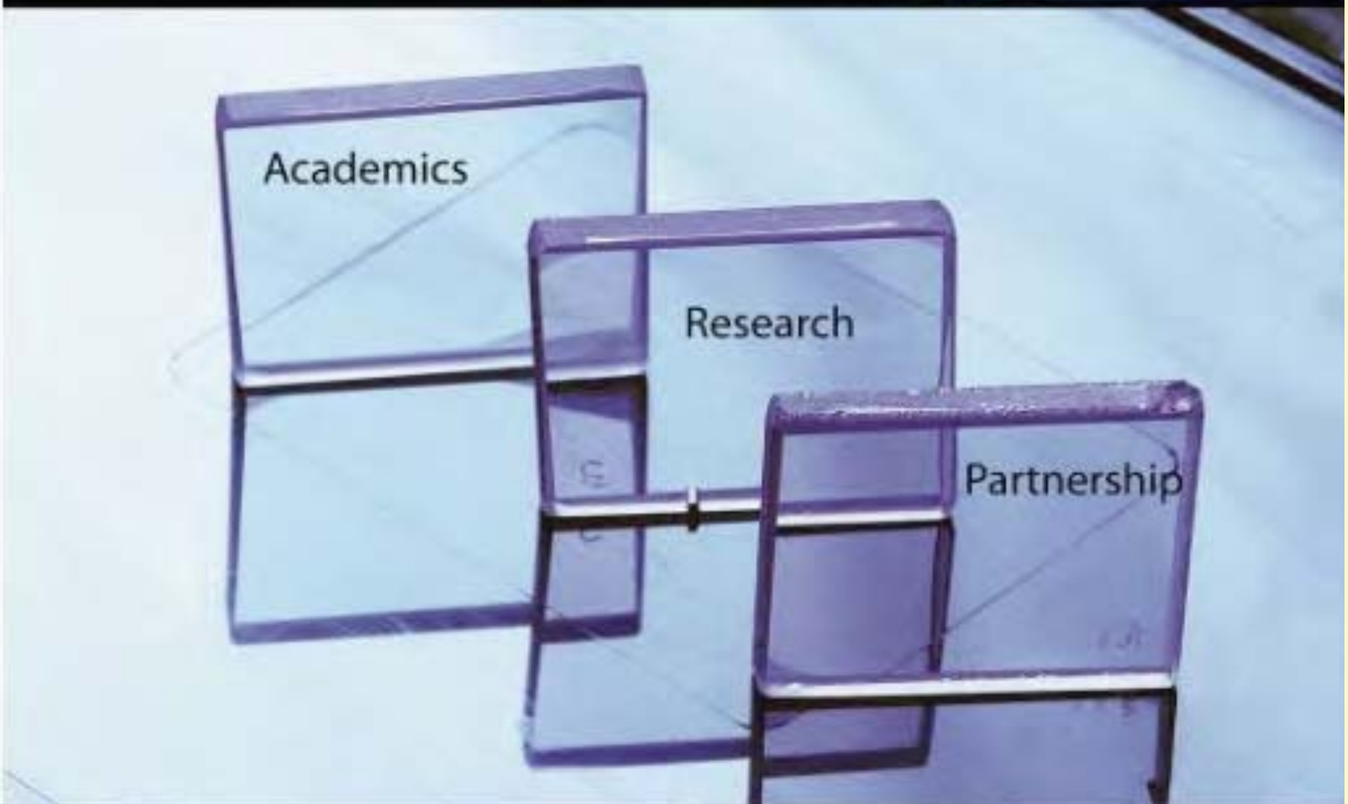
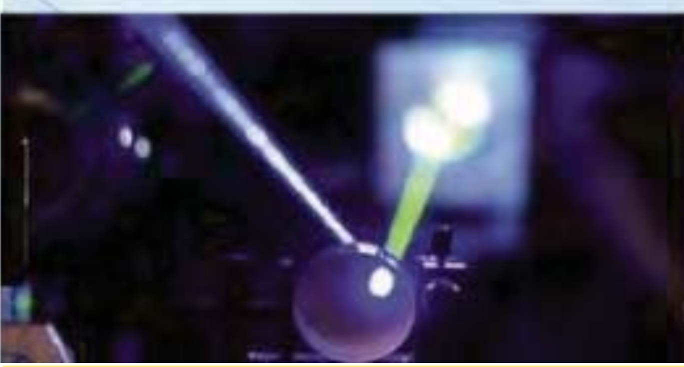
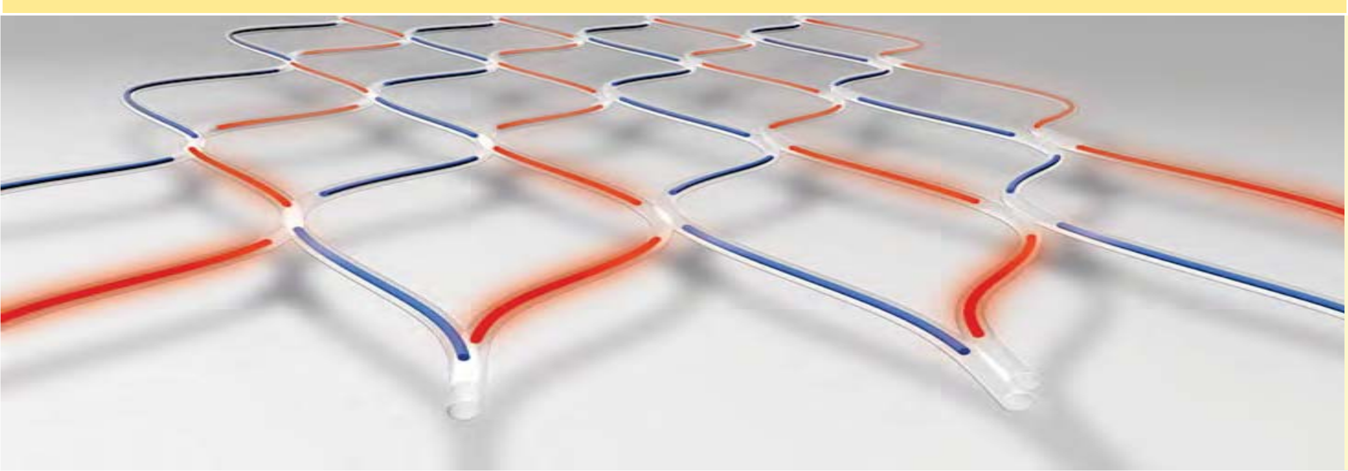




Symposium and Industrial Affiliates Program

UCF CREOL, The College of Optics and Photonics

2013



Light in Action

Industrial Affiliates Program
Friday, 8 March, 2012
UCF Student Union

8:00	Continental Breakfast, Registration, and Exhibits		UCF Student Union
8:30	Welcoming Remarks	**MJ Soileau**	UCF Vice President for Research
8:50	Welcome and overview of CREOL	**Bahaa Saleh**	Dean & Director, CREOL, UCF

Symposium: Light in Action

Session I. Manufacturing

9:15	Advances in optical diagnostics for laser processing	**Jyoti Mazumder**	University of Michigan
9:45	Fabrication of metamaterials	**Debashis Chanda**	CREOL, UCF
10:05	Break & Exhibits		UCF Student Union

Session II. Optogenetics

10:25	Reshaping the optical dimension in optogenetics	**Alipasha Vaziri**	University of Vienna
10:55	Optical action at mesoscales	**Aristide Dogariu**	CREOL, UCF

Session III. Displays

11:15	Holographic 3-D displays	**Nasser Peyghambarian**	University of Arizona
11:45	Next-generation LCD displays	**ST Wu**	CREOL, UCF
12:05	Lunch Served & Exhibits		UCF Student Union

Session IV. Lithography

1:00	Nanoscale lithography using visible light	**John Fourkas**	University of Maryland
1:30	Fabrication of volume bragg reflectors	**Leon Glebov**	CREOL, UCF

Session V. Photonics Entrepreneurship

1:50	"Making entrepreneurship work"	**Milton Chang**	Incubic Management, LLC
2:20	Discussion, questions & answers	**Milton Chang**	
2:40	Panel discussion on "Future challenges for photonics in manufacturing"	**Jim Pearson - moderator**	Selected CREOL Affiliates
3:20	Break & Walk to CREOL Building		

Session VI. Poster Session, Tours, Exhibits, and Awards

3:40	Poster Sessions; Lab Tours; Exhibits; (contiguous).	**CREOL Graduate Students**	CREOL rooms 102 & 103; Tours start from lobby; exhibits in lobby
5:30	Poster award presentation; reception	**Bahaa Saleh**	CREOL, UCF
6:30	End of Day		CREOL Building

Thursday, 7 March, Afternoon Session

Short Courses

1:00– 2:30 PM Room 102

Lasers in Manufacturing

Instructor: Aravinda Kar, UCF

This short course is an introduction to laser techniques for advanced manufacturing based on interdisciplinary concepts. Four areas will be discussed in this course: 1) Basic properties and types of lasers for manufacturing. 2) Laser beam focusing and shaping. 3) Laser-material interactions, and optical and thermophysical properties. 4) Examples of laser-advanced manufacturing such as optical trepanning for drilling and laser doping of compound semiconductors for novel sensors and detectors.

1:00– 2:30 PM Room 125 HEC

Plasmonic & Metamaterials

Instructor: Pieter Kik, UCF

The unique optical properties of metal nanostructures have led to ultrasensitive biochemical sensors, nanoscale light sources, bio-compatible optical markers, and many more thanks in large part to plasmon resonances. This course covers fundamental aspects of plasmonic structures, and how these have enabled new technologies. Topics include biosensing using surface enhanced Raman scattering, refractive index based plasmonic sensors, metamaterial based perfect absorbers, metamaterial based polarization optics, and plasmonic nanolasers.

