Symposium and Industrial Affiliates Program
2018

UCF

CREOL, The College of Optics and Photonics

Advances in Optics & Photonics
Industrial Affiliates Symposium
19–20 April 2018

CREOL Building 102 & 103 — ***Thursday, 19 April***

Short Courses 9:00AM–12:15PM

9:00-10:30AM, CREOL Building, Room 102
Title: Advanced Infrared Systems
Instructor: Ronald Driggers

This short course covers the past fielded technology in infrared systems as well as current fielded technologies in the areas of target acquisition (TA) and intelligence, surveillance, and reconnaissance (ISR). More importantly, we cover new breakthroughs in cryogenically-cooled infrared systems to include dual band detectors, smaller infrared detector pitch, large format focal planes, higher operating temperature MWIR detectors, deeper well capacity readout integrated circuits, freeform and flat optics. These breakthroughs enable many different system capabilities which will be discussed. In addition, a short discussion about uncooled infrared systems on where they are currently and where they are going will be provided.

9:00-10:30AM, CREOL Building, Room 103
Title: Deep Learning for Computer Vision
Instructor: Mubarak Shah

Computer vision, which is part of artificial intelligence, deals with the automatic analysis of images and videos using computers. Applications of computer vision include Biometrics (e.g. face recognition), UAV video analysis, human activity and action recognition, bio-medical image analysis, geo-localization, self-driving cars, video and image retrieval, robotics etc. Computer vision has been very active area of research for many decades and researchers have been working on solving important challenging problems. During the last few years, Deep Learning involving Artificial Neural Networks has been disruptive force in computer vision. Employing deep learning, tremendous progress has been made in a very short time in solving difficult problems and very impressive results have been obtained in image and video classification, localization, semantic segmentation, caption generation, geo-localization, etc. New techniques, datasets, hardware and software libraries are emerging almost every day. Deep Computer vision is impacting research in Robotics, Natural Language understanding, audio and speech recognition, Computer Graphics, multi-modal analysis etc.

In this tutorial, I will first briefly describe basics of deep neural networks and then present a quick overview of my research at UCF Center for Research in Computer Vision, employing deep learning.

10:45-12:15PM CREOL Building, Room 102
Title: LIDAR Design for Autonomous Vehicles
Instructor: **Umar Piracha**

This short course gives an overview of various laser ranging techniques and the performance achieved by various lidar manufacturers for enabling autonomous vehicles. Design trade-offs and challenges for designing a lidar system will also be discussed.

10:45-12:15PM CREOL Building, Room 103
Title: Validation and Application of the Army's Electro-Optical Imager Targeting and Surveillance Model
Instructor: **Rich Vollmerhausen**

The Army purchases imaging hardware to help soldiers execute missions at some time in the future and somewhere in the world. The Targeting Task Performance (TTP) resolution metric is used to predict the utility of imaging hardware for targeting and surveillance purposes. This short course discusses the logic, validation scope, and correct application of the TTP metric. Some time is spent describing historical methods and the misapplication of the current model by mixing old and new methodologies.

12:10 LUNCH Break

Student Talks 1:30PM-2:30PM (CREOL Building rooms 102/103)

1:30	2 µm Fiber Lasers: Power Scaling Concepts and Challenges	Student of the Year- Alex Sincore
	Superchiral Light Generation on Degenerate Achiral Surfaces	Abraham Vazquez-Guardado
	Polarization Diffractive Optical Elements for Augmented and Virtual Reality Displays	Yun-Han Lee
	Towards Integrated and Stabilized Frequency-Comb Generation on Chip	Marcin Malinowski

Poster Session, Reception, Lab Tours & Guest Speaker 2:30PM-5:30PM (CREOL lobby and balcony-Room 102/103)

2:30	Student Poster Session	CREOL lobby & balcony
	Lab Tours	Tours start from CREOL lobby
4:30	Seminar: Women in Optics & Photonics	Elizabeth Rogan-CEO, OSA

Fairwinds Alumni Center, Ballroom A,B,C ***Friday, 20 April***

8:30	Continental Breakfast and Walk-in Registrations		
9:00	Welcome and Overview of CREOL	Bahaa Saleh	Dean & Director, CREOL, UCF

Technical Symposium

Session I

9:45	Organic Light Emitting Devices (OLEDs): A Revolution in Displays and Lighting	Stephen Forrest	University of Michigan
10:15	Sensing Molecules and Isotopes with Frequency Combs	Konstantin Vodopyanov	CREOL, UCF

10:35 BREAK & EXHIBITS

Session II

10:55	U.S. Army Challenges and Opportunities for Positioning, Navigation and Timing (PNT) in Contested Environments	Phil Perconti	USARL
11:25	Ultrafast Optical Signal Processing Using Optical Frequency Combs	Peter Delfyett	CREOL, UCF

Product Review

11:45	IMEC	Bert Gyselinckx	
11:53	BRIDG	Brett Attaway	
12:01	ASML	Adel Joobeur	

12:10 **LUNCH Served**

1:25	Laser Institute of America – Advancing Laser Industrial Applications and Safety	Nathaniel Quick	Executive Director, LIA

Session III

1:45	Building the Vision for Autonomous Mobility	Jason Eichenholz	Luminar Technologies Inc
2:15	Fiber Optics at CREOL	Axel Schulzgen	CREOL, UCF

2:35 BREAK & EXHIBITS

Session IV

2:55	Electromagnetic Surface Waves: Riding Two Horses While Straddling a Fence	Akhlesh Lakhtakia	Pennsylvania State University
3:25	Development of Curved Image Sensors for Future Imaging Systems	Kyle Renshaw	CREOL, UCF

Award Presentations

3:45	Distinguished Alumni Award	Richard DeSalvo	Harris Corporation
4:00-5:00	Reception		

Stephen R. Forrest
University of Michigan

Abstract: Organic light emitting devices, or OLEDs, are very thin (nanometer) devices made primarily with carbon-containing dye compounds. They are extremely attractive due to their simplicity, flexibility, light weight, and ultrahigh efficiency. Following their invention 30 years ago, OLEDs are now exploding into the marketplace, with prospects of ultimately replacing liquid crystal displays for mobile applications, virtual and augmented reality systems, as well as monitors and in televisions. Equally exciting is their imminent entry into the world of lighting. Yet before this revolutionary technology can dominate these applications, there are still several challenges that must be overcome. These challenges include improving their useful lifetime, improving light outcoupling using cost effective and simple methods, and finding very low cost and rapid methods to pattern very high resolution and low cost pixelated displays. While considerable progress has been made, there is much that remains to be discovered, engineered and implemented. This talk will focus on the "grand challenges" faced in perfecting OLED technology, and will provide a perspective about the future of display and lighting technology based on advances yet to come.

B. A. Physics, 1972, University of California, MSc and PhD Physics in 1974 and 1979, University of Michigan. In 1985, Prof. Forrest joined the Electrical Engineering and Materials Science Departments at USC. In 1992, Prof. Forrest became the James S. McDonnell Distinguished University Professor of Electrical Engineering at Princeton University. He served as director of the National Center for Integrated Photonic Technology, and as Director of Princeton's Center for Photonics and Optoelectronic Materials (POEM), and from 1997-2001, he chaired Princeton's Electrical Engineering Department. In 2006, he rejoined the University of Michigan as Vice President for Research, where he is the Peter A. Franken Distinguished University Professor. A Fellow of the APS, IEEE and OSA and a member of the National Academy of Engineering and the National Academy of Sciences and the National Academy of Inventors, he received the IEEE/LEOS Distinguished Lecturer Award in 1996-97, and in 1998 he received the IPO National Distinguished Inventor Award as well as the Thomas Alva Edison Award for innovations in organic LEDs. In 1999, Prof. Forrest received the MRS Medal for work on organic thin films. In 2001, he was awarded the IEEE/LEOS William Streifer Scientific Achievement Award for advances in photodetectors for optical communications. In 2006 he received the Jan Rajchman Prize from the Society for Information Display for invention of phosphorescent OLEDs, and is the recipient of the 2007 IEEE Daniel Nobel Award for innovations in OLEDs. In 2017 he was the recipient of the IEEE Jun-Ichi Nishizawa Medal. Prof. Forrest has authored ~580 papers in refereed journals, and has 311 patents. He is co-founder or founding participant in several companies, including Sensors Unlimited, Epitaxx, Inc., NanoFlex Power Corp. (OTC: OPVS), Universal Display Corp. (NASDAQ: OLED) and Apogee Photonics, Inc., and is on the Board of Directors of Applied Materials. He is past Chairman of the Board of the University Musical Society. He has also served from 2009-2012 as Chairman of the Board of Ann Arbor SPARK, the regional economic development organization and is now on its Board of Directors. He has served on the Board of Governors of the Technion – Israel Institute of Technology where he is a Distinguished Visiting Professor of Electrical Engineering. Currently, Prof. Forrest serves as Lead Editor of Physical Review Applied and recently joined the Air Force Studies Board.

Sensing Molecules and Isotopes with Mid-IR Frequency Combs

Konstantin Vodopyanov
CREOL, The College of Optics & Photonics, UCF

Abstract: Mid-infrared (mid-IR) spectroscopy offers supreme sensitivity for on-site and standoff detection of trace gases, solids and liquids, based on strong telltale vibrational bands in this part of the spectrum. The technique of Fourier-transform dual-comb spectroscopy (DCS) with phase-coherent sources has the advantage of extremely fast data acquisition combined with superior spectral resolution and broadband coverage. DCS requires high degree of coherence between the two optical frequency combs and most experiments that simultaneously take full advantage of the dual-comb technique (broad spectral coverage, comb-tooth resolved spectra, and rapid scans) have so far privileged the near-infrared domain. In my group at CREOL, we demonstrated a new platform for mid-IR DCS. It is based on generation of a subharmonic – an inverse process with respect to the second harmonic generation. This allows creating coherent combs with an unprecedented frequency span, e.g. over an octave, and reaching deep mid-IR (> 10 μm). Our present DCS setup is based on a pair of subharmonic optical parametric oscillators (OPOs) pumped by two phase-locked thulium-fiber combs. With this source, we demonstrate massively parallel detection in a mixture of up to 22 trace molecular gases (NO, OCS, N2O, CO, CO2, CH4, C2H6, C2H4, C2H2, and H2O) and their isotopologues containing 13C, 17O, 18O, 15N, 33S, 34S, and 2H (deuterium) isotopes, with sub-Doppler resolution and parts-per-billion sensitivity. For example, we can 'sniff' more than ten trace molecules (including their isotopologues) in ambient air. The other salient features of our technique are fast (typically 10s) acquisition of massive (350k mode-resolved spectral points) data, and absolute optical frequency referencing (e.g. to atomic clock). We presently focus on both biomedical and security applications of the mid-IR spectral combs.

Konstantin Vodopyanov obtained his MS degree from Moscow Institute of Physics and Technology (Phys-Tech) and his PhD and DSc (Habilitation) from the Oscillations Lab. of Lebedev Physical Institute (later General Physics Inst.) led by Nobel Prize winner Alexander Prokhorov. Konstantin served an assistant professor at the Moscow Phys-Tech, an Alexander-von-Humboldt Fellow at the University of Bayreuth, Germany, and as a Royal Society postdoctoral fellow and lecturer at Imperial College, London, UK. In 1998, he moved to the United States and became head of the laser group at Inrad, Inc., NJ, and later director of mid-IR systems at Picarro, Inc.,CA. He also co-founded and provided technical guidance for several US companies. In 2003 he returned to Academia (Stanford University, 2003-2013) and is now a 21st Century Scholar Chair & Professor of Optics at CREOL, UCF. Dr. Vodopyanov is a Fellow of the American Physical Society (APS), Optical Society of America (OSA), SPIE - International Society for Optical Engineering, UK Institute of Physics (IOP). He has > 350 technical publications and is member of program committees for several major laser conferences including CLEO (General Chair in 2010), OSA High Brightness Sources and Light-driven Interactions Congress, and Photonics West. His research interests include nonlinear optics, mid-IR and terahertz-wave generation, ultra-broadband frequency combs, comb spectroscopy and its applications in biomedical research.

U.S. Army Challenges and Opportunities for Positioning, Navigation and Timing (PNT) in Contested Environments

Philip Perconti
Director, US Army Research Laboratory

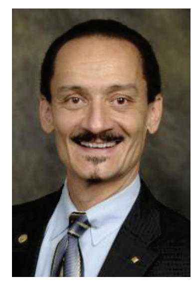
Abstract: The U.S. Army must operate in contested environments where GPS is not assured. This talk will focus on optics and photonics research efforts that the U.S. Army Research Laboratory is undertaking to provide GPS-quality assured PNT.

Philip Perconti is a member of the Senior Executive Service and serves as the Director of the U.S. Army Research Laboratory (ARL), the Army's premier laboratory for basic and applied research and analysis. ARL conducts research and analysis in weapons and materials, sensors and electron devices, computational and information sciences, human research and engineering, vehicle technology, and survivability and lethality analysis. ARL's Army Research Office executes the Army extramural basic research program in scientific and engineering disciplines. The Laboratory consists of approximately 2,000 civilian and military employees with an annual budget of over $1 billion. Prior to this, Dr. Perconti served as the Director of the Sensors & Electron Devices Directorate of the ARL. He was responsible for leading and transitioning the Army's primary basic and applied research programs in sensors, electronics, sensor information processing, and power and energy technologies. In addition, he led ARL's S&T campaign for Materials Research. His duties included operation of unique electronics and photonics materials fabrication and characterization facilities that enable world-class, Army-relevant, component research and development. He was also responsible for planning, executing and balancing mission and customer program needs to ensure science and technology dominance for the Army.

Ultrafast Optical Signal Processing using Optical Frequency Combs

Peter Delfyett
CREOL, The College of Optics & Photonics, UCF

Abstract: The recent advent of optical frequency combs has opened up new avenues in the area of optical communications and signal processing. In this talk, I will review recent developments within our research group on the use of optical frequency combs in ultra wideband and ultrafast optical signal processing. Key items will be in the generation, modulation, transmission and detection of optical combs and how these new methods dramatically improve the performance of optical communication and signal processing systems. The salient feature of this approach is the ability exploit the optical coherence of frequency combs to realize ultrafast parallel signal processing architectures that provide signal processing rates equal to the aggregate bandwidth of the optical comb, while only using electrical signals that possess bandwidths equal to the comb spacing. Finally, we will highlight how chip scale integration can be used to make these technologies and systems, compact, cost effective and energy efficient to facilitate rapid transitioning into commercial applications.



Peter Delfyett received the B.E.(E.E.) degree from The City College of New York, the M.S. degree in EE from The University of Rochester, the M. Phil and Ph.D. degrees from The Graduate School & University Center of the City University of New York. After obtaining the Ph.D. degree, he joined Bell Communication Research as a Member of the Technical Staff, where he concentrated his efforts towards generating ultrafast high power optical pulses from semiconductor diode lasers, for applications in applied photonic networks. Currently, he is Pegasus Professor and Trustee Chair Professor of Optics, EE & Physics at CREOL, The College of Optics and Photonics, and is currently serving as the Director of the Townes Laser Institute. He is a Fellow of APS, IEEE, NAI, NSBP, OSA, and SPIE and is the recipient of the APS Edward Bouchet Award, and the 2014 Medalist from the Florida Academy of Science. He has over 750 scientific publications in refereed journals and conference proceedings and 41 US patents.

IMEC, Bert Gysenlinckx

Embracing a better life

BRIDG, Brett Attaway

BRIDG – Bridging the Innovation Development Gap

ASML, Adel Joobeur

Faster, stronger, greener

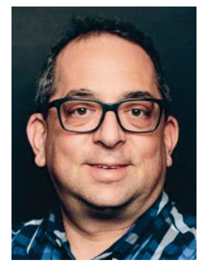
Nathaniel R. Quick
Executive Director, Laser Institute of America

The Laser Institute of America (LIA), founded 50 years ago, in 1968, is the professional society for laser applications and safety. LIA cultivates innovation, ingenuity and inspiration to promote the continued growth and safe use of lasers, by bridging laser research with applications. At LIA, we believe in the importance of sharing new ideas about lasers through collaborations. In fact, laser pioneers such as Dr. Arthur Schawlow and Dr. Theodore H. Maiman were among LIA's original founders who set the stage for our enduring mission to promote laser applications and their safe use through education, training and symposia. LIA was formed by people who represented the heart of the profession—a group of academic scientists including developers and engineers who were truly passionate about taking an emerging laser technology and turning it into a viable industry. We are embarking on the next 50 years by undertaking initiatives to modernize the LIA brand. By accelerating the digitization of our publications we intend on providing an easily assessable library of knowledge to our members. Additionally, we are improving courses by redesigning and expanding the course content. LIA will also collaborate with UCF to develop a course curriculum focused on laser processing of advanced materials. Today, I will highlight new laser-material technologies that impact several industrial sectors including advanced materials, semiconductor/electronics, life sciences, energy conversion, lighting, industrial sensors, internet of things (IoT), and chemical and gas treatment.

Nathaniel R. Quick, is a past president, past secretary, past board member and fellow of LIA. He was confirmed as the Executive Director of the Laser Instituter of America October 22, 2017. Additionally, he is the president and CTO of AppliCote Associates, LLC, Lake Mary, FL., an affiliate of CREOL, specializing in advanced materials transformation using high pressure laser implantation. He currently holds 62 U.S. patents and has over 60 publications to his name. Quick earned his PhD from Cornell University in materials science and engineering. In the past, Quick served as vice president of research and development for the fluid dynamics division with Pall/Memtec Corp; technology program manager in economic conversion at Kaiser Hill, LLC/ EG&G Rocky Flats; president of applications technology with Indiana Inc., supervisor of technology applications/keypads and interconnect technology/resident metallurgist with Bell Labs/AT&T; vice president of quality control and laboratory operations at Washburn Wire Products; and materials scientist with Eastman Kodak's research division. Honors and awards include the Minority Engineers Outstanding Contributions award; Cornell University's Outstanding Achievement Business/Professions Center for Leadership and Development award; and the Indianapolis Indiana and EG&G Award of Excellence Rocky Flats (twice).
He is a fellow of the African Scientific Institute, a past guest NIST researcher and a past member of the Army Science Board. He is chairman of the UCF Materials Science and Engineering's industrial advisory board, and is currently a graduate faculty scholar. He is currently a member of ASM International and the Materials Research Society.

Jason Eichenholz
Co-Founder & CTO of Luminar

Abstract: Autonomous mobility is the disruptive technology of our era, and at its core are optical sensing challenges. Getting better data required to operate safely is the key to a driverless future, and this all hinges on new kind of LiDAR built for self-driving scenarios. Join Jason Eichenholz, Co-Founder of Luminar, in a talk on the requirements for self-driving vehicles and a vision for a major breakthrough in LiDAR.



Jason Eichenholz is a serial entrepreneur and pioneer in laser, optics and photonics product development and commercialization. Over the past twenty-five years, he led the development of hundreds of millions of dollars of new photonics products. Before joining Luminar as CTO and co-founder, Eichenholz was the CEO and founder of Open Photonics, an open innovation company dedicated to the commercialization of optics and photonics technologies. Prior to that, he served as the Divisional Technology Director at Halma PLC. In that role he was responsible for supporting innovation, technology and strategic development for the Photonics and Health Optics Divisions. Before joining Halma, he was the CTO and Board Member of Ocean Optics Inc. as well as the Director of Strategic Marketing at Newport/Spectra-Physics. Eichenholz is a fellow of SPIE, the international society for optics and photonics, as well as a fellow of the Optical Society (OSA). He has served as the principal investigator for Air Force and DARPA funded research and development programs and holds ten U.S. patents on new types of solid-state lasers, displays and photonic devices. Eichenholz has a M.S. and Ph.D in Optical Science and Engineering from CREOL – The College of Optics and Photonics at the University of Central Florida and a B.S. in Physics from Rensselaer Polytechnic Institute.

Axel Schülzgen
CREOL, The College of Optics & Photonics, UCF

Abstract: Starting around 2010 substantial efforts have been made at CREOL/UCF to develop one of the leading research facilities in the area of optical fiber technology in the US. Today, CREOL's fiber optics research center has gained international recognition and is a cornerstone for collaboration with academic institutions as well as local and nationwide industrial partners. This presentation will highlight current examples of fiber optics research at CREOL. In a first example, we will demonstrate how recent advances in fiber fabrication technology impacts our ability meet technological challenges such as the delivery of laser pulses with extreme peak powers through hollow core fibers. Second, we created and studied a new type of image transmitting fibers for medical applications based on fundamentally new approach to transverse light confinement in disordered dielectric structures. Finally, using an example in the area of optical fiber sensors, we will show the transition from proof-of-concept laboratory experiments to structural monitoring in the real world.

Axel Schülzgen received his PhD in Physics from Humboldt-University of Berlin, Germany. Since 2009 he is Professor of Optics at CREOL, University of Central Florida. He also holds an Adjunct Research Professor position at the College of Optical Sciences, University of Arizona. His research interests include optical fiber devices, components, materials, and structures with applications in fiber laser systems, fiber optic sensing, and optical communications. Professor Schulzgen is a senior member of the Optical Society of America and a member of the International Society for Optics and Photonics SPIE and the German Physical Society.
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Electromagnetic Surface Waves: Riding Two Horses While Straddling a Fence

Akhlesh Lakhtakia
Pennsylvania State University

Abstract: An electromagnetic surface wave is like a rodeo athlete riding two horses simultaneously on either side of a fence. The surface wave straddles the planar interface of two half-spaces each occupied by a different material. Remove the interface by making the two partnering materials identical, and the surface wave vanishes. Moreover, there is no guarantee that a chosen pair of partnering materials will necessarily support the existence of a surface wave at a specific frequency. Although the surface-plasmon-polariton wave is guided by the planar interface of a metal and a dielectric material, other surface waves do not require one of the partnering materials to be a metal. These nonplasmonic surface waves are guided by the planar interface of two dissimilar dielectric materials. Either both partnering materials are homogeneous, or one is periodically nonhomogeneous in the direction normal to the interface, or both are periodically nonhomogeneous in the direction normal to the interface. The nonplasmonic surface waves are classified as Dyakonov waves, Tamm waves, Dyakonov-Tamm waves, and Uller-Zenneck waves. Whereas Uller-Zenneck waves underlie ground-wave propagation, applications of Dyakonov waves, Tamm waves, and Dyakonov-Tamm waves are beginning to emerge in optical sensing with prospects also for communications. Compounding of surface waves can occur when a thin layer of a third material is interposed between two dissimilar dielectric materials.

Akhlesh Lakhtakia received the BTech (1979) and DSc (2006) degrees from the Indian Institute of Technology (Banaras Hindu University) and the MS (1981) and PhD (1983) degrees from the University of Utah. In 1983 he joined the Department of Engineering Science and Mechanics at Penn State as a post-doctoral research scholar, where he became a Distinguished Professor in 2003 and the Charles Godfrey Binder Professor in 2006. His current research interests include electromagnetic scattering, surface multiplasmonics, bioreplication, forensic science, solar energy, sculptured thin films, metasurfaces and mimumes. He was elected a fellow of Optical Society of America (1992), SPIE (1996), Institute of Physics (UK) (1996), American Association for the Advancement of Science (2010), American Physical Society (2012), Institute of Electrical and Electronics Engineers (2016), Royal Society of Chemistry (2016), and Royal Society of Arts (2017). He received the 2010 Technical Achievement Award from SPIE and the 2016 Walston Chubb Award for Innovation from Sigma Xi.

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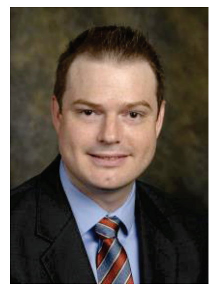
Development of Curved Image Sensors for Future Imaging Systems

Kyle Renshaw
CREOL, The College of Optics & Photonics, UCF

Abstract: There are enormous optical advantages to use a curved image sensor in place of conventional flat focal plane arrays (FPA) because optical systems intrinsically focus to a curved focal surface. For this reason, biological imagers such as the human eye have evolved a curved image sensor (i.e. the retina) that enables use of a simple lens to achieve nearly diffraction-limited imaging over a wide field-of-view (FOV). Today's digital imagers sample the curved focal surface using a flat FPA resulting in field-curvature aberrations that impose stringent constraints between an imager's focal length, aperture size, FOV and resolution. Development of curved image sensors would remove these constraints and create a new paradigm for optical system design. We are developing a fabrication technology to convert a wafer-based CMOS circuit into a stretchable circuit that can be molded into the desired spherical or aspheric shape. This technology will provide curved image sensors with small pixel pitch and large curvatures suitable for the next generation of visible or infrared imaging systems.



Kyle Renshaw received his PhD in Applied Physics and his MS in Electrical Engineering, both from the University of Michigan. He focused on the development of hybrid organic/inorganic optoelectronics. After completing his PhD, Dr. Renshaw spent two years in the Advanced Technology Center at Northrop Grumman supporting the development of advanced electro-optical and infrared (EOIR) systems including imaging, tracking, missile warning and countermeasure systems. In the fall of 2015, he joined the College of Optics and Photonics (CREOL) as an Assistant Professor. At CREOL, he directs the Thin-Film Optoelectronics (TFO) group, which conducts research on novel optoelectronic devices enabled by thin-film materials. His group uses organic and hybrid organic/inorganic semiconductors to develop sensors, photovoltaics and LEDs that can be fabricated on large, flexible or non-planar substrates.

Elizabeth Rogan
CEO, The Optical Society

Abstract: From the political arena to Hollywood to the sciences, gender equity has become a predominant focus of thought leaders worldwide, but change has been incremental. Scientific societies have a responsibility to improve the participation of women in STEM fields like optics and photonics. The Optical Society along with its sister societies are making an impact by focusing on the participation of women in our programs and honors. Liz Rogan will share insights regarding OSA and its partners' initiatives.

Liz Rogan has been at OSA for more than 20 years in positions initially focused on operations, the last position being Chief Operating Officer. Beginning in 2002, she was honored with the role of Chief Executive Officer of OSA and The OSA Foundation. As OSA CEO, she reports to the Board of Directors and is responsible for the oversight, strategic direction and fiscal soundness of programs and activities of this $40M, 150+ staff society. The OSA Foundation has a $10M+ reserve and activities include fundraising and program development. In 2016 Chad Stark became the Foundation Executive Director. In addition, Liz is the society's spokesperson and advocate to a wide range of OSA constituencies, including its members, volunteers, co-sponsors and customers, throughout the global optics community. Liz holds a B.A. in accounting from the University of Connecticut, is a CPA, and is an alumnus of an executive business program from the Wharton School at the University of Pennsylvania.

2018 Distinguished Alumni Award

Richard DeSalvo

Richard DeSalvo is head of the Microwave Photonics Group at Harris Corporation in Melbourne, FL. He was one of CREOL's first Florida native graduate students, and among the first to obtain the PhD in Physics at UCF in 1993. Dr. DeSalvo is a leader in areas of microwave photonics integration, coherent lightwave communications, and virtual photonics. He continues strong interaction with CREOL, the College of Optics and Photonics, as a Graduate Faculty Scholar, and he has lead partnerships with our faculty on major federal contracts. Dr. De Salvo continues to give our students, both undergraduates and graduates, opportunities for internships at Harris as well as long-term employment. Currently at least nine of our graduates or current students are working in his group.

Exhibitors

Amplitude Systems
One Broadway
Cambridge, MS 02142
617-401-2195
www.amplitude-systemes.com

Tektronix
14200 SW Karl Braun Dr.
Beaverton, OR 97077
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www.tek.com

Newport Corp.
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877-835-9620
www.newport.com

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7 Airport Park Road
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860-408-5000
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190 NeoCity Way
Kissimmee, FL 34744
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www.imec-int.com

IPG Photonics
50 Old Webster Road
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The Optical Society
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202-223-8130
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LightPath Technologies
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www.lightpath.com

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Society For Information Display
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www.sid.org

BRIDG
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Kissimmee, FL 34741
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www.icamr.net

ASML
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Wilton, CT 06897
203-761-4000
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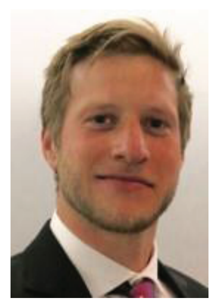
Student of the Year Presentation

2 μm Fiber Lasers: Power Scaling Concepts and Challenges

Alex Sincore

Fiber lasers have experienced explosive growth in the past decades, with 1 μm Ytterbium-doped lasers holding >13 % of the laser market. Fiber lasers operating at longer wavelengths, specifically 2 μm Thulium-doped lasers, are experiencing a similar growth in system performance. However, the power scaling challenges faced at 1 μm are inherently different at 2 μm. The two major limitations are high thermal loads and nonlinear effects. To address the first issue, we propose in-band pumping which substantially reduces the quantum defect. We have demonstrated >90% efficient 2 μm fiber lasers with plans to scale over 100 W. As for nonlinear effects, there is a lack of data identifying which nonlinearities limit 2 μm fiber lasers. We address this by investigating nonlinear thresholds with a variable spectral bandwidth, nanosecond pulsed fiber laser. We determine that stimulated Brillouin scattering limits narrow linewidth 2 μm sources. On the other hand, modulation instability limits broader linewidth 2 μm sources, which is not found at 1 μm. Overall, with this knowledge and proper system design, Thulium-doped fibers can continue to grow and provide high power systems for emerging applications..

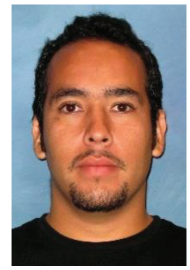


Alex Sincore received the B.S. degree in physics from the University of Florida, Gainesville in 2012. He went on to receive his M.S. degree in optics from CREOL, The College of Optics & Photonics at the University of Central Florida, Orlando in 2014. He is currently a Ph.D. candidate in the optics program at CREOL. Since 2012, he has been a graduate research assistant in the Laser Plasma Laboratory. His primary research interests are in designing and developing high-power and high-energy fiber lasers. Additional research interests include applications in material processing and atmospheric propagation, nonlinear effects in optical fibers, and nonlinear frequency conversion to the mid-infrared..

Student Presentations

Superchiral Light Generation on Degenerate Achiral Surfaces

Abraham Vazquez-Guardado

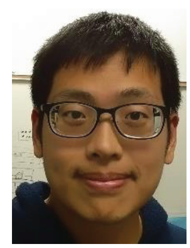


A novel route of superchiral near-field generation is demonstrated based on geometrically achiral systems supporting degenerate and spatially superimposed plasmonic modes. Such symmetric systems generate single-handed chiral near-field with simultaneous zero far-field circular dichroism. The phenomenon is theoretically elucidated with a rotating dipole model, which predicts uniform single- handed chiral near-field that flips handedness solely by the change in excitation handedness. This property allows detection of pure background free molecular chirality through near-field light-matter interaction, which is experimentally demonstrated in precise identification of both handedness of a chiral molecule on a single substrate with about four orders of magnitude enhancement in detection sensitivity compared to its conventional volumetric counterpart. The proposed concept removes the current constraint in surface-enhanced chiroptical spectroscopy requiring both chiral plasmonic enantiomers to perform enantiomeric discrimination. I envisage the result of this work will promote further fundamental and applied research in biosensing, where not only the detection of the target analyte would be feasible but its chiral configuration such as proteins or DNA strands.

Abraham Vázquez-Guardado is a CREOL PhD Student in the Nano-Optics group led by Dr. Debashis Chanda. He received the B.Eng. in Electrical Engineering from the Universidad Autonoma de Nayarit, and the M.S in optics from the Instituto Nacional de Astrofisica, Optical y Electronica (INAOE), Mexico. His research focuses on enhanced light-matter interactions with applications in biosensing and molecular chirality detection on hybrid cavity-coupled plasmonic systems. He has currently published five as first author and nine as co-author peer-reviewed journal publications.

Polarization Diffractive Optical Elements for Augmented and Virtual Reality Displays

Yun-Han Lee



Polarization diffractive optical elements based on geometric phase exploits the in-plane rotation of liquid crystal (LC) axis to encode the wave-front profile to two-dimensional distribution. This approach enables LC-based ultra-thin high-efficiency grating deflectors and lenses to be electrically switchable. By utilizing this type of switchable lenses and deflectors, we can produce display images with depth content, and enhance the display resolution for virtual reality displays. For augmented reality displays, we also demonstrated a large-angle high-efficiency grating deflector which can be used as a wave-guide coupler.

Yun-Han Lee is currently a Ph.D. student in Prof. Shin-Tson Wu's research group. He received his MS degree in Physics from National Taiwan University in 2011. His research mainly focuses on liquid crystal devices for augmented reality and virtual reality displays. He has published 19 journal papers and 8 conference proceedings.

Towards Integrated and Stabilized Frequency-Comb Generation on Chip

Marcin Malinowski

Frequency combs are composed of a set of narrow, equally-spaced lines in the frequency domain and therein in lays their utility.

When stabilized, the combs offer the ability to measure optical cycles of atomic oscillations and thus measure time in atomic clocks. The broad spectrum of optical frequency combs is useful in spectroscopy, while their stability enables both the absorption and the phase shift to be determined. The unprecedented stability enable precise measurement of Doppler shift of distant stars. Their low phase noise enables coherent data transmission with advanced modulation formats due to long coherence length. Finally, beating of comb lines can be used in microwave synthesis. However, current comb systems are bulky and limited to tabletop demonstration. The ultimate goal of this project, funded by DARPA, is to transform the comb technology into chip-scale. This talk will concentrate on the design and testing of integrated nonlinear components for frequency comb generation, namely, dispersion engineering of nonlinear waveguides of chalcogenide and silicon nitride, thin-film periodically-poled lithium niobate waveguides for frequency doubling, ancillary fiberized sub-100-fs laser sources, and amplifiers needed to compensate for insertion losses, and finally detection of carrier-envelop offset from the generated coherent supercontinuum. System-level comparison of performing pulse compression in microrings versus waveguides will also be provided.

Marcin Malinowski is a Ph.D. student in CREOL working under Dr. Sasan Fathpour on integrated frequency comb sources and Brillouin scattering for microwave signal processing. He holds a Bachelors and Masters in Experimental and Theoretical Physics from University of Cambridge. He is a first author on one peer-review journal article and co-author on 21 journal articles and conference proceedings.

Posters

Poster 1

An Integrated Mode-Transparent Power Splitter based on Multimode Interference

*Mohammed A. Al-Mumin[1], Yuanhang Zhang[2], Huiyuan Liu[2], Chi Xu[2], Lin Zhang[3], Patrick LiKamWa[2], and Guifang Li[2]**
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The successful implementation of mode-division multiplexed (MDM) optical communication networks will require mode-transparent devices where amplifying, switching and routing of MDM signals are performed. Take the most basic device, the power splitter for example, it is generally believed that it can only be implemented in free space since integrated-optics implementations such as the Y junction and direction couplers are mode dependent. In this paper, a 1x2 four-mode integrated beam splitter based on multimode interference (MMI) couplers is proposed and verified using 2D and 3D simulation. The 3D simulation is used to optimize the input waveguide position and the core/cladding refractive index difference for the TE_{00}, TE_{01}, TE_{10}, and TE_{11} input waveguide modes. Insertion loss and mode-dependent loss as low as 0.1 dB and 0.2 dB are predicted. A 1x2 4-mode MMI beam splitter was fabricated on SiO_2 and tested experimentally for the first time. The performance of the splitter such as power splitting ratio over the full C-band is presented.

Poster 2

Chiral Light-Matter Interaction on Degenerate Achiral Plasmonic Systems

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A novel route of superchiral near-field generation is demonstrated based on geometrically achiral systems supporting degenerate and spatially superimposed plasmonic modes. When excited with CPL an effective rotating resonance arises, whose spatiotemporal distribution, and not its field distribution as previously thought, enables this unique superchiral near-field as theoretically explained with an achiral oscillating point dipole model. We experimentally demonstrate, for the first time, vibrational circular dichroism (VCD) where both chiral enantiomers are accurately identified at very low concentration ~3.8 nL volume with 3 %wt molecular on a single achiral plasmonic substrate. This research enables the possibility of advanced biosensing, where not only the detection of target analytes but its chiral configuration would be possible: like real time monitoring of protein folding events.

Poster 3

Image Transport Through Glass-Air Disordered Fiber with Transverse Anderson Localization

Jian Zhao,[1,] Yangyang Sun,[1] Zheyuan Zhu,[1] Donghui Zheng,[1,2] Jose Enrique Antonio-Lopez,[1] Rodrigo Amezcua Correa,[1] Shuo Pang[1], Axel Schülzgen[1]*
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We present a randomly disordered glass-air optical fiber with transverse Anderson localization effects. This novel fiber features a 28.5% air filling fraction and low attenuation below 1 dB per meter at visible wavelengths. The quality of images transported through this fiber is shown to be comparable to, or even better than, that of images sent through commercial multicore imaging fiber. We also demonstrate robust high-quality optical image transfer through 90cm-long fiber with disordered structure. The effects of variations of wavelength and feature size on transported image quality are investigated experimentally. And we further demonstrate that deep neural networks can be trained to recover images transported through the disordered optical fiber at variable working distances without any distal optics further improve the bandwidth and overall performance for these devices, as well as to create new devices useful for polarization control using this design.

Poster 4

Liquid Sensor Based On Optical Surface Plasmon Resonance in a Dielectric Waveguide

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In this work, we have demonstrated a novel optical surface Plasmon resonance (SPR) sensor head that is based on the launching a surface plasmon resonance in a dielectric waveguide. A SPR is excited at the gold metal-dielectric interface on top of an inverted-rib-type dielectric waveguide. The inverted-rib waveguide of the SPR sensor head is made of a thin layer of siliconoxynitride SiO_xN_y with a refractive index of 1.526 for the cladding layer and a layer of SU-8 polymer for the guiding layer. The SPR sensor head was designed to allow monitoring of analyte media with a refractive index ranging from 1.44 to the 1.502.Broadband light from an erbium doped fiber amplifier with a wavelength spectrum spanning from 1500 nm to 1580 nm, was coupled into the SU-8 guiding layer using a 40× microscope objective lens. After the guided light has passed through the SPR sensor head region, the light intensity remaining in the guided mode was captured using an optical spectrum analyzer (OSA). In order to measure the sensitivity of the device, a set of reference liquids representing the analyte medium and with refractive index varying from 1.442 to 1.502 were applied to the SPR sensor head and the transmission spectrum was monitored. Depending on the refractive index of the liquid in contact with the gold metal, the sharp dip in the transmission spectrum occurred at a wavelength of 1525 nm for the low refractive index liquid and it was shifted to 1537 nm for the high index liquid. The highest sensitivity of the devices was measured to be S = 189.26 nm.RIU^{-1}. We show that this device can potentially be totally integrated with the light source and detection unit as well as the liquid delivery system via microfluidic channels making it an extremely compact unit.

Poster 5

Stable, Cost-Effective Perovskite-Polymer Composites as Tunable Downconverters for Tailored Lighting

*Juan He[1], Caicai Zhang[2, 3], Eric Calkins[1, 3], Yanan Wang[3, 4], Hao Chen[1, 3], Shin-Tson Wu[1, *], Yajie Dong[1, 2, 3, *]*
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As the applications of solid state lighting (SSL) technologies move beyond simple energy saving to new arena (e.g. lighting for human wellbeing or horticultural lighting for improved productivity), tailored lighting with delicate spectral, intensity and spatial control is becoming increasingly important. Working with blue LEDs, tunable downconverters with narrow emission peaks should provide the most cost-effective approach for fine spectral control. While metal halide perovskites have emerged as promising solar photovoltaic or light emitting downconverter materials with high efficiency and outstanding tunability, the lack of long-term stability is one of the key issues that impede practical applications of perovskite materials. Here we report a swelling-deswelling microencapsulation strategy to achieve well dispersed, intimately passivated perovskite nanoparticles inside polymer matrixes and lead to perovskite-polymer composite films with high PL efficiency, color purity and unprecedented stability against heat and water exposure. The process is very simple and cost-effective, with no need of high temperature growth, nor postsynthetic purification or transfer. By tuning the halide compositions, perovskite-polymer composite films of different colors are obtained, covering whole visible spectrum range continuously, with narrow linewidths of 16 nm ~ 44 nm. Without further encapsulation, the samples can survive boiling water treatment with no obvious PL decay, and can be immersed in water for several months and still maintain the initial PL intensity, representing unprecedented environmental stability for perovskite-based emitters reported to date. The continuously tunable emission spectra, super low processing cost and outstanding environmental stability make these perovskite-polymer composite films highly promising downconverter options for tailored lighting.

Poster 6

Semi-Empirical Model Projections of High Power Quantum Cascade Lasers

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A 4.65 μm emitting quantum cascade laser structure is tested and characterized in both pulsed and continuous wave operation. Continuous wave power is measured above 3 W. The parameters measured are used in a semi-empirical power projection model to predict device behavior. Once the model is verified against the structure, design modifications are made to optimize the structure. InGaAs layers are simulated around the InGaAs/AlInAs laser core embedded in the InP waveguide, laser core doping is increased by 60%, and the laser core is broadened to 90 μm. This modified design is projected to achieve 19.8 W in continuous wave operation from a single facet, 5mm long device with a high reflection coated back facet. Linear power scaling with device length predicts continuous wave operation over 30 W when the device is scaled to 10 mm, near the upper limit for practical device lengths.

Poster 7

Subwavelength Focusing by Microdroplets Carrying Semiconductor Nanoparticles for Deposition on Flexible Substrates

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Subwavelength phenomena have drawn substantial interest in developing innovative laser-material interaction methods for harnessing the novel properties of nanostructures. Currently subwavelength structures are created by placing solid microspheres on substrates, but this process is impractical for rapid manufacturing applications. To overcome this drawback of current technology, we have achieved subwavelength structures using microdroplets that carry nanoparticles to the surface and simultaneously focus a laser beam to a subwavelength diameter like a superlens. Since the evanescent waves offer a near-field mechanism for subwavelength focusing, the microdroplets are dispensed through a conical hollow laser beam so that laser-material interactions occur immediately above the substrate surface. Three optical effects and a microfluidic cooling effect have been postulated to induce the deposition of subwavelength nanostructures on a silicon wafer.

Poster 8

Fabrication of Transparent Magneto-Optical YIG Ceramics

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Due to its superior Verdet constant, Yttrium Iron Garnet (YIG) has long been recognized as an important magneto-optical material, particularly in the field of high-power infrared isolators. When processed in bulk polycrystalline ceramic form, the transmission of this material is greatly affected by the presence of pores and deviation from stoichiometry. This work investigates the densification of phase-pure YIG ceramics by way of Conventional Solid-State Reactive Sintering (CSSRS) and specifically addresses the role played by the atmosphere and sintering additives on the microstructure and densification kinetics. We show that infrared-transparent bulk-sized ceramics can be obtained with a 3 μm grain size under optimal sintering conditions.

Poster 9

Femtosecond Laser Transverse Mode Conversion by an Achromatic Volume Phase Mask

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Ultrafast femtosecond laser systems have enabled many breakthroughs in the fields of science and technology. Their continued development and growth has led to industrial applications such as high-precision micro-machining, industrial processing, ultra-fast detection, biology, and material processing. However due to the large spectral bandwidth necessary for creating short pulses, it is quite difficult to manipulate their transverse mode structure. Conventionally, phase masks have been used to convert laser mode structures, but they are inherently monochromatic. We developed an achromatic phase mask with which broadband sources can undergo more efficient mode conversion. This achromatic phase mask involves a holographically encoded phase profile inside a transmitting volume Bragg grating paired with two surface transmitting diffraction gratings having twice larger periods. This device enables the same phase incursion for different wavelengths. Here we present femtosecond transverse mode conversion from the fundamental order TEM00 to TEM01, TEM10, and TEM11. The commercial femtosecond source had ~12.8 nm of bandwidth centered at 780 nm and a temporal pulse duration of <100 fs. The average power from the source was ~60 mW, and its peak power reached levels close to 10 kW. The mode converted beam had the same bandwidth and showed no angular dispersion. The overall diffraction efficiency of the achromatic phase mask was 41%, due to the low diffraction efficiencies of the used surface gratings at 780 nm. Optimization of the gratings will achieve efficiencies higher than 60%. This achromatic phase mask technique can be used to further femtosecond beam shaping techniques.

Poster 10

High-Efficiency Holographic Optical Elements Recorded in Photo-Thermo-Refractive Glass by Visible Radiation

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Photo-thermo-refractive (PTR glass) is a photosensitive silicate glass that allows for permanent refractive index change as a result of UV exposure followed by thermal development. Holographic optical elements (HOEs) produced in PTR glass possess high efficiency and provide stability to heat and high-power radiation. Volume Bragg gratings (VBGs) recorded in PTR glass using UV radiation are extensively used for laser beam control applications in the visible and IR spectral regions. A potential ability for recording with visible radiation would render possible to create complex HOEs such as holographic lenses and curved mirrors along with the traditional planar gratings in PTR glass for use in the visible spectral region. However, the photosensitivity of PTR glass is limited to the UV region, and, for that reason, no such holograms have been produced before. The present paper demonstrates a method for recording complex HOEs using visible radiation in PTR glass. The technique comprises two step recording process where glass is first exposed to a uniform UV beam and then the hologram is recorded during subsequent exposure to an interference pattern of a pulsed visible beam. The areas exposed to both UV and visible beams would have larger refractive index than areas exposed to UV radiation only. Thus, an effective positive refractive index change is obtained due to visible radiation in PTR glass. The method was used to fabricate several high-efficiency transmitting HOEs in PTR glass for application in the visible spectral region including complex holograms.

Poster 11

Flat-field Illumination Microscopy for Large Field-of-View Quantitative Imaging

Ian Khaw[1]*, Benjamin Croop[1], Jialei Tang[1], Anna Möhl[2], Ulrike Fuchs[2], Kyu Young Han[1]
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Fluorescence imaging is a powerful tool for understanding of molecular mechanisms of cellular processes and functions. It is desirable to have a robust imaging method that enables us to obtain quantitative information. However, in laser-based fluorescence imaging, the nonuniform illumination distribution by the Gaussian-shaped beam results in severe problems for quantitative analysis of images. Additionally, it limits the field-of-view and leads to rapid photobleaching at the center of the beam. The solution for the uneven distribution is to have an even illumination beam. The method proposed is the reshaping of the Gaussian illumination profile into a Flattop illumination profile by using refractive optics. Our results showed that the flat-field illumination yielded far more leveled intensities and much wider field-of-view compared to Gaussian profile. We demonstrated epi- and TIRF illumination with multiple wavelengths. Our method is likely to combine with high-throughput imaging as well.

Poster 12

Volumetric X-Ray Diffraction Tomography using a Low-Brilliance Table-Top Source

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Conventional computed tomography (CT) only reconstructs the attenuation map of the sample, which shows poor contrast among materials with similar electron densities, such as soft tissues or liquids. X-ray diffraction tomography (XDT) probes the angular-dependent diffraction profiles within a volumetric object, and displays high-contrast and specificity among materials that are otherwise hard to distinguish on conventional CT image. However, due to the weak diffraction cross-section, the existing pencil-beam XDT either requires a high-brilliance synchrotron source, or tens of hours in image acquisition using a traditional X-ray tube. Fan-beam XDT has been proposed to parallelize the acquisition of pencil-beam XDT, but the use of collimators on the detector limits the collection efficiency. Here we propose a high-efficiency multiplexing scheme based on structured cone-beam illumination to image the sample. Our system improves the source utilization compared to pencil-beam XDT, yet does not rely on detector collimator to localize and resolve the scattering profile of each point. Based on the reconstructed X-ray diffraction profile, we have demonstrated the three-dimensional material classification of the sample. Our method reduces the imaging time by one order of magnitude compared to existing table-top XDT systems. Similar to the evolution of CT, the multiplexing scheme we proposed has the potential to become the next generation XDT.

Poster 13

Enhanced Ablation with a Femtosecond-Nanosecond Dual-Pulse

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Kilometer-range projection of laser light with intensity sufficient to ablate most materials is possible with laser filamentation. During filamentation of femtosecond pulses centered at 800nm in air, intensity clamping limits the intensity of a single filament to ~1014 W/cm2, which limits the amount of material that can be removed by a single pulse. In this work, an auxiliary source of laser radiation in the form of a lower intensity (1010 W/cm2) nanosecond pulse is used to augment the ablation by a single femtosecond pulse with the same intensity as that of a single filament (1014 W/cm2). Dual-pulses consisting of a 50fs pulse at 800nm and 8ns pulse at 1064nm, with varying inter-pulse delays, are incident on GaAs wafers. The volumes of the craters produced are used to determine the optimal temporal spacing of the pulses for maximal material removal. Analysis of the crater surface features post-ablation with optical microscopy reveals the dominating mechanisms of material removal in each case. Ultra-fast shadowgraphy of the plasmas ejected from the sample provide further insight on the dynamics leading to enhanced ablation. The ablation dynamics are strongly affected by the temporal engineering of the dual-pulse. This work demonstrates an effective potential means of enhancing the ablation by laser filaments for long-range stand-off ablation.

Poster 14

Compression of Yb:KGW Laser Pulses with Multi-Plate and Hollow-Core Fiber Compressors

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We investigate the spectral broadening and compression of pulses from a Yb:KGW laser amplifier separately with the use of a multi-plate continuum (MPC) and a hollow-core fiber (HCF). The pulses were compressed from 280 fs to below 20 fs with the MPC and HCF compressors, using a single pass multi-stage multi-plate continuum utilizing thin fused silica windows, and a 1.4 m long xenon filled hollow-core fiber with a 400 micron diameter, respectively. We further compare the compression factor and energy throughput of the two pulse compressors. Our results suggest that both the MPC and HCF systems can generate a broad supercontinuum capable of supporting few-cycle pulses from moderately high average power Yb based laser sources.

Poster 15

Silicon Nitride Grating Couplers with High Efficiency and Broad Bandwidth

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A grating coupler based on silicon nitride is proposed for coupling light from vertical emitting lasers to planar silicon nitride waveguides. With the high alignment precision of e-beam lithography system, grating patterns can be written on top of existing devices with positioning error of less than 50 nm, enabling parallel optical interconnections for vertical emitting nanolasers. The fabrication processes are simple, only requiring one e-beam lithography following by one standard contact mask photolithography. With the help of a metallic reflector layer, a coupling spectrum with a peak efficiency of 30% and a 3-dB bandwidth of 100 nm has been observed experimentally when light was launched from an optical fiber during the test. The alignment tolerance between the light emitter and the grating coupler is relatively relaxed. For example, a misalignment of 1.5 μm along any planar direction, leads to a reduction of the peak coupling efficiency from 30% to 24%, an additional insertion loss of 1 dB.

Poster 16

Endogenous Alpha-Synuclein Analysis using Single-Molecule Pull-Down Assay

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Parkinson's disease (PD) is the second most common neurodegenerative disease, but molecular mechanisms underlying PD pathogenesis remain unclear. Alpha-synuclein (α-SYN) and its oligomeric species are implicated as a key player in Parkinson's disease. Thus, the determination of α-SYN expression levels and its oligomerization states is crucial to understand PD. However, it has been challenging to analyze them quantitatively because of the limited amount of specimens and the lack of techniques that are insensitive to the size and conformation of α-SYN oligomers. Here, we demonstrated quantitative analysis of endogenous α-SYN taken from postmortem human brain tissue using a single-molecule pull-down (SiMPull) assay. The SiMPull assay probes immunoprecipitated proteins, which are then tagged with a fluorescent molecule for imaging and detection. By utilizing in vivo crosslinking, we preserved the native oligomerization state of the α-SYN proteins. Our results showed that the tissue lysates from the substantia nigra of a human PD brain showed 3.3-fold higher number of α-SYN molecules and 2.4-fold higher oligomeric population compared to a healthy brain. Combining our SiMPull assay with uniform excitation and one-to-one fluorophore labeling has allowed us to perform direct, quantitative intensity-based analysis of the single-molecule data, rather than the traditional and slow technique of measuring photobleaching steps. Our technique is a powerful diagnostic tool for the detection of various neurodegenerative diseases, such as Parkinson's disease and Alzheimer's disease, and can be used to analyze various biospecimens not limited to post mortem brain tissue.

Poster 17

Using Fluctuations in Coherent Scattering for Sensing Through Obscurants

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The ability to characterize an object obscured by other scattering objects is of paramount importance due to its application in different areas e.g. biomedical and sensing. In recent years, remarkable advances have been achieved in imaging and sensing different objects thorough a turbid medium. However, usually these methods are either in conjunction with a complex computational method or elaborated optical instruments which may be impractical for characterizing dynamics objects.

We exploit the enhanced fluctuations of integrated scattered intensity from random scattering potentials illuminated sequentially by non-stationary probing fields that can be obscured by turbid media. Proposed approach can provide information about both the characteristic length of the target and the motion of the scattering potential's center of mass. We will show that this problem can be approached by exploiting active Stochastic Optical Sensing in which information carrier is statistical properties of the integrated scattered intensity from the targeted potential under stochastic illumination.

Poster 18

Hybrid Organic-Inorganic Perovskite LEDs

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Organic light emitting diodes (OLEDs) have emerged as a new technology for lighting and display applications. OLEDs enable inexpensive fabrication of efficient and large area emitters, however, there is a considerable roll-off in efficiency at high brightness. This roll-off reduces power efficiency and limits the peak brightness that can be achieved. Hybrid organic-inorganic perovskite (perovskite) has shown its potential to address the roll-off problem at high brightness. Here, we seek to replace the OLED emissive layer with a perovskite film to produce a perovskite LED (PLED) that utilizes the extraordinary optoelectronic properties of perovskites including high charge carrier mobility, tunable bandgap and low defect density. In the first step, we modelled active layer of PLED using Monte Carlo simulation to have a better understanding of the device working mechanism. Using this simulation, we confirm that the device efficiency will increase at higher drive current. We relate this behavior to high charge carrier mobility combined with the presence of crystal defects, which leads to enhancement of free carrier recombination at higher driving current. We will use the model to investigate governing mechanisms for non-radiative recombination and optimum device condition for higher efficiency. We have demonstrated perovskite growth using thermal-evaporation to achieve pure alpha phase of formamidinium lead triiodide (FAPbI3). Next, we will incorporate these films into novel device architectures to produce high-efficiency and high-brightness PLEDs.

Poster 19

Optical Parametric Oscillation in a Random Polycrystalline Medium: ZnSe Ceramic

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We demonstrate an optical parametric oscillator (OPO) based on random phase matching in a polycrystalline $\chi^{(2)}$ material, ZnSe. The subharmonic OPO utilized a 1.5-mm-long polished ZnSe ceramic sample placed at the Brewster's angle and was synchronously pumped by a Kerr-lens mode-locked Cr:ZnS laser with a central wavelength of 2.35 μm, a pulse duration of 62 fs, and a repetition frequency of 79 MHz. The OPO had a 90-mW pump threshold, and produced an ultra-broadband spectrum spanning 3-7.5 μm. The observed pump depletion was as high as 79%. The key to success in achieving the OPO action was choosing the average grain size of the ZnSe ceramic to be close to the coherence length (~ 100 μm) for our 3-wave interaction. This is the first OPO that uses random polycrystalline material with quadratic nonlinearity and the first OPO based on ZnSe. Very likely, random phase matching in ZnSe and similar random polycrystalline materials (ZnS, CdS, CdSe, GaP) represents a viable route for generating few-cycle pulses and multi-octave frequency combs, thanks to a very broadband nonlinear response.

Poster 20

Environmental Test of Quantum Dot Light Emitting Diode

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While OLEDs have struggled to find a niche lighting application that can fully take advantage of their unique form factors as thin, flexible, light weight and uniformly large -area luminaire, photomedical researchers have been in search of low cost, effective illumination devices with such form factors that could facilitate widespread clinical applications of photodynamic therapy (PDT) or photobiomodulation (PBM). Although existing OLEDs can't achieve the required high power density at the right wavelength windows for photomedicine, the ultrabright and efficient deep red quantum dot light emitting devices (QLEDs), developed by our group, can nicely fit into this niche.

The QLEDs show peak emission wavelength of 620 nm, narrow peaks bandwidth of 22 nm and can achieve high current efficiency (20.5 Cd/A at ~20, 000 Cd/m2) and small efficiency roll-off at high driving current density. Ultra-high brightness of 165, 000 Cd/m2 can be achieved at current density of 1000 mA/cm2, which sets a new brightness record for existing organic related red light emitting devices.

We have carried out preliminary PBM and PDT tests in vitro and demonstrated that QLED PBM increased cell metabolism in multiple cell lines by ~11-25% over control systems and QLED PDT could efficiently kill bacterial and cancerous cells, in a similar fashion with parallel studies using inorganic LEDs.

The demonstrations of ultrabright deep red QLEDs and their effectiveness for PBM and PDT warrant further studies investigating QLED devices for photomedical application and could enable the widespread use and clinical acceptance of photomedicine.

Poster 21

Clear 3D Single-Molecule Imaging inside Cells with an Extended Imaging Area via Highly Inclined Swept Illumination

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Illumination via a highly inclined and laminated optical sheet (HILO) could effectively decrease the generation of out-of-focus background for three-dimensional (3D) single-molecule fluorescence imaging. However, HILO illumination with favorable signal to background ratio (SBR) can only support a small imaging field-of-view (FOV), which is not suitable for cellular or high throughput imaging. Here, we present a highly inclined swept tile microscopy (HIST) that solves the fundamental limitations of HILO illumination, enabling 3D single-molecule imaging with a full FOV and high SBR. Our new imaging technique showed a much thinner optical sectioning depth and >40-fold larger FOV than conventional HILO microscopy. We demonstrated that it is possible to image mRNA with a few probes using single-molecule RNA fluorescence in situ hybridization in cultured cells and mouse brain tissue.

Poster 22

Performance Modeling of Terahertz and mm-Wave for Pupil Plane Imaging

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Terahertz (THz) and mm-Wave sensors are becoming increasingly important in industrial, security, medical and defense applications. Major problems with sensing in this region is the resolution, sensitivity, and resulting visual acuity of the imaging systems. There are different fundamental parameters in the design a system which have significant effects on the imaging performance. IMEC and the University of Central Florida College of Optics and Photonics are developing new THz and mmW components and systems. Photonic solutions have been at the technological forefront in THz band applications and are being pursued by our team. A single scanned antenna does not provide reasonable resolution, sensitivity, and speed. An effective approach to imaging is placing a high-performance antenna in a two-dimensional (2D) antenna array to achieve higher radiation efficiency and higher resolution of the imaging systems. Here we present the performance modeling of a pupil plane imaging system to determine the resolution and sensitivity efficiency of the imaging system. We are pursuing resolution and sensitivity from both a photonic radiometry and linear system approach as well as the bi-static radar approach.

Poster 23

Cryogenic (4 K) Performance Projections for Ultra-Small Cavity Oxide-Free VCSELs

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Efficient optical data transfer from cryogenic environments into room temperature has growing applications. Achieving high efficiency at the cryogenic temperatures is a key challenge because of the need to reduce heating in the cryogenic environment. The optical data transfer may be done by using a free space interconnect or through one or more optical fibers. Vertical-cavity surface-emitting lasers (VCSELs) could provide a compact, low cost and very efficient solution. However, oxide VCSELs suffer internal stress due to the oxide and have other reliability problems, especially for cryogenic operation. Oxide-free VCSELs have recently been introduced that can be scaled to small size (micron size) with very low power consumption and high reliability for cryogenic data transfer. Laser diode simulation is now well established in its physics, and this can be applied to VCSELs to project their low temperature operation. In this work we make projections of key VCSELs properties using an analysis based on the temperature dependent threshold and temperature dependent differential gain for 4 K operation. This model projects that 20 GHz small signal modulation can be achieved at 4 K at bias current ≤1 μA. This extremely low bias current and the expected high efficiency at the cryogenic operation make the oxide-free VCSEL an important route for cryogenic optical interconnects. In conclusion in this work projections are made for 4 K operation based on oxide-free VCSEL sizes of 1 to 4 μm diameter shown to operate efficiently at room temperature.

Poster 24

UAV Infrared Signature and UAV Detection and Tracking Data Collection and Analysis

Nicolette Fudala[1], David Shelton[2], Eddie Jacobs[3], Orges Furxhi[2], Robert Nicholas[1], Ronald Driggers[1], Stephen McClanahan[4], Teresa Pace[4]*
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Defense against unmanned aerial vehicles (UAVs) has become an increasing concern for both national security and the private sector as UAV availability has increased over the last 5 years. Detection and tracking is vital to combating UAV air threats and is a need that can potentially be fulfilled by infrared search and track (IRST) where radar and other methods may be ineffective (e.g., plastic air vehicles). A series of experiments are currently in progress addressing two questions. One goal is to assess whether or not IRST is a viable option for the detection and tracking of commercially available miniature UAVS with a maximum takeoff weight (MTOW) of 10kg or less. These UAVs are concerning because they are able to carry an adequate payload to be a threat, but are too small to be detected by radar at long distance. The first study involves collecting long-wave infrared (LWIR) signatures of commercial mini-UAVs at range in clear sky and cloudy backgrounds. Results compare LW IRST performance estimates to two candidate sensor suites. The second goal concerns how to improve L3 Technologies' existing and potential sensor configurations, sensor performance models, and UAV detection tracking algorithms in LWIR and mid-wave infrared (MWIR) for fixed-wing and rotary UAVs of varying sizes. A second set of three experiments in collaboration with University of Memphis involves the following: One test collects up-close radiometric signatures of various UAVs at different aspect angles in clear sky, cloudy, and terrestrial backgrounds for use in modeling. A second test involves collecting signal-to-noise ratio (SNR) as a function of range for various resolved and unresolved UAV targets and comparing to modeled SNR. A third and final test involves collecting ground-truthed radiometric and GPS position data for different ConOp (concept of operations) scenarios, mapping the data, and cataloguing in a database. Results for this experiment are to be determined.

Poster 25

Nonlinear Integrated Optics for Frequency Comb Offset Stabilization

Marcin Malinowski[1], Guillermo F.C. Gonzales[1], Ashutosh Rao[1], Saeed Khan[1],Jean-Etienne[3] , Michael Plascak[1], Ricardo Bustos Ramirez[1] , Ming Wu[3], Peter Delfyett[1,2], Sasan Fathpour[1,2]*

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An on-chip stabilized frequency comb source could potentially revolutionize the field of optics in the same manner that microwave synthesis impacted microelectronics in the 1940s. While frequency combs have numerous proven applications such as precise measurement of atomic oscillations in atomic clocks, dual-comb spectroscopy with superior resolution, microwave synthesis and astronomical spectograph calibration, they are bulky setups limited to lab demonstrations. An on-chip frequency comb source could be deployed in on-chip spectrometers, miniature atomic clocks for precise time-keeping or optical frequency synthesizers. At the heart of such a frequency comb source lies a mode-locked laser, which is stabilized through nonlinear optical circuits. This poster summarizes our efforts in designing the required nonlinear devices and their subsequent integration. The core functionality is provided by thin-film lithium-niobate frequency-doublers, chalcogenide waveguides, whose high third-order nonlinearity permits compression of seed pulses. Through heterogeneous integration and inclusion of couplers and filters, they form an integrated f-2f referencing circuit that permits the detection of the carrier-envelope offset of the mode-locked laser.

Poster 26

Vertically-Stacked Anti-Polar Diode(VAD) Pixel for Organic Semiconductor Image Sensors

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An imaging sensor with hemispherical focal plane array (FPA) can not only create a wide FOV but also acquire a better image quality by reducing aberration. Also, by providing another degree of freedom can reduce lenses complexity for low cost and highly compact image system. Organic photodetectors(OPDs) have benefits in flexible sensors area compared to conventional inorganic sensors but lack of ability being scaled into an array due to immature thin film transistors(TFTs). The objective of this effort is to develop a pixel structure based on OPDs that can be readily fabricated onto a hemispherical surface for curved image sensors. A vertically-stacked anti-polar diode pixel architecture is being developed to provide a high fill-factor, 2-terminal device that can be fabricated on a hemispherical surface using existing high-resolution patterning techniques for OPDs.

Poster 27

Broadband Photon-Pair Generation on a Silicon Chip using Nanophotonic Periodically-Poled Lithium Niobate Waveguides

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The on-chip generation, manipulation, and detection of quantum states of light via photon-pair sources, passive waveguiding elements, such as interferometers, frequency splitters, electro-optic switches and single-photon detectors, holds great promise for quantum information processing. Such quantum-photonic chips readily benefit from well-established semiconductor manufacturing techniques. Here, we present a new class of photon pair sources on a silicon chip. The source is based on nanophotonic periodically-poled lithium niobate waveguides and presents MHz rate pair generation. We spectrally resolve the second-order coherence of broadband biphoton pairs using a time-of-flight fiber spectrometer. Spectrally resolved coincidence-to-accidental ratios of over 300 are measured. Our source establishes a new platform for efficient and scalable integrated quantum-photonics in conjunction with our previous demonstrations of high-speed electro-optic modulators and versatile nonlinear optical frequency converters.an average of two photons. Unfortunately, such quantum super-sensitivity is highly vulnerable to the slightest decoherence effect, particularly at certain phase values – blind spots – where sensitivity to small drifts in the value of the optical phase lost entirely. This difficulty is often addressed by use of a reference phase within the interferometer. Here we show through numerical simulations that we can instead use an ancilla – another degree of freedom, such as photon polarization – that can be tweaked at the input and output ports of the interferometer to maximize the precision. Through calculation of the Fisher information, we show that globally super-sensitive unbiased estimators are attainable for a range of decoherence probabilities. Furthermore, we also present simulations of an adaptive measurement scheme that can achieve super-sensitivity using this process without prior information or a reference phase.

Poster 28

Evaluation of Triangle Orientation Discrimination for Field Testing of Imager Performance

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Triangle orientation discrimination (TOD) is an observer task useful for characterizing the practical performance of electro-optical imaging systems. We generated simulated imagery of TOD targets viewed at various ranges through a High Definition Longwave (HDLW) imaging system. The simulated imagery was presented to human subjects in a TOD experiment, and the probability of identification (PID) was determined as a function of range. We present the PID curves and show that TOD is suitable for field testing of ID range.

Poster 29

Broadband Near-Infrared Supercontinuum for Z-Scan Nonlinear Spectroscopy

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Broadly tunable and high power laser sources are of great interest for nonlinear characterization of materials. Additionally, using a single beam that contains a broadband spectrum with sufficient spectral energy density to replace optical parametric generators/amplifiers is our starting point for this work. Using a single-filament supercontinuum (SC) generated in gas is a good method to obtain high spectral brightness for this purpose. Supercontinuum generated in condensed materials has been demonstrated thoroughly, but the low damage threshold has limited the use as a tunable source for nonlinear optics applications. Supercontinuum generated in gases for tunable Z-scans was previously presented by Balu et al. [1], where a femtosecond pulse centered at a wavelength of 775 nm was used to create the SC across the visible. Ensley et al. [2] also demonstrated energy and spectral enhancement in the visible and near-infrared (IR) by pumping at 780 nm and introduced a weak seed pulse at 650 nm, extending the usable range of SC from 300 nm to 1100 nm. In this work, we present IR-SC generation in the range 800 – 1600 nm by pumping at 1800 nm in Krypton (Kr) gas and prove its applicability by performing Z-scans to measure two-photon absorption (2PA) and nonlinear refraction in Gallium Arsenide (GaAs).

References

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[2] T. R. Ensley, D. A. Fishman, S. Webster, L. A. Padilha, D. J. Hagan, and E. W. Van Stryland, "Energy and spectral enhancement of femtosecond supercontinuum in a noble gas using a weak seed," *Opt. Express*, vol. 19, no. 2, p. 757, Jan. 2011.

Poster 30

Anisotropic Polarization Dependence of High Harmonic Generation in Ferroelectric Crystal BaTiO3

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Following the 2011 discovery of high-order harmonic generation (HHG) in a bulk crystal, the properties of HHG have been investigated in different condensed matter systems. Unlike atomic gases which give rise to only odd harmonic orders, solids which lack inversion symmetry enable the generation of both odd and even harmonics. The polarization states of even harmonics have been recently investigated in non-centrosymmetric crystals, and the observation of perpendicularly-polarized harmonics, with respect to the driving laser polarization, can be seen as a manifestation of the Berry phase. Ferroelectric crystals offer a unique opportunity to control HHG using symmetry, as they exhibit spontaneous permanent dipole moment that is controllable by an external electric field. Here, we study mid-IR driven high harmonic generation from the ferroelectric crystal BaTiO3. We observe anomalous behavior in the driving laser polarization-dependent harmonic spectra, and in the polarization states of odd and even harmonic orders, which are unlike that observed in other bulk sample

Lab Tours

TOUR A **Start times:** **2.30 pm** and **3.30 pm**

243 **Plasmonics and Applied Quantum Optics Lab**
Mercedeh Khajavikhan
paqo.creol.ucf.edu

201 **Fiber Optics Lab**
Axel Schulzgen
fol.creol.ucf.edu

A325 **NanoBioPhotonics Laboratory**
Ryan Gelfand
nbp.creol.ucf.edu

A326/7 **Optical Nanoscopy Lab**
Kyu Young Han
nanoscopy.creol.ucf.edu

TOUR B **Start times:** **2.30 pm** and **3.30 pm**

263 **Microdroplet Superlens for Nanomanufacturing**
Aravinda Kar
lamp.creol.ucf.edu

255A **Optical Frequency Synthesizer**
Peter Delfyett
up.creol.ucf.edu

246 **Ultrafast Laser Processing Laboratory**
Xiaoming Yu
ulp.creol.ucf.edu

202 **Integrated Photonics and Energy**
Sasan Fathpour
ipes.creol.ucf.edu

Laboratories and 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. Other facilities, like the Optical Materials Laboratory (pictured below) are located on the main UCF campus.

College 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 facility equipment includes a Suss MJB-3 and MJB-4 aligners, 2 Plasma-Therm 790 RIE systems with silicon and III-V etching capabilities, a Temascal and V&N E-beam evaporators, along with an atomic force microscope, a profilometer, a rapid thermal annealer, a bonder, a scriber and microscope. 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 containing class 100 and class 10,000 cleanrooms. Used in the development of optoelectronic semiconductor devices. The facility includes a Suss MJB-3 aligner, a Plasma-Therm 790 RIE/PECVD, an Edwards thermal evaporator, and a bonder, 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 fidelity 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

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.

Optical Materials Laboratory (OML)

The Optical Materials Laboratory (OML) is a new 4,000 square-foot facility with state-of-the-art laboratory fabrication and characterization capabilities for research in optical ceramics, IR glasses and glass-ceramics as well as optical fibers. It features dedicated ceramic laboratories with extensive powder processing and sintering equipment, IR glass and glass-ceramic advanced manufacturing, and cutting-edge MOCVD fiber-preform fabrication laboratory. These laboratories also include dedicated analytical tools and post-processing capabilities offering student training opportunities in these areas. The OML is located on the UCF main campus (Building 154 on 12765 Ara Drive) in close proximity to the Material Characterization Facility (MCF).

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

Zygo Facility

Rm 211B. Shared facility administered by Martin Richardson.

TOWNES INNOVATIVE SCIENCE & TECHNOLOGY FACILITY (TISTEF)

The TISTEF site is a secure facility located at the Kennedy Space Center, Florida. It was a Navy SSC PAC operated facility, but is now an Air Force facility on NASA property, managed and operated by UCF. TISTEF was originally built in 1989 to support the Strategic Defense Initiative Organization's Innovative Sciences and Technology Office (SDIO/ISTEF). Today TISTEF has a much broader mission; it supports research and development of electro-optics sensing technologies for DOD, commercial and academic applications. DOD customers include: the Army, Navy Air Force, DARPA, and DIA. The facilities include a laser and optics laboratory, a 1 km laser test range, a precision tracker (gimbal) with a 0.5 meter telescope and coude mirror path (for laser transmission), and several transportable trackers capable of supporting active (laser) or passive testing at remote sites. Additionally, TISTEF maintains an assortment of telescopes, optics, and sensors to support various data collection requirements. Since TISTEF is a tenant of the 45th Space Wing and NASA, operating agreements are in place that permit tasking AF Eastern Range and NASA assets as needed. It also has standardized range operations and procedures for laser testing against boosting rockets, satellites, and other terrestrial targets. TISTEF has a close partnership with the CREOL which provides access to cutting edge R&D and expertise in atmospheric propagation of lasers, laser communications, laser radar (LADAR), fiber-optic lasers, passive imaging, and optical design.

FACULTY FACILITIES

DIFFRACTIVE AND HOLOGRAPHIC OPTICS LAB

Conducting rigorous analysis, design, and demonstration of diffractive and holographic optical elements, subwavelength grating structures and their applications, E-M theory of grating diffraction, holographic optical information processing and storage, volume holography. Leonid Glebov.

DISPLAY AND PHOTONICS LAB

Developing 1) Advanced displays including LCDs, quantum dots, perovskites, LEDs, OLEDs, augmented reality and virtual reality, and sunlight readable displays, 2) Adaptive lenses for tunable-focus lens, optical imaging and light field displays, and 3) Adaptive optics for wavefront correction and laser beam control. Shin-Tson Wu.

FIBER OPTICS LAB

Research in fiber fabrication technology, nano-structured fibers, nonlinear fiber materials, fiber lasers, and fiber sensing applications. Axel Schülzgen and Rodrigo Amezcua.

FLORIDA ATTOSECOND SCIENCE AND TECHNOLOGY LAB

Generation of attosecond (10-18 s) and zeptosecond (10-21 s) X-ray pulses. Zenghu Chang.

GLASS PROCESSING AND CHARACTERIZATION LABORATORY (GPCL)

Investigating the design, processing methodologies, fabrication and characterization of novel oxide and non-oxide glass and glass ceramic materials for the infrared. Applications include, on-chip sensors, bulk and film materials for GRIN, optical nanocomposites, 3D printing of chalcogenide materials. Kathleen Richardson.

INTEGRATED PHOTONICS & ENERGY SOLUTIONS LAB

Specializing in fundamental and technological aspects of silicon-based optoelectronic devices and chips, including their energy efficiency issues. The lab encompasses near- and mid-infrared setups for characterizing the devices fabricated in CREOL's Nano Fabrication Facility. Sasan Fathpour.

LASER ADVANCED MATERIAL PROCESSING (LAMP)

Engaged in novel manufacturing technology; new materials synthesis including optical, electronic and magnetic materials for a variety of applications such as sensors, detectors and medical devices; and process physics modeling. Aravinda Kar.

LASER AIDED MATERIALS PROCESSING LABS
Investigating the interaction of lasers with absorbing and non-absorbing materials, growth, solidification, and plasma effects; laser CVD; laser ablation, laser drilling, cutting, welding; developing process-monitoring and diagnostic techniques. Stephen Kuebler (NPM) and Martin Richardson (LPL).

LASER PLASMA LAB
Conducting research on X-ray and EUV optics and sources, X-ray microscopy, laser-aided material processing, and laser generated plasmas. Martin Richardson.

LASER SYSTEM DEVELOPMENT LABS
Developing new solid-state lasers, external cavity semiconductor lasers and amplifiers, seeding lasers, laser-induced damage, far infrared semiconductor lasers, high-average-power solid state lasers, semiconductor and solid state volume Bragg lasers, high power laser beam combining, ultra-high-intensity femtosecond lasers, new solid state lasers and materials development (crystals & glasses). Michael Bass, Martin Richardson, Peter Delfyett, Leonid Glebov.

LIQUID CRYSTAL DISPLAY LAB
Investigating 1) advanced liquid crystal display materials, display devices, and device modeling, 2) electronic laser beam steering and adaptive optics using fast-response spatial light modulators, 3) adaptive liquid crystal and liquid lenses for forveated imaging and zoom lens, and 4) bio-inspired tunable optical filters using cholesteric liquid crystals. Shin-Tson Wu.

MID-INFRARED COMBS GROUP (MIR)
Broadband mid-infrared ($\lambda > 2.5$ μm) frequency combs generation based on subharmonic optical parametric oscillators. Trace molecular sensing and coherent dual-comb spectroscopy using octave-wide MIR combs. Biomedical applications of frequency combs. Photonic THz wave generation and THz imaging. Nano-IR spectroscopy. Konstantin Vodopyanov.

MULTI-MATERIAL OPTICAL FIBER DEVICES LAB
Research on novel optical fiber structures, nanophotonics, fiber-based optoelectronic devices, optical imaging using large-scale three-dimensional arrays constructed from photosensitive fibers, and mid-infrared fiber nonlinear optics. Ayman Abouraddy.

MULTIPLