm

259 **Liquid crystal displays and Voltage-stretchable liquid crystal surface**
Dr. Shin Tson Wu — http://lcd.creol.ucf.edu

227 **Seeded Femtosecond White Light Continuum**
Dr. David Hagan and Dr. Eric Van Stryland — http://nlo.creol.ucf.edu

140/143 **Laser Development and Materials Processing**
Dr. Martin C. Richardson — http://lpl.creol.ucf.edu

TOUR D Start times: 2.30pm and 3.15pm

255 **Low noise chirped pulse laser with an intra-cavity Fabry-Pérot etalon** ★ **Featured in talk**

Dr. Peter Delfyett — http://up.creol.ucf.edu

180 **Molecular Beam Epitaxy Lab**
Dr. Winston Schoenfeld — http://npdg.creol.ucf.edu

180 **Semiconductor Laser Lab**
Dr. Dennis Deppe

Building Map
First Floor

Building Map
Second Floor

Industrial Affiliates Program

Program

Membership in the Industrial Affiliates (IA) program provides to industrial corporations, organizations, and individuals many benefits, most of which are also of mutual benefit to the College of Optics and Photonics. One of these mutual benefits is the regular communication and contact the program provides between the research faculty and students at the College and the IA member company's engineers and scientists who are developing new technologies and products for their business. Other benefits include:

- Establishing a close association with this leading institute in optics, lasers, and photonics
- Exposure to the latest research and developments in cutting edge technologies
- Availability of sophisticated measurement, test, and calibration facilities
- Early notice of students approaching graduation (the next generation of experts in the field) and access to their CVs
- Ability to post job openings on the College's website (exclusive benefit for IA members)
- Close interactions with the faculty, each of whom are leaders in their fields
- Opportunity to make presentations about the member's company and products to the faculty and students of the College
- Access to the College's periodic newsletter, Highlights, and monthly e-Highlights
- Notification of seminars at the College
- Opportunity for free presentation space at the annual Industrial Affiliates Day meeting
- Several Web-based benefits, including linkage to the company's web site from the College website
- For companies who donate equipment, getting their hardware/software in the hands of some of the leading researchers—faculty and students—in the field provides visibility to future customer prospects and information on its impact in leading-edge research
- Demonstration by the company of its support of the College, its research programs, and its effective corporate cooperation and partnership activities

In addition, we use many mechanisms to give visibility to our Industrial Affiliates that can be valuable to them in marketing their products. Wherever possible, the level of the membership is indicated. Examples of current practices include:

- Listing in the CREOL Highlights quarterly newsletter
- Special recognition at the annual Industrial Affiliates Day
- Listing in other publications, where appropriate, including on the website (with a link to the company's website)
- Company name plaque prominently displayed in the entrance lobby of the CREOL building.

There are also many intangible benefits that accrue from association with this dynamic research and education institution. Among these are facilitated access to and collaboration with other specialized facilities within the University of Central Florida and the central Florida area. In addition to resources in the Center for Research & Education in Optics & Lasers (CREOL) the Florida Photonics Center of Excellence (FPCE), and the Townes Laser Institute, UCF facilities include the following major research centers:

- Nano-Sciences & Technology Center (NSTC)
- Advanced Materials Characterization Facility (AMPAC)
- Materials Characterization Facility (MCF)
- Biomolecular Science Center
- Institute for Simulation and Training (IST)
- Center for Distributed Learning
- National Center for Forensic Science (NCFS)
- Florida Solar Energy Center (FSEC)
- Florida Space Institute (FSI)

The College's faculty and students play leading roles in both local and international professional associations and can provide effective introductions to the extensive network of industry and expertise to which CREOL, The College of Optics & Photonics, connects. Through the IA program, members can also readily connect with other optics, photonics, and industrial organizations through local Florida organizations in which the College maintains an active participation, including the Florida Photonics Cluster (FPC), the Laser Institute of America (LIA), Florida High Technology Corridor Council (FHTCC), the UCF Technology Incubator — ranked #1 in the US in 2004 — and a large family of laser and optics companies in the Central Florida region.

Industrial Affiliates Members

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Nufern
Memoriam Members: *Dr. Arthur H. Guenther and Dr. William C. Schwartz*

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Thorlabs
TRUMPF, Inc.
Vectronix Inc.
Veeco Instruments-Metrology
Zygo Corporation

Affiliate Members

Aerotech, Inc.
Analog Modules
Applicote Associates, LLC
DILAS Diode Laser, Inc.
eVision, LLC
Gooch & Housego, LLC.
Harris Corporation
HORIBA Jobin Yvon
Imagine Optics, Inc.
Insight Technology
JENOPTIK Optical Systems Inc.
Kaufman & Robinson, LLC
L-3 Communications
Laser Institute of America
Laser Path Technologies
Lee Laser
Luna Innovations, Inc.
NKT Photonics
Northrop Grumman Aerospace Systems
Optigrate Corp.
Photonics Spectra
Photonics Online
Princeton Instruments
Quioptic
QPC Lasers/Laser Operations LLC
R-Soft Design Group
Ray Williamson Consulting
Sciperio, Inc.
SPIE- The Int'l Society for Optics & Photonics
Teledyne ODI
OSA, The Optical Society
Tower Optical Corporation
TwinStar Optics, Coatings & Crystals
Vytran LLC
Yokogawa Corporation of America

Why Florida?

All high-tech companies benefit from Florida's business environment, which emphasizes innovation, collaboration, and talent formation for today's global markets. From start-ups focused on turning the latest academic research into commercially viable products and technologies, to established industry giants, Florida has what high-tech companies need.

Florida Photonics Industry Cluster

Florida's photonics cluster is the 4th largest in the US, with over 270 companies employing over 5,700 professionals focused on the design, development, manufacturing, testing, and integration of photonics products and related systems. The photonics and optics cluster in Florida spans a very broad range of industry sectors, including lasers, fiber optics, optical and laser materials, thin film coatings, optical components, optoelectronic fabrication and packaging, and photonic systems integrators, addressing almost all applications from energy to medicine to defense. The state's colleges and universities have established interdisciplinary programs and centers focusing on pho-tonics/optics, which graduate over 100 photonics specialists (AS to PhD) each year. The Florida Photonics Cluster, a 501c(6) trade association, (www.floridaphotonicscluster.com) is dedicated to serving the industry and to making Florida the place to go for photonics solutions.

Innovation Economy

Nowhere else is the spirit of innovation more evident than in the State of Florida, which has the reputation as the "Innovation Hub of the Americas". The state's pro-business, pro-technology climate, combined with easy trade access to key growth regions of the Americas, as well as the rest of the world, provide a fertile environment for establishing and growing businesses. Some of the unique resources available to entrepreneurs include the Florida Virtual Entrepreneur Center (www.flvec.com), GrowFL (www.growfl.com), and several business incubators (www.floridahightech.com/region.php) including the rapidly growing and award-winning UCF Business Incubator (www.incubator.ucf.edu).

Top Quality of Life & Great Place for Photonics

Since 2001, Florida has earned top rankings in Harris Poll's "most desirable place to live" survey, so it's no surprise why Florida has become a top destination for high-tech industry, and in particular for the photonics industry. The University of Central Florida houses CREOL, The College of Op-tics and Photonics, and in addition to CREOL, the College houses the Townes Laser Institute and the Florida Photonics Center of Excellence. In addition, the Florida Photonics Cluster, several vigorous university incubators, proactive regional and state-level economic development organizations, and a dynamic grouping of cutting-edge companies form a photonics hub focused on advancing Florida's photonics industry.

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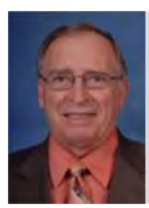

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Thank you for attending!

We look forward to seeing you at the next Industrial Affiliates Day

CREOL’s 25th Anniversary
Friday, March 16, 2012