2:45– 4:15 PM Room 125 HEC

Biomedical Imaging

Instructor: Bahaa Saleh, UCF

This short course is an introduction to optical techniques for extracting spatial and spectral information on biological tissues, cells, and molecules. The course will cover four areas of biomedical imaging: 1) Laser scanning fluorescence techniques, including confocal microscopy, multiphoton microscopy, and super-resolution techniques. 2) Interferometric techniques for axial imaging such as optical coherence tomography. 3) Tomographic techniques for 3D imaging such as optical diffraction tomography and diffuse optical tomography. 4) Spectral imaging techniques, with examples including oximetry for imaging of brain activity.

2:45– 4:15 PM Room 102

Organic & Polymeric Optical Materials

Instructor: Stephen Kuebler, Professor of Chemistry and Optics, UCF

Organic photonics is a dynamic field that arcs across many established and emerging technologies, including bioimaging, organic photovoltaics, liquid crystal displays, and nonlinear optical materials. In this short course we will review the fundamental concepts that link organic molecular and polymeric structure with their optical properties and performance. The discussion will draw upon concepts from chemistry, physics, materials science, and optics, making connections to contemporary applications.

Advances in Optical Diagnostics for Laser Processing

Jyoti Mazumder, University of Michigan

Abstract: Recently Additive Manufacturing (AM) has been hailed as the "third industrial revolution" by Economist magazine [April -2012]. Precision of the product manufactured by AM largely depends on the on line process diagnostics and control. AM caters to the quest for material to suit the service performance, which is almost as old as the human civilization. An enabling technology which can build, repair or reconfigure components layer by layer or even pixel by pixel with appropriate materials to match the performance will enhance the productivity and thus reduce energy consumption. With the globalization, "Economic Space" for an organization is now spreads all across the globe. The promise of AM for Global Platform for precision additive manufacturing largely depends on the speed and accuracy of in-situ optical diagnostics and its capability to integrate with the process control.

The two main groups of AM are powder bed (e.g. Laser Sintering) and pneumatically delivered powder (e.g. Direct Metal Deposition [DMD]) to fabricate components, DMD has closed loop capability, which enables better dimension and thermal cycle control. This enables one to deposit different material at different pixels with a given height directly from a CAD drawing. The feed back loop also controls the thermal cycle. *New optical Sensors are either developed or being developed to control geometry using imaging, cooling rate by monitoring temperature, microstructure, temperature and composition using optical spectra. Ultimately these sensors will enable one to "Certify as you Build".* Flexibility of the process is enormous and essentially it is an enabling technology to materialize many a design. Several cases will be discussed to demonstrate the additional capabilities possible with the new sensor. Conceptually one can seat in Singapore and fabricate in Shanghai. Such systems will be a natural choice for a Global "Economic Space".

Jyoti Mazumder is Robert H. Lurie Professor of Engineering in the Department of Mechanical Engineering and Materials Science and Director of NSF Industry University Co-operative Center for Lasers and Plasmas in Advanced Manufacturing at the University of Michigan in Ann Arbor. He is also an elected member of National Academy of Engineering.

He has published more than 375 papers, co-authored books on Laser Chemical Vapor Deposition and Laser Materials Processing. He also edited/co-edited 10 books on topics related to laser materials processing and Mechanical Engineering. He holds 17 U.S. patents. He is taking his research to market by commercializing DMD through a start up called POM Group Inc. DMD systems are installed in four continents. Some of his laser welding patents are licensed to Ford Motor Company.

Dr. Mazumder has received numerous awards and honors for his research including, Schawlow Award for seminal contribution to laser application research from Laser Institute of America in 2003, William T. Ennor Award for manufacturing from ASME in 2006, Adams Memorial Membership award from American Welding Society in 2007, Thomas A. Edison Patent Award from ASME in 2010 for inventing First closed loop Direct Metal Deposition system, which will significantly enhance some aspect of Mechanical Engineering, Distinguished University Award in 2012 from the University of Michigan. Manufacturing Engineer of the Year (1986) from Society of Manufacturing Engineer, University Scholar (1985) and Xerox (1987) award from University of Illinois. He is also Fellow of American Society of Mechanical Engineers (ASME). American Society of Metals (ASM) and Laser Institute of America (LIA). He served as the president of the Laser Institute of America in the year 2000. Dr Mazumder was Editor in Chief of the *Journal of Laser Applications* until December 2009.

Fabrication of Metamaterials

Debashis Chanda, Nanoscience Technology Center and CREOL, UCF

Abstract: The talk will focus on the design and development of high throughput, large scale and low cost fabrication of optical nanostructures for enhanced light-matter interactions in artificially structured metal/dielectric structures (metamaterials, plasmonic nanostructures), transformation optics for display/camouflage, strong coupling between photonic and plasmonic resonances and trapping light in thin film solar cells. We are currently pursuing approaches based on proximity field nanopatterning, soft nanoimprint lithography and nanotransfer printing patterning techniques. In their current forms, these methods can produce diverse classes of 3D and quasi-3D nanostructures with excellent structural uniformity and small features sizes. Their operational characteristics avoid practical challenges in patterning speed and area coverage associated with established techniques such as electron and focused ion beam lithography. In one example, we developed a nanotransfer printing based fabrication approach to large-area, high-quality negative index metamaterials (NIMs) with three-dimensional layouts with throughputs and areal coverage that are approximately one hundred million times higher than those possible with conventional techniques. Measurements and simulations show expected negative index behaviors, with figures of merit that exceed those of small samples fabricated in the usual way. In other work, we used soft nanoimprint lithography to create structures with plasmonic responses that couple strongly to modes of integrated, asymmetric Fabry-Perot cavities. We demonstrated that this arrangement can exhibit highly enhanced or diminished reflection properties, effectively like a narrow band absorber, but in a way that can be tuned reversibly using the techniques of opto-fluidics. We also developed wave optics light trapping schemes to enhance light absorption in thin-film silicon solar cells and demonstrated cell efficiency of >10% in just 2.8μm thick c-Si cells.

Debashis Chanda is an assistant professor jointly appointed with NanoScience Technology Center and College of Optics and Photonics (CREOL), UCF since August 2012. He did his post-doctoral research with Prof. John A. Rogers at Beckman Institute, University of Illinois at Urbana-Champaign between 2009-2012. His present work involves advancing fundamental understanding of light-matter interactions in artificially structured metal/dielectric structures (metamaterials, plasmonic nanostructures), transformation optics for display/camouflage, strong coupling between photonic and plasmonic resonances and trapping light in thin film solar cells. Some of these works appeared as cover article (Nature Nanotechnology, Laser Focus World) in quite a few press releases and news coverage (MIT Tech Review, Physics Today, Nanotechweb, Physics.org etc). Dr. Chanda received his PhD from University of Toronto working with Prof. Peter Herman where he developed a diffractive optics lithography based high throughput laser fabrication technique of large area fabrication of 3-dimensional photonic crystals. The work was recognized in the form of several awards, including prestigious National Sciences and Engineering Research Council (NSERC) fellowship. Before that he worked for ABB and Philips research labs for couple of years each on optical/RF communications and opto-electronics component design projects.

Reshaping the Optical Dimension in Optogenetics

Alipasha Vaziri, University of Vienna

Abstract:: In the recent years the combination of genetic tools and optics (optogenetics) has allowed cell type specific optical initiation of neuronal response opening up the way to a range of studies in neuroscience. The most widely used approach has been the optical activation of the genetically expressed light-gated channel, Channelrhodopsin-2 (ChR2), to initiate population activity in neuronal circuits. However, targeted single-cell-level optogenetic activation of large number of genetically identical neurons with temporal precessions comparable to the spike timing remained challenging.
Using such "sculpted light" sources we have demonstrated targeted, single cell specific optogenetic initiation of neuronal response on acute hippocampal slices of rat and mouse as well as rapid sequential activation of arbitrary spatio-temporal patterns of large number of neurons. Besides extending these studies to a larger neuronal population and to in vivo studies, we expect a major future application of patterned light stimulation to be in high-throughput mapping of neuronal connectivity.
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Alipasha Vaziri is a Professor at the University of Vienna, a group leader the Institute of Molecular Pathology (IMP) and is heading the interfaculty research platform Quantum Phenomena and Nanoscale Biological Systems (QuNaBios). His research interest lies at the interface between biology and physics. He his applying and developing new technologies based on ultrafast and quantum optics to study biological structure and function with spatial and temporal resolution. In parallel he is interested in possible role that non trivial quantum effects might play in bimolecular processes.
Before moving to Vienna he worked as a researcher at Janelia Farm Research Campus of the Howard Hughes Medical Institute on developing super resolution imaging and new ontogenetic techniques. He has a background is in quantum optics and quantum information. He worked as a postdoctoral fellow with William D. Phillips on Bose Einstein Condensation at the National Institute of Standard and Technology (NIST) and received his PhD at the University of Vienna with Anton Zeilinger. In his PhD he demonstrated for the first time the quantum entanglement of orbital angular momentum (OAM) of light which thereafter triggered a worldwide research activity on OAM as a new resource for quantum information and communication.

Optical Control of Active Matter

Aristide Dogariu, CREOL, UCF

Abstract: Light induces mechanical action in different ways. The conservation of linear and angular momenta carried by optical waves is essential for understanding and manipulating the forces generated by light. We will show that harnessing light at scales comparable with the wavelength opens new possibilities for sensing, guiding, and controlling material systems.

Arisitde Dogariu is the Florida Photonic Center of Excellence Professor at CREOL, The College of Optics & Photonics, at the University of Central Florida. He received his PhD from Hokkaido University in Japan and his research interests include wave propagation and scattering, electromagnetism, optical sensing and imaging. He has published extensively in the broad area of optical physics and has served in a number of editorial positions. Professor Dogariu is a Fellow of the Optical Society of America and the Physical Society of America..

Laser Writing of Updateable Holographic 3D Displays on Photorefractive Polymers

Nasser Peyghambarian, University of Arizona

Abstract: One of the applications of lasers is in 3D holographic displays. In this presentation, the recent advances in photorefractive (PR) polymers and their applications for dynamic 3D display technology will be reviewed. The advantages provided by these plastic materials include better performance (larger figure of merit), faster response time and large area. We have now demonstrated PR polymers with 12”x12” area full color and exhibit high resolution, color.

The research has been supported by AFOSR, and NSF Engineering Research Center, CIAN.

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Nasser Peyghambarian is currently a Professor at the College of Optical Sciences and also at the Department of Materials Science & Engineering at the University of Arizona. He is the Chair of Photonics and Lasers and serves as Director of the NSF Center for Integrated Access Networks (CIAN). He is the Founder of NP Photonics, Inc and TIPD, LLC. He received his Ph.D. in solid-state physics from Indiana University in 1982, specializing in optical properties of semiconductors before joining the optics program at the University of Arizona. His research interests include holographic 3D display, Holographic 3D telepresence, fiber optics, fiber lasers and amplifiers, optical components for communication, nonlinear optical materials and devices, integration of polymers with CMOS circuitry, glass-organic hybrid materials and devices, and adaptive electro-active lenses for eyewear. He is the recipient of the International Francqui Chair, Belgium 1998-1999. He is a Fellow of the Optical Society of America, the American Physical Society, Society of optical engineers, SPIE and the American Association for the Advancement of Science

Next-Generation Liquid Crystal Displays

Shin-Tson Wu, CREOL, UCF

Abstract: After more than three decades of active research and development, and massive investment in manufacturing technology thin-film-transistor liquid crystal display (TFT-LCD) has finally dominated the flat panel display technology. Nowadays, LCDs have become indispensable in our daily life, ranging from smartphones, tablet and desktop computers, TVs, and data projectors. It seems like the LCD technology is fairly mature. The most critical issue on viewing angle has been overcome using multi-domain structures and optical film compensation. The mostly complained response time has been improved to 2-5 ms through low viscosity LC material development, driving circuitry, and thin cell gap approach. The contrast ratio has exceeded one million-to-1 through local dimming of the LED backlight. The color gamut could exceed 100% NTSC if RGB LED backlight is used. What's more is that the cost is also reduced dramatically by investing in advanced manufacturing lines. So, what is next?

In this talk, I will focus on next-generation LCDs for mobile displays and TVs. In mobile displays, my research group has developed a new LCD with superior performance to iPhone 5 in terms of higher transmittance, simpler electronics, and cell gap insensitivity. To meet the strict Energy Star 5.4 regulation for large-screen TVs, our group has developed a low-voltage polymer-stabilized blue phase LCD based on Kerr effect-induced isotropic-to-anisotropic transition. Blue-phase LCD exhibits drastically different features from conventional nematic, such as 10X faster response time, no need for alignment layer, and cell gap insensitivity. With field sequential RGB LED colors, the spatial color filters can be eliminated so that both optical efficiency and resolution density can be tripled. Several display manufacturers, such as Samsung and AUO, have demonstrated impressive prototypes. The dawn of the blue-phase LCD era is on the horizon.

Shin -Tson Wu is a Pegasus professor at University of Central Florida (UCF). Prior to joining UCF in 2001, he was with Hughes Research Laboratories (Malibu, California). He received his Ph.D. in laser physics from University of Southern California (Los Angeles, California, USA) and BS in physics from National Taiwan University (Taipei, Taiwan). Prof. Wu is a Charter Fellow of the National Academy of Inventors, a Fellow of the IEEE, OSA, SID, and SPIE. He is a recipient of SID Slottow-Owaki prize (2011), OSA Joseph Fraunhofer award/Robert M. Burley prize (2010), SPIE G. G. Stokes award (2008.

Nanoscale Lithography using Visible Light

John Fourkas, University of Maryland

Abstract According to the Abbe criterion, creating ever smaller lithographic features involves using radiation or charged particles of ever shorter wavelengths. However, in semiconductor nanolithography, feature sizes have reached a regime in which radiation or particles of the necessary wavelength are expensive to produce, propagate and manipulate. The resultant technological challenges threaten, for the first time, to slow the progress of Moore's Law. However, if visible light could be used to create features on the scale of tens of nanometers, the expense and complexity of semiconductor nanolithography could be reduced considerably. I will discuss some of our recent progress towards this goal.

John Fourkas received a BS with honors and an MS, both in Chemistry, from Caltech in 1986. He received his PhD in Chemistry from Stanford University in 1991, where he worked in the group of Michael Fayer. He was an NSF Postdoctoral Fellow with Mark Berg at the University of Texas and Keith Nelson at MIT before joining the Chemistry faculty of Boston College in 1994. He was promoted to Associate Professor in 2000 and Professor in 2001. He moved to the University of Maryland in 2005, where he holds the Millard Alexander Chair in Chemistry. He is a member of the Department of Chemistry & Biochemistry, the Institute for Physical Science and Technology, the Chemical Physics program, and the Maryland NanoCenter. He was a Visiting Fellow at JILA in Boulder, CO in 2002, and has also been a Senior Editor of the Journal of Physical Chemistry since 2002. His research focuses on the use of ultrafast lasers and nonlinear optical techniques to probe, control and fashion condensed matter.

Fine Laser Beam as a Power Manufacturing Tool for Commercial Production of Diffractive Optical Elements

Leon Glebov, CREOL, UCF

Abstract: Diffractive optical elements have wide applications in different areas of optics, photonics and laser industries for fine filtering, spectral analysis, multiplexing/demultiplexing, beam control, etc. Traditionally, these elements are based on extremely precise fabrication of complex profiles on the surface of suitable optical materials. This is a very well established technology that includes fine mechanics, multilevel photolithography, and different types of etching or deposition. Invention at UCF of a technology of high-efficiency volume diffractive elements produced by a holographic technique based on photo-thermo-induced refractive index change in the volume of optical glass dramatically changed the technology of diffractive optical elements fabrication and enhanced achievable parameters of those elements. Development of a photosensitive glass with a top level of optical homogeneity and very specific spectral properties combined with development of a large aperture holographic setup operating in UV region with top level of elimination of optical aberrations and phase fluctuations enabled fabrication of diffractive optical elements with unprecedented spatial frequency exceeding 9000 lines per millimeter that can withstand multi-kilowatt laser radiation. These elements have found wide applications in fine filtering for spectroscopy and laser beams control. This is an impressive demonstration how optics is converted from a science enabling fine measurement to a powerful manufacturing tool.

Leon Glebov got his Ph.D. in Physics (major in Optics) from State Optical Institute, Leningrad, Russia (1976). He has been affiliated with that institute up to 1995 holding different positions in research and scientific management. Since 1995 Dr. Glebov has been at CREOL/ The College of Optics and Photonics, University of Central Florida as a Research Professor. He has published a book and more than 300 papers in scientific journals and holds 15+ Russian patents, and 9 awarded and 3 pending US patents. He is a member of Organizing and Program Committees for a number of International Conferences. Dr. Glebov is a fellow of American Ceramic Society, the Optical Society of America and SPIE – International Society for Optics and Photonics; he is a recipient of SPIE Denis Gabor award in holography. The main directions of his research are optical properties of glasses, holographic optical elements, and semiconductor, solid state and fiber lasers controlled by volume Bragg gratings. Leon Glebov is a founder and VP for R&D of OptiGrate Corporation which develops and fabricates holographic optical elements (volume Bragg gratings) for multiple applications in lasers and photonics.

Every Startup can Succeed

Milton Chang, Incubic Management, LLC

Entrepreneurs want to succeed, and investors want to make investments. Yet raising money is tough, especially for starting companies that make and sell hardware and equipment. This is in part due to the low rate of success using the conventional approach: raising significant capital to pursue a hot idea, and then spending freely to gain "first-mover" position in the market. This approach is no better than taking a "hit or miss" approach. In order to get funded, an entrepreneur must be able to substantiate that the business makes sense, that it can succeed, and that it has the ability to provide investors a handsome return.

This presentation will describe a low-risk startup model, which is based on more than a dozen companies the author has successfully incubated. In a nutshell, the right approach has the following requirements:

- Start with an idea in an area of familiarity
- Do due diligence to challenge assumptions
- Establish realistic goals based on what is achievable
- Formulate a viable business strategy
- Be committed to develop the business thoughtfully over time

Fundamentally a business must be able to use capital efficiently to create value in order to succeed. That means an entrepreneur must know something about business and management, not just about the product and/or technology to properly lead the business.

This presentation will also provide career guidance to students, encouraging everyone to take an interest in business and management to improve job performance, gain upward mobility, and also have the option to become an entrepreneur. You will be glad that you did when you realize that it is challenging to maintain a technical edge in a 40-year career! Students, this is one seminar you don't want to miss!

Milton Chang is managing director of Incubic Management LLC and is the author of Toward Entrepreneurship. He was president of Newport and New Focus, which he took public. He is currently director of MBio Diagnostics, and Aurrion, spends time advising companies and mentoring entrepreneurs, and writes a monthly business column for Laser Focus World. Chang is currently a member of the SEC Advisory Committee on Small and Emerging Companies and a Trustee of the California Institute of Technology.

Chang earned a B.S. in electrical engineering with highest honors from the University of Illinois and M.S. and Ph.D. degrees in EE from Caltech and he has completed the Harvard Owner President Management program. He received a Distinguished Alumni Award from Caltech in 2002, and was also named a Distinguished Alumnus by the University of Illinois. He is a Fellow of IEEE, Optical Society of America, and the Laser Institute of America (LIA), and past president of IEEE Photonics Society and LIA. He has also served on the visiting committee of the National Institute of Standards and Technology, and on the committee to write Optics and Photonics: Essential Technologies for Our Nation for the National Academies.

Panel Discussion

James Pearson, Special Consultant, CREOL & Executive Director, Florida Photonics Cluster

James Pearson received his PhD in Electrical Engineering & Physics from the California Institute of Technology. Since joining UCF in 2004, From 2004-2009 at UCF he served as Director, Research & Administration for CREOL, The College of Optics and Photonics and Special Assistant to the UCF VP for Research. He was responsible for establishing research partnerships with individuals and organizations in areas of interest to the UCF faculty and for several special projects including Interim Director, Advanced Materials & Processing Center (AMPAC) and Homeland Security Liaison for UCF. Currently semi-retired, he is Special Consultant for CREOL, contributing to a variety of projects including marketing and partnership development, photonics technician training and certification, and support of the Florida Photonics Cluster. Prior to joining UCF, he was Executive Director of ISA – The Instrumentation, Systems, & Automation Society (1999-2004), Executive Director of SPIE – The International Society for Optical Engineering (1993-1999), and held several positions within United Technologies Corporation (1976-1993), including Chief Scientist at the Research Center, and President of UT Optical Systems. He is a Life Fellow of SPIE, Fellow of OSA, and a Senior Life Member of IEEE, and has served on the Board and several committees of these societies. He served the Council of Engineering and Scientific Society Executives (CESSE) as President, 2001-2002; Secretary, 2000-2001; and member of the Board of Directors, 1995-2003.

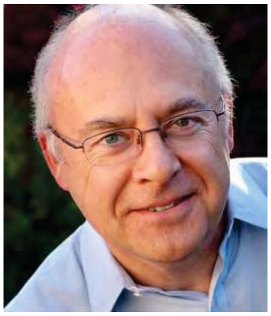
Panel Discussion

Jay Kumler, JENOPTIK Optical Systems. Inc.

Jay Kumler holds a B.S. Physics from Miami University, and a M.S. Optics from the University of Rochester. Following several years with United Technologies Optical Systems, he co-founded and served as President of Coastal Optical Systems, which was sold to JENOPTIK AG in 2002. Since 2002, he has served as President of JENOPTIK Optical Systems. JENOPTIK has optical manufacturing plants in Florida, Alabama, and Massachusetts that design and manufacture projection lenses, cinematography lenses, thermography cameras, semiconductor inspection equipment, and lenses for in-vivo fluorescence imaging and genome sequencing. JENOPTIK was awarded the 2011 FastTech Award by South Florida Business Journal, recognizing the company as the 4th fastest growing tech company in South Florida.

He is an SPIE Fellow, and served on the SPIE board of directors from 2010-2012. He has also served as Chairman of the Corporate & Exhibitor and Finance Committees for SPIE. He was the conference chair of the SPIE OptiFab conference from 2007-2011. He wrote a chapter in "Engineering a High-Tech Business" published in 2008.

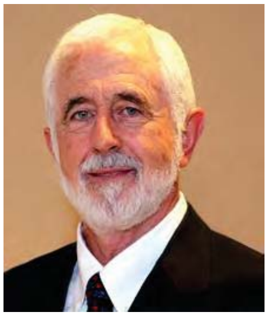
Stephen Anderson, SPIE



Stephen Anderson joined SPIE – The international society for optics and photonics– in 2011 as Industry & Market Strategist after being actively involved in the lasers and photonics marketplace for more than 30 years. Before joining SPIE, Anderson was Associate Publisher and Editor-in-Chief of Pennwell's "Laser Focus World," where he directed the editorial strategy for all media and platforms. During his 18 year tenure at PennWell, Anderson supervised the Annual Review and Forecast of the Laser Marketplace and led the highly regarded Lasers & Photonics Marketplace Seminar, held annually at SPIE's Photonics West. He also co-founded the "BioOptics World" brand. Anderson is responsible for tracking the photonics industry technology and markets to help define long-term strategy at SPIE, while also facilitating development of SPIE's industrial engagement activities. He routinely presents market survey results and industry commentary at US and international forums. Anderson holds a chemistry degree from the University of York, (England), and an Executive MBA from Golden Gate University in San Francisco, CA.

Panel Discussion

Peter Baker, LIA



Peter Baker is Executive Director of the Laser Institute of America (LIA), a position he has held since 1988. He previously held President, CEO, and Senior Management positions in several laser companies. He is a Past President of the Council of Engineering and Scientific Societies and is a Past President and Fellow of LIA.

Jochen Deile, Trumpf Inc.

Jochen Deile studied applied physics in Heilbronn, Germany. He joined TRUMP F in Germany as a laser development engineer in 1998. In 2000 he transferred to TRUMPF Inc. in Farmington, CT to assume the role of laser development manager. In parallel he has been participating in the industrial doctorate program at Heriot Watt University in Edinburgh, Scotland.

Exhibitors

Edmund Optics
101 East Gloucester Pike
Barrington, NJ 08007
1-800-363-1992
www.edmundoptics.com

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

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

Block Engineering
377Simarano Drive
Marlborough, MA 01752
508-341-4603
www.blockeng.com

Inrad Optics
181 Legrand Avenue
Northvale, NJ 07647
201-767-1910
www.inradoptics.com

Photonics Online
VertMarkets, Inc
5 Walnut Grove Ste 320
Horsham, PA 19044
215-675-1800
www.vertmarkets.com

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

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864-486-7125
www.AFLglobal.com

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Pittsfield, MA 01202-4949
413-499-0514
www.Photonics.com

Exhibitors (continued)

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

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

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

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

Lightpath Technologies
2603 Challenger Tech Court
Orlando, FL 32826
407-382-4003
www.lightpath.com

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

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

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

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

Optimax Systems Inc.
6763 Dean Parkway
Ontario, NY 14519
877.396.7846
www.optimaxsi.com

Aerotech
101 Zeta Drive
Pittsburgh, PA 15265
www.aerotech.com

Exhibitors (continued)

Gentech
445 St-Jean-Baptiste, #160
Quebec
Canada G2E 5N7
418-651-8003
www.gentech-eo.com

Ocean Optics
830 Douglas Ave
Dunedin, FL 34698
727-733-2447
www.oceanoptics.com

Sterile Enviroment Technologies - SET3
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Student of the Year Award

Neng Bai
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Thesis: "Mode-division multiplexed optical communication in few-mode fibers"

As a promising candidate to break the single-mode fiber capacity limit, mode-division multiplexing (MDM) explores the spatial dimension to increase transmission capacity in fiber-optic communication. Two linear impairments, namely loss and multimode interference, present fundamental challenges to implement MDM. This talk will describe methods to resolve those two issues. To compensate loss of different modes, we propose multimode EDFAs with reconfigurable multimode pumps. To de-multiplex signals subject to multimode interference in the MDM, adaptive frequency-domain equalization (FDE) has been proposed and investigated. The multimode EDFA and the FDE algorithm have been used to demonstrate 30 terabit/s MDM-WDM transmission in a few-mode fiber.

Neng Bai was born in Hunan, China. He received B.E. degree in Electrical Engineering from Tianjin University, China in 2008. Currently, he is pursuing the Ph. D. degree in Optics in the University of Central Florida. He is working with Dr. Guifang Li in Optical Fiber Communications Group at CREOL. From 2010 to 2011, he was a research intern in NEC labs, America, working on few-mode EDFA and mode division multiplexed transmission systems. Mr. Bai is the author or co-author of 8 journal papers, 14 conference proceedings and 5 pending patents. He was the 2012 recipient of SPIE Scholarship in Optics and Photonics.journal papers, 17 conference presentations and 1 patent.

Posters

Poster 1

Luminescent quantum dots in solution-derived chalcogenide glass films

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Abstract

Chalcogenide glass films are attractive for components of optical chemical sensing devices due to their transparency to mid-infrared light and high refractive index. A compact light source is needed to reduce the size of such a device, and quantum dots (QDs) offer the potential to meet this requirement. Solution-based film processing offers the possibility to incorporate dispersed QDs into the film matrix. Challenges include aggregation and luminescence quenching due to residual amine solvent in the film matrix. PbS QDs were synthesized with a colloidal approach, and their incorporation into a solution-derived $Ge_{23}Sb_7S_{70}$ glass film was investigated. Films were subjected to various heat treatments in order to remove residual solvent. Results showed that successful luminescence could be obtained from QDs in the film matrix, and that optimized heat treatments are important to maximize luminescence intensity.

Poster 2

Silicon-on-nitride waveguides for mid- and near-infrared integrated photonics

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Abstract

Silicon-on-nitride ridge waveguides are demonstrated and characterized at mid- and near-infrared optical wavelengths. Silicon-on-nitride thin films were achieved by bonding a silicon handling die to a silicon-on-insulator die coated with a low-stress silicon nitride layer. Subsequent removal of the silicon-on-insulator substrate results in a thin film of silicon on a nitride bottom cladding, readily available for waveguide fabrication. At the mid-infrared wavelength of 3.39 μm, the fabricated waveguides have a propagation loss of 5.2 ± 0.6 dB/cm and 5.1 ± 0.6 dB/cm for the transverse-electric (TE) and transverse-magnetic (TM) modes, respectively.

Poster 3

Optical Nanostructures for Enhanced Light-Matter Interactions and Energy Harvesting

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Abstract

Research at Dr. Chanda's Nano-Optics Research Lab focuses on confining coherent/partially-coherent or incoherent light at nanoscale to enhance light-matter interactions for novel device applications as well as energy harvesting purposes. The emphasis is given to design and development of high throughput, large scale and low cost fabrication of optical nanostructures for enhanced light-matter interactions in artificially structured metal/dielectric structures (metamaterials, plasmonic nanostructures), transformation optics for display/camouflage, strong coupling between photonic and plasmonic resonances and trapping light in thin film solar cells.

Poster 4

Advanced Fringe-Field Switching Using a Negative Anisotropy Liquid Crystal

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Abstract

Mobile displays, such as smartphones and tablet computers, have become indispensable in our daily life. Wide viewing angle, high resolution for Retina display, low power consumption for long battery life, and pressure-resistance for touch screen are the key requirements. Fringe-field switching (FFS) liquid crystal display (LCD), in which the electric-field-induced molecular reorientation takes place mainly in horizontal direction, satisfies the above criteria and is commonly used in these displays. We report a high performance negative dielectric anisotropy ($\Delta\varepsilon$) liquid crystal for FFS display (n-FFS). We compare the electro-optic characteristics of n-FFS cells to FFS cells employing positive $\Delta\varepsilon$ LCs (p-FFS). With comparable driving voltage and response time, the n-FFS cell has advantages in higher transmittance, single gamma curve, less cell gap sensitivity and slightly wider viewing angle, which shows great potential to replace p-FFS for next-generation mobile displays. LC director deformation distribution is analyzed to explain these performance differences.

Advanced Characterization of Novel Fiber Designs for High Power Fiber Laser Applications

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Abstract

Well-known, unique benefits of optical fibers such as low-loss light transmission, compactness, stability and robustness make them ideal candidate for a very broad range of applications including data transmission, sensing and probing, fiber laser and amplifiers. The demonstration of microstructured fibers in the past decade opened the route to an infinite number of fiber designs, leading to significant advances in fiber-based applications.

In particular, performances of high power fiber lasers and amplifiers largely benefitted from the development of new fibers design. Large mode area (LMA) fiber designs made of very large core and reduced numerical aperture seem to be the best candidate for scaling the available output power while providing diffraction-limited beam quality. Such fibers usually support highly-confined fundamental mode and few additional higher order modes. Very recent studies on LMA fiber-based laser systems operating at high power reported on strong spatial beam degradation above a certain laser threshold due to high-order mode (HOM) induced instabilities.

In an effort to understand and prevent high-order mode instabilities, one of our long term research projects involves building a high power fiber laser system integrating the new-generation of LMA fiber with enhanced design to address modal instability limitations. The poster details advanced experimental characterization of some prototypes LMA fiber designs candidates to deliver stable, high-power, diffraction-limited beam quality, including LMA step-index fiber, LMA photonic crystal fibers (PCF), LMA leakage channel fibers (LCF) and multicore fiber structures (MCF) with mode areas exceeding 2000 μm^2. A mode analysis technique based on S^2 imaging is performed to determine single-mode guidance conditions and thus conclude on the ability to deliver diffraction-limited output beams. Results are presented and comment on the suitability of proposed designs for integration in high power laser systems.

Poster 6

Fiber Bragg Gratings as In-Situ Calibration of Piezospectroscopic Stress-Mapping

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Abstract

Fiber Bragg gratings have well known stress-sensing capabilities. Here we show their use in the understanding and calibration of a novel stress-sensing technique, piezospectroscopy utilizing chromium-doped alpha-alumina nanoparticles. These particles are embedded into epoxies and coatings that can then be applied to structure surfaces, such as airplane wings, and utilized to create maps of the stress distribution with high spatial resolution. Because this is a new technique, there is still much to learn about the stress-sensing properties of the nanoparticles. By integrating fiber Bragg gratings into the epoxies, an accurate measure of the stress that is transferred from the substrate into the nanoparticle containing coating can be obtained. This then gives an in-situ calibration for the stress maps obtained by measuring the stress-dependent emission spectra from the piezospectroscopic nanoparticles. The fiber Bragg gratings have very high sensitivity and accuracy, but lack the spatial resolution offered by the nanoparticle containing epoxies, making the combination of the two methods ideal for measuring the stress across a surface with both high sensitivity and high spatial resolution.

Poster 7

Direct Laser Writing using a Chalcogenide Glass

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Abstract

Multi-photon direct laser writing (DLW) with a continuous-wave mode-locked femtosecond laser can be used to fabricate two-dimensional structures in a thin film of thermally deposited As_2S_3 chalcogenide glass. After photo-patterning unexposed regions of the film can be removed with a polar organic solvent, leaving behind a free-standing structure in As_2S_3. High etch selectivity was observed, with unexposed regions dissolving roughly 3000 times faster than exposed regions. Square patterns were fabricated over a range of powers by scanning the beam parallel to the substrate. Pillar arrays were created by scanning the beam normal to the substrate using a range of average focused laser powers and center-to-center spacing. With both patterns, the features size increased steadily with average laser power, and features could be created with average power as low as 0.2 mW. This work opens a new route to complex electronic and optical structures based on micro- and nano-scale patterning of the semiconductor As_2S_3.

Poster 8

Elaboration and optimization of tellurite glasses and glass-ceramics for optical fiber amplification applications

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Abstract

Tellurite-based oxide glasses have been elaborated and tested as promising materials for Raman gain applications, due to their high nonlinear optical properties (NLO) and wide transparency range. While promising, the relationship between glass structure, vibrational responses and nonlinear optical properties (NLO) is not well understood. A vibrational multipolar analysis (IR – Raman – hyper Raman) has been developed to permit analysis of the respective contributions of different species in tellurite glass matrix, and finally correlate the network to the properties. Tellurite TeO_2-chain like structures have been found to be at the origin of the (hyper)polarizability, leading to high Raman gain values.

This presentation discusses the impact of the short-range order on the glass' linear and nonlinear optical properties (α and g_R). We report findings on tellurite-based glass and glass-ceramic materials. Glass ceramic studies will be highlighted with measurements of the nucleation and growth-like curves that permit precise quantification and control of crystallization in candidate glass compositions.

Poster 9

Europium Doped Barium Bromide Iodide Scintillator Ceramics for Gama Ray Detection

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Abstract

This work shows the first results to our knowledge on the fabrication and optical characterization of Eu^{3+}:BaBrI scintillator ceramics. The potential of rare earth doped alkaline earth metal halide materials as scintillators was recently identified and the demonstration of good scintillation properties in single crystals soon followed. The pathway towards ceramics promises larger detector areas and lower overall manufacturing costs, but not without challenges. In this work, we describe a multi-step process for synthesizing starting material and hot-pressing Eu^{3+}:BaBrI in an ultra-clean environment necessary to avoid reaction with the ambient atmosphere. Fabricated ceramics are characterized for optical transmission, and scintillation behavior.

Poster 10

Path to Multi Kilowatt Spectral Beam Combining by Air Cooling Volume Bragg Gratings

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Abstract

Volume Bragg gratings have been successfully used in spectral beam combining of high power fiber lasers with narrow channel separation and in four channel passive coherent beam combining of fiber lasers with power levels above 650W. Further power scaling is limited by thermal lensing in the glass, which degrades beam quality and hurts combining efficiency. Turbulent air flow blown across both surfaces of the grating is both an easy and cheap solution, but has been avoided in the past due to concerns of how the air density fluctuations will hurt beam quality. It is now shown that air cooling has no adverse effect on the M^2 parameter, and that air cooling removes any thermal distortion formed in the beam from the VBG at high power levels.

Volume Bragg gratings are routinely made in photosensitive glass with low absorption on the level of 10^{-4} cm^{-1}. Without access to kilowatt level lasers, absorption in the glass is artificially increased by 140 times such that 8.9KW beams are simulated using 60W lasers. With air cooling for a beam with normalized power of 8.9KW, M^2 is maintained near 1.1 and diffraction efficiency is held near 90%, indicating that air cooling alone could be used to allow for the power scaling of beam combining with VBG's to multi-kilowatt level output power.

Poster 11

The effect of aberrated recording beams on reflecting Bragg gratings

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Abstract

Reflecting Bragg gratings have been used in a variety of applications including beam combining, output couplers for narrow frequency lasers, etc. Wide aperture gratings, which are typically recorded using two-beam interference in a photosensitive medium, generally require that the fringe period remain constant over several millimeters in order to achieve the necessary spectral response. However, if aberrations are present in the recording beams the fringe pattern will become distorted, degrading the performance of the grating. Here we characterize the aberrations in terms of their Zernike polynomials and determine how the presence of each aberration distorts the overall fringe pattern. We find that if an aberration is present the spectral profile of the grating will demonstrate a reduced diffraction efficiency, spectral broadening, washed-out side lobes, and may also have an overall displacement in the resonant wavelength. These effects are reduced for gratings which were initially designed with a wide spectral acceptance but are much more severe for gratings which are designed for a narrow spectral acceptance. Unlike thin-film gratings these aberrations cannot be removed by balancing the aberrations in each arm, but must be actively removed using either specialized optics or an aberration-compensating mask.

Poster 12

Three Extrusion Strategies as Routes Towards Robust Infrared Multimaterial Fibers

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Abstract

We describe three classes of extrusion methodologies that we have recently developed at CREOL. These three novel approaches enable the extrusion of multimaterial fiber preforms that we then use to produce robust infrared fibers. (1) Vertical stacking in a multimaterial billet in which we combine chalcogenides glasses for infrared transmission and a thermoplastic polymer for mechanical support. The vertical stacking in the billet is converted to radial nesting in the preform and in turn the fiber, which is consequently provided with a built-in protective polymer jacket. (2) A new extrusion strategy, efficient disc-to-fiber multimaterial coextrusion, reduces the amount of chalcogenide glass needed in the billet and allows the fabrication of tens meters of chalcogenide fiber with 10–20 micron core diameter starting from two 10-mm-diameter 3-mm-thick glass discs. In light of the perennial difficulties in synthesizing high-purity, large-sized chalcogenide glass, our approach will enable fostering exchange of techniques between academic and industrial settings. (3) Finally, we introduce a new technique we call double-piston extrusion that produces an axially uniform preform with an arbitrary core-to-cladding ratio that affords unprecedented flexibility in combining disparate materials and close to 100% efficiency of material usage from the glasses to optical fiber.

Poster 13

Power-scaling of an OPCPA System Based on DPSS Pump Technology

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Abstract

Over the last 7 years, several laboratory-scale laser facilities based on optical parametric chirped-pulse amplification (OPCPA) emerged to generate few-cycle pulses with durations of less than 10 fs. Diode-pumped, solid-state (DPSS), picosecond amplifier systems as driving laser technology offer the potential to establish the next generation of high-average power, high-energy OPCPA systems. We present the recent developments on our picosecond, DPSS system towards the anticipated 100 W pumping-level for OPCPA pumping.

Our pump beam generation is based on a hybrid MOPA configuration with several amplifier stages currently providing an output of >10 W at 3 or 5 kHz. The stability of this pump line dramatically affects the performance of the OPCPA system, since the energy is transferred directly from the pump to the seed pulse in the optical parametric amplifier. A static or dynamic change of beam overlap due to high beam pointing fluctuations leads to extreme OPCPA output fluctuations. Here, we discuss the long-term performance, stability and usability of the pump beam generation operating at the 10 W-level.

In addition, two booster stages are currently development to generate a pump beam at the 100 W-level. Several design constraints exist for DPSS rod amplifiers: Low small signal gain, high intensities potentially leading to optical damage, accumulation of nonlinear phase, thermal lens and depolarization losses. The design and key studies are presented potentially allowing power scaling of the current system to over 40 mJ pulse energy with an average power exceeding 100 W.

Poster 14

Possibility for Breaking the Unity Efficiency Barrier: Semiconductor Laser Optically Pumped by an Integrated Light Emitting Diode

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Abstract

In this abstract, we report experimental results of a possible route to an integrated laser chip that can break the unity power conversion efficiency barrier. Our experimental work makes the first demonstrations of the integrated chip scheme. The chip uses the monolithic integration of an LED pump with a semiconductor laser, for which the LED acts as an optical pump as well as a heat pump to the laser. Our calculations based on material parameters indicate that with proper design, this combination with a quantum dot laser active material could result in the laser chip power conversion efficiency exceeding unity efficiency.

Poster 15

Plasmon resonances in multi-material nanoparticle trimers for extreme field enhancement

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Abstract

Few-particle clusters consisting of spherical nanoparticles made from different materials are numerically investigated. These structures are expected to provide large electric field enhancement due to cascaded plasmon resonances. Cascaded plasmon resonance occurs when metallic nanostructures with identical plasmon resonance frequency but different polarizability are mutually coupled. We have previously shown that cascading field enhancement can be observed in dimer structures where the metal nanoparticles have different size but identical composition. In this study a novel approach is demonstrated in which the coupled nanoparticles consist of different materials. We investigate cascaded field enhancement in Ag-Au-Ag trimer structures. The polarization-dependent field enhancement and scattering spectra of the trimers were calculated numerically as a function of nanoparticle size and inter-particle spacing. We demonstrate that multiplicative cascading field enhancement can occur in multi-material trimer structures. The presented structure appears compatible with chemical synthesis and assembly methods, suggesting that cascaded multi-material trimers could form the basis of biochemical sensors that require large electric field enhancement.

Poster 16

Molecular studies of filamentation in Carbon Dioxide

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Abstract

Laser filamentation of ultra-short pulses has largely been studied in air or pure gases (Ar, N_2, O_2) with little or no extensive work in complex molecules. In particular, studies of CO_2 as the propagation medium for filamentation are relevant for several reasons, including its importance as an atmospheric gas (0.035 ppmv on Earth, 95% by volume on Mars), its role in the mid-IR propagation window, its generation in combustion, and the needs for sensing it.

Molecular interaction of a femtosecond filament (800 nm, 130 fs, 1 mJ) has been studied for the influence of molecular alignment of CO_2 on the filamentation parameters, the initial collapse and length of the filament.

The post-pulse alignment dynamics [1] of CO_2 molecules, as characterized by the expectation value of $<(\cos\theta)^2>$ (the conventional measure of alignment), for a laser intensity of 60 TW cm^{-2} is shown in Figure 1. $<(\cos\theta)^2>=1$ corresponds to perfectly aligned molecules and $<(\cos\theta)^2> = 1/3$ corresponds to a random distribution of all orientations of the molecules. The alignment exhibits periodic free field revivals. The initial wave packet is precisely reconstructed at multiples of the rotational period. The effect of such a pre-aligned CO_2 molecular medium on the filament creation [2-5] will be shown.

This work was funded under the AFOSR-JTO Multidisciplinary Research Initiative FA95501110001 "Fundamental studies of Filamentation Interaction" and the State of Florida.

Poster 17

Broadband THz detection in the counter-propagating configuration using THz-enhanced plasma fluorescence

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Abstract

Novel technologies have made it possible to exploit the terahertz (THz) band for many sensing and imaging applications in areas such as homeland security, non-destructive evaluation and environmental monitoring [1,2]. However, THz sensing and detection at stand-off distances remain a challenge due to the high THz losses in air [3]. THz-Radiation Enhanced Emission of Fluorescence (THz-REEF) [4-6] is a technique that could potentially overcome this limitation by using a laser-induced air plasma as the THz sensing medium.

This study is the first demonstration of THz-REEF measurements taken in the counter-propagating configuration, which closely simulates stand-off THz sensing scenarios where the forward propagating probe pulse interacts with the reflected, backward-propagating THz signal.

The enhancement profiles of the plasmas captured using an iCCD clearly revealed the differences in the signals retreivable from the two pump-probe geometries. Using a probe plasma created by a dual-wavelength pulse, the THz waveform could be coherently detected in the counter-propagating configuration without the need of a probe delay scan.

Poster 18

Sub-bandgap Energy Detection of Pulsed and CW Radiation using Extremely Nondegenerate Two-photon Absorption in Wide-gap Semiconductors

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Abstract

In extremely nondegenerate (END) two-photon absorption (2PA), annihilation of two-photons of very different energies leads to creation of single electron-hole pair in direct-gap semiconductors. This nondegeneracy shows several orders increase in the magnitude of the 2PA coefficient which scales inverse cube of the bandgap energy of the semiconductor. Based on this enhancement we observe detection of both pulsed and CW sub-bandgap radiation in uncooled commercially available GaAs and GaN photodetectors. It is observed that in case of pulsed detection of sub-bandgap radiation, background current due to the degenerate two-photon absorption of the high energy photon pulses of the 2PA photon pairs results additional contribution to noise hence reduces the signal to noise ratio. In CW detection of sub-bandgap radiation the background current occurs due to one-photon Urbach tail absorption of the high energy photon of the 2PA photon pairs. In CW detection the Urbach tail absorption limits the signal to noise ratio and may be improved by reducing the nondegeneracy.

Poster 19

Generation of High-Flux Attosecond XUV Continuum with a 10 TW Driving Laser

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Abstract

Intense isolated attosecond sources are required to perform attosecond pump – attosecond probe experiments or to stimulate ultrafast nonlinear phenomena in the XUV region. However, such pulses have not yet been generated due to the low efficiency of the high harmonic generation (HHG) process and limited driving laser power used in previous experiments. Here we demonstrate that the generalized double optical gating (GDOG) method can be implemented using a driving IR laser that delivers 200 mJ, 17 fs pulses at 800 nm for up-scaling the attosecond photon flux. These laser pulses are focused in argon to generate an XUV continuum supporting 280 as isolated attosecond pulses. The energy of the XUV pulse is over 100 nJ at generation location.

Poster 20

Novel LIBS and Raman Sensor Fusion Strategies for Fluorescence Reduction

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Abstract

Laser-Induced Breakdown Spectroscopy (LIBS) and Raman spectroscopy are considered to be superstars in analytical science due to their advantages such as fast analysis speed, simple instrumentation, none or minimal sample destruction, and on-line analysis capabilities. Due to the similarity of the instrumentation, sensor fusion of LIBS and Raman spectroscopy is very attractive. "One laser, one spectrometer, one detector": this is the motivation for this technological innovation. As a result, both analyses can be performed with a single system with a lower cost.

Different strategies are investigated for LIBS-Raman sensor fusion. A conventional 532 nm Nd:YAG system can provide robust performance with lowest cost. However, fluorescence due to the visible excitation can be a problem in certain applications. Two new paradigms are proposed and demonstrated for fluorescence reduction:

- An ultraviolet approach (266 nm from a quadrupled Nd:YAG laser) couples the advantages of fluorescence reduction for Raman and efficient ablation for LIBS. Resonance Raman and fluorescence emission can be separated due to their different spectral ranges. On the LIBS side, UV excitation shows reduced ablation threshold due to strong absorption of the laser emission.
- A approach in the near-infrared (785 nm from a Ti:Sapphire system) reduces fluorescence emission due to low absorption from the majority of materials, and brings the advantages of femtosecond ablation (when mode-locked and amplified) for LIBS that generates weaker continuum background.

Poster 21

Time-resolved Measurement of Nonlinear Refraction Using Beam Deflection

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Abstract

We introduce a beam deflection technique, derived from the photothermal deflection spectroscopy, to measure the ultrafast nonlinearities of the material. This technique applies the flexibility of excite-probe techniques to measure not only the absolute magnitude but also the temporal dynamics of the nonlinear refraction responses, allowing a decoupling of the electronic and nuclear contribution, which is essential for the understanding of the physical mechanisms underlying these nonlinear responses. A well characterized molecule, carbon disulfide (CS2), was used to test the sensitivity of this technique, which is equivalent to an optically-induced phase change of $\lambda/1000$. By independently varying the wavelength or polarization of the two beams, it can also be used to study the dispersion or different tensor elements of the nonlinear refractive index.

Poster 22

Fourier Transform Infrared Spectroscopy of Laser Induced Plasma

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Abstract

Laser-induced plasma is a mature technology that has many applications such as laser fusion, short wavelength radiation sources, optical emission spectroscopy and chemical synthesis. The diagnostics of these different types of plasmas has been studied for more than 50 years to gain a better understanding of the fundamentals of the interaction between the electromagnetic field of the laser pulse and the matter. However, the diagnostics of the molecular composition and kinetics of plasmas is still infrequent. Fourier Transform Infrared Spectroscopy can be used for such diagnostics by observing the emission/absorption of the vibrational modes of the molecules. This instrument can be modified further to operate in a pulsed mode to diagnose the molecular formation of laser-induced plasma. Technical implementation, experimental results and analysis of the laser-induced plasma in the mid-infrared region are shown.

Poster 23

Attosecond Transient Absorption Experiments on Atoms and Molecules

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Abstract
One of the most fundamental goals of attosecond science is to understand and to control the dynamic evolution of electrons in matter. Attosecond transient absorption spectroscopy is one powerful method which can uncover the fastest dynamics of electrons in atoms and molecules. With the addition of a moderately intense laser field, the absorption spectrum of the target gas can be modified, allowing measurement of and demonstrating control over the electron motion on ultrafast timescales. Here we apply the attosecond transient absorption spectroscopy technique to study the electron dynamics in bound and “quasi-bound” autoionizing states of noble gas atoms and small molecules. The isolated attosecond pulses produced with generalized double optical gating with low photon energies present a promising route to “filming” electron evolution on the attosecond timescale.

Poster 24

Luminescent quantum dots in solution-derived chalcogenide glass films

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2.Institut des Sciences Moléculaires, University of Bordeaux / CNRS, France
3.IOM-CNR, INSTM and Dipartimento de Ingegneria Meccanica Settore Materiali, Università di Padova, Italy
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Abstract
Chalcogenide glass films are attractive for use in optical chemical sensing devices due to their transparency to mid-infrared light and high refractive indices enabling small device footprints [1, 2]. A compact light source is needed to reduce the size of such a device, and quantum dots (QDs) offer the potential to meet this requirement. Solution-based film processing offers the possibility to incorporate dispersed QDs into the film matrix. Challenges include aggregation and luminescence quenching due to residual amine solvent in the film matrix. In the present study, PbS QDs were synthesized via a colloidal approach, and their incorporation into a solution-derived $Ge_{23}Sb_7S_{70}$ glass film was investigated. Films were subjected to various heat treatments in order to remove residual solvent. Results showed that successful luminescence could be obtained from QDs in the film matrix, and that optimized heat treatments are important to maximize luminescence intensity.

Poster 25

Wavelength Tunable Selectively Intermixed Quantum Well Fabry-Pérot Laser

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Abstract

We demonstrate a monolithic tunable laser on a QW laser structure by integrating an optical beam steering section with an area-selectively intermixed QW gain section. Wavelength tuning is achieved by steering the laser beam over an optical gain medium that consists of three laterally adjacent quantum well regions selectively intermixed to varying extents and have three different optical bandgaps. The device output had a total wavelength tuning range of 17nm that was controlled by injecting separate electrical current values to each of the steering contacts and the amplifier contact. As the optical beam is steered over the selected region, it experiences a peak in the gain spectrum that is determined by the degree of intermixing of the QW and that sets the lasing wavelength.

Poster 26

Versatile phase stabilization technique for holographic recording of large aperture volume Bragg gratings

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Abstract

Volume Bragg gratings (VBGs) are high precision optical devices with feature sizes as small as fractions of a micrometer. To achieve a consistent high quality recording of such small feature sizes, precision control in the fabrication process is necessary. Of the various fabrication processes used to make VBGs, holographic recording of a two beam interference pattern allows for the largest aperture size. This technique is preferred for creating large aperture gratings for free space applications. In order to mitigate smearing of the interference pattern during the recording process, it is necessary to implement relative phase stabilization of the recording beams. This includes a vibration isolated table, shielding from air fluctuations, and often, an active phase stabilization system to control the position of the fringe pattern within a fraction of the grating period. We present a new method for phase stabilization of a holographic recording system for VBGs. The primary feature of this method is that it is extremely flexible and simple to integrate into an existing holographic recording setup. The setup allows for Bragg gratings with arbitrary tilt and resonant wavelength to be recorded and is completely independent of the recording medium. The effect of phase stabilization on a VBG is discussed and an experimental demonstration of the benefits of this phase stabilization setup on the performance of a VBG is presented. This system opens new avenues of research into novel VBG structures by allowing for more efficient use of incident recording power.

Poster 27

Plasmonic Mid-IR spectrometer

Farnood K. Rezaie[1,*], Chris J. Fredericksen[2], Walter R. Buchwald[3,4], Justin W. Cleary[5], Evan M. Smith[1], Imen Rezadad[1], Andrew Davis[4] and Robert E. Peale[1]
[1]Department of physics, UCF
[2]LRC Engineering, Inc., Orlando, FL
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[5]Sensors Directorate, AFRL, Wright Patterson AFB
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Abstract

A compact spectrometer-on-a-chip featuring a plasmonic molecular interaction region has been conceived, designed, modeled, and partially fabricated. The silicon-on-insulator (SOI) system is the chosen platform for the integration. The low loss of both silicon and SiO_2 between 3 and 4 μm wavelengths enables silicon waveguides on SiO_2 as the basis for molecular sensors at these wavelengths. Important characteristic molecular vibrations occur in this range, namely the bond stretching modes C-H (Alkynes), O-H (monomeric alcohols, phenols) and N-H (Amines), as well as CO double bonds, NH_2, and CN. The device consists of a broad-band infrared LED, photonic waveguides, photon-to-plasmon transformers, a molecular interaction region, dispersive structures, and detectors. Photonic waveguide modes are adiabatically converted into SPPs on a neighboring metal surface by a tapered waveguide. The plasmonic interaction region enhances optical intensity, which allows a reduction of the overall device size without a reduction of the interaction length, in comparison to ordinary optical methods. After the SPPs propagate through the interaction region, they are converted back into photonic waveguide modes by a second taper. The dispersing region consists of a series of micro-ring resonators with photodetectors coupled to each resonator. Design parameters were optimized via electro-dynamic simulations. Fabrication was performed using a combination of photo- and electron-beam-lithography together with standard silicon processing techniques

Poster 28

Submicron optical waveguides and microring resonators fabricated by selective oxidation of tantalum

Payam Rabiei[1*], Jichi Ma[1], Saeed Khan[1,2], Jeff Chiles[1] and Sasan Fathpour[1,2]
[1]CREOL, UCF
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Abstract

Submicron tantalum pentoxide ridge and channel optical waveguides and microring resonators are demonstrated on silicon substrates by selective oxidation of the refractory metal, tantalum. The novel method eliminates the surface roughness problem normally introduced during dry etching of waveguide sidewalls and also simplifies fabrication of directional couplers. It is shown that the measured propagation loss is independent of the waveguide structure and thereby limited by the material loss of tantalum pentoxide in waveguides core regions. The achieved microring resonators have cross-sectional dimensions of ~600 nm × ~500 nm, diameters as small as 80 μm with a quality, Q, factor of 4.5×10^4, and a finesse of 120.

Poster 29

Compositional-tailoring of optical properties in IR transparent chalcogenide glasses for precision glass molding

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[b] CREOL, UCF
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Abstract

Five chalcogenide glasses in the GeAsSe ternary glass system were melted, fabricated into polished flats, and molded using a laboratory-scale precision glass molding (PGM) machine. Using binary arsenic triselenide, $As_{40}Se_{60}$, a commonly available industrial glass as a starting point, this effort examined the effect of adding 5 mol% of either Ge or Se to the composition which is known to influence structural as well as optical properties. The density, refractive index, and thermoptic coefficient (dn/dT) were measured for the glasses prior to and after PGM. For the bulk glasses examined, both the refractive index and dn/dT decreased as the molecular percentage of either Ge or Se is increased. After the PGM process, glasses demonstrated an "index drop" consistent with oxide glasses noted in literature [1]. This index drop was also found to be compositionally dependent, again decreasing as the molecular percentage of either Ge or Se is increased and loosely correlated to the starting index of the bulk glasses.

[1]"Refractive index and dispersion variation in precision optical glass molding by computed tomography" W. Zhao et al. App Optics. **48** 19 3588-3595 (2009)

Poster 30

High-Q Lithium Niobate Microring-Resonators on Silicon

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Abstract

Submicron lithium niobate waveguides and resonators are demonstrated on silicon by a novel and reliable ion implantation and wafer bonding technique. Thin films of lithium niobate on Y-cut substrates are prepared by a smart cut method. The films have thicknesses as low as 400nm and the optical quality of the films are identical to bulk lithium niobate crystals. Waveguide ridges are formed by selective oxidation of tantalum to avoid etching lithium niobate. Since no etching is required low loss waveguides are achieved on lithium niobate. Submicron waveguides and micro-ring resonators are demonstrated. The micro-resonators have Q as high as 7.25×10^4. The high index contrast waveguides of lithium niobate allows low V modulators to be demonstrated in near future.

Poster 31

Plasmonic Mid-IR spectrometer

Farnood K. Rezaie[1,*], Chris J. Fredericksen[2], Walter R. Buchwald[3, 4], Justin W. Cleary[5], Evan M. Smith[1], Imen Rezadad[1], Andrew Davis[4] and Robert E. Peale[1]
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Abstract

A compact spectrometer-on-a-chip featuring a plasmonic molecular interaction region has been conceived, designed, modeled, and partially fabricated. The silicon-on-insulator (SOI) system is the chosen platform for the integration. The low loss of both silicon and SiO_2 between 3 and 4 μm wavelengths enables silicon waveguides on SiO_2 as the basis for molecular sensors at these wavelengths. Important characteristic molecular vibrations occur in this range, namely the bond stretching modes C-H (Alkynes), O-H (monomeric alcohols, phenols) and N-H (Amines), as well as CO double bonds, NH_2, and CN. The device consists of a broad-band infrared LED, photonic waveguides, photon-to-plasmon transformers, a molecular interaction region, dispersive structures, and detectors. Photonic waveguide modes are adiabatically converted into SPPs on a neighboring metal surface by a tapered waveguide. The plasmonic interaction region enhances optical intensity, which allows a reduction of the overall device size without a reduction of the interaction length, in comparison to ordinary optical methods. After the SPPs propagate through the interaction region, they are converted back into photonic waveguide modes by a second taper. The dispersing region consists of a series of micro-ring resonators with photodetectors coupled to each resonator. Design parameters were optimized via electro-dynamic simulations. Fabrication was performed using a combination of photo- and electron-beam-lithography together with standard silicon processing techniques

Poster 32

Selective perfect absorption and excitation of surface plasmon polariton in IR by suspended gratings

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Abstract
We experimentally demonstrate a structured thin film that selectively absorbs incident electromagnetic waves in discrete bands, which by design occur in any chosen range from near UV to far infrared. Also we theoretically and experimentally demonstrate excitation of surface plasmon polariton (SPP) by such periodic structures in the mid IR. The structure consists of conducting 2D suspended gratings structure or randomly oriented, irregular shaped conducting islands separated from a conducting plane by a dielectric layer. By changing dimensions and materials, we have achieved broad absorption resonances centered at 0.35, 1.1, 14, and 53 microns wavelength. The peak absorption ranges from 85 to 99%. Angle-dependent specular reflectivity spectra are measured using a UV-visible or Fourier spectrometer. Optimum thickness of the dielectric is necessary for perfect absorption to occur. However for sample with thinner dielectric spacer with 7.5-micron-period 2D gratings of gold, sharp absorptions around 7.9 and 5 microns are obtained, which correspond to the first and second order SPP excitations respectively. These wavelengths are in excellent agreement with theoretical calculations for SPP excitation at normal incidence at Au-SiO2 interface. Finite difference time domain (FDTD) simulation was performed to confirm excitation of SPP from electric field distribution at resonance wavelengths. Perfect absorbers have application to thermal detectors. SPP excitation by suspended gratings can be especially exploited for sensing applications because of the fact that the excitation is highly efficient and insensitive to angle of incident as compared to conventional grating or prism coupling of SPP.

Poster 33

Femtosecond Dual-Arm Z-Scan On Ceramic And Single Crystals Of YAG

Samuel Paul David*, Honghua Hu, Trenton Ensley, David J. Hagan, Eric W. Van Stryland, Romain Gaume
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Abstract
Transparent ceramics of YAG have several advantages compared to single crystals for high-power solid-state lasers. The sign and magnitude of the nonlinear refractive index, n_2, is an important materials parameter for high power ultra-short pulsed lasers. Z-scan is an easy and effective technique to measure n_2 rapidly. Recently, dual arm Z-scan has been developed to measure the differences of n_2 between two samples, by performing simultaneous Z-scans on two identical Z-scan arms to minimize the correlated noise induced by laser fluctuations, e.g. pulse energy fluctuations, beam pointing fluctuations, beam size changes and temporal fluctuations etc. Single crystal and transparent ceramics of YAG of identical thicknesses were prepared and dual arm Z-scan was performed on both the samples under femtosecond laser pulses at 1300 nm with pulsewidths of 125 fs (FWHM). Both the samples showed positive n_2 (7.7×10^{-16} cm^2/W), which is the same for both ceramic and single crystal and closely matches with the reported value measured earlier using nano-second laser pulses at 532 nm. The samples do not show any nonlinear absorption. It is found out that the grain boundaries do not contribute to any change in n_2 value in transparent ceramics. The accuracy of the experiments, calculated n_2 values and their significance on ceramics for ultra-short lasers will be discussed.

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 ft² 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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- Mid-infrared metrology 260

Martin Richardson

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- High Intensity femtosecond laser interactions 140, 112–117
- Laser Spectroscopy & Sensing Lab 140, 123 & 123A, 112- 117
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- X-ray microscopy 123
- Laser Materials Processing 141
- High Intensity CEP Laser 117
- Laser Tissue Interaction Lab 262
- Thin disk laser development

Bahaa Saleh

- Quantum Optics Lab 204

Axel Schülzgen

- Fiber Optics Lab 201

Winston Schoenfeld

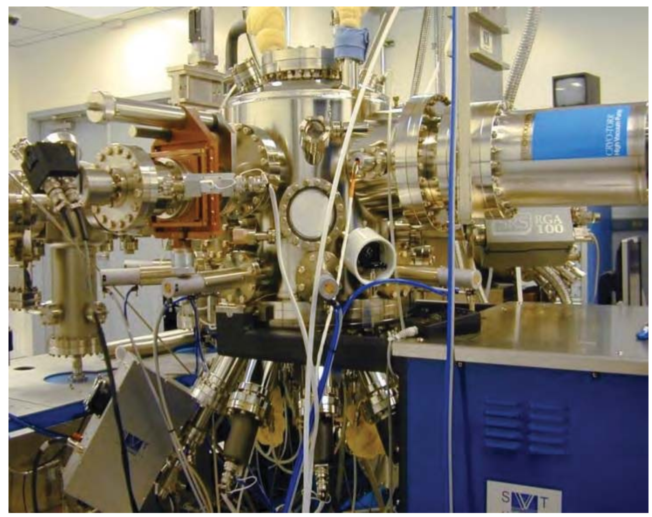
- Nanophotonics Devices Lab 156
- Nanophotonics Fabrication Facility 180B
- Wide Band Gap Characterization Lab A112
- Oxide MBE Lab 180C

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

Shin-Tson Wu

Boris Zeldovich

Nanophotonics Fabrication Facility



MBE Facility

Lab Tour Schedule

Guided tours start at **3:45 pm** and at **4.30 pm** in the CREOL lobby and last about 40 minutes.

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

TOUR A Start times: 3.45 pm and 4.30 pm

260	**Liquid crystal display and adaptive lens** Dr. Shin Tson Wu http://lcd.creol.ucf.edu
233	**Femtosecond 2-photon vs. 1-photon fluorescence** Dr. David Hagan and Dr. Eric Van Stryland http://nlo.creol.ucf.edu
201	**Fiber optics laboratory** Dr. Axel Schulzgen http://fol.creol.ucf.edu

TOUR B Start times: 3.45 pm and 4.30 pm

A105	**Fiber Fabrication Facility** Dr. Ayman Abouraddy, Dr. Rodrigo Amezcua Correa, and Dr. Axel Schulzgen http://www.townes.ucf.edu/
154	**Volume holographic elements for laser beam control** Dr. Leonid Glebov http://ppl.creol.ucf.edu/
PS140	**FAST (Florida Attosecond Science and Technology) Lab** Dr. Zenghu Chang http://fast.creol.ucf.edu

Building Map

First Floor

Building Map

Second Floor

Industrial Affiliates 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

Life Members

Cobb Family Foundation
Northrop Grumman Corporation
Nufern
Memoriam Members: *Dr. Arthur H. Guenther and Dr. William C. Schwartz*

Medallion Members

Breault Research
FLIR
Newport Corporation
Northrop Grumman Laser
Optical Research Assoc.
Paul G. Suchoski, Jr

Senior Members

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CST of America
Cubic Defense Applications
Edmund Optics
ER Precision Optical
Lambda Research Corporation
LAS-CAD GmbH
LightPath Technologies
Lockheed Martin
Ocean Optics
Ophir-Spiricon
Optimax Systems
Radiant Zemax, LLC
Thorlabs
Tektronix
TRUMPF, Inc.
V & N
Zygo Corporation

Affiliate Members

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AFL
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Applicote Associates, LLC
Block Engineering, LLC
eVision, LLC
Florida Turbine Technologies, Inc.
Gentec-EO, Inc.
Gooch & Housego, LLC.
Harris Corporation
HORIBA Jobin Yvon
Inrad Optics
JENOPTIK Optical Systems Inc.
L-3 Communications
Laser Institute of America
Lee Laser
NKT Photonics
Optigrate Corp.
Optoelectronics Industry Development Assoc.
Photonics Online
Photonics Spectra
Princeton Instruments
Qioptic
QPC Lasers/Laser Operations, LLC
Quantum Technologies
Ray Williamson Consulting
R-Soft Design Group
Resonetics, LLC
SCD.USA, LLC
Sciperio, Inc.
Sterile Environment Technologies-SET3
SPIE- The Int'l Society for Optics & Photonics
StellarNet, Inc.
Teledyne ODI
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.

Faculty

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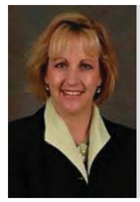

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Thank you for attending!
We look forward to seeing you at our next
CREOL Affiliates Day
Friday, March 7, 2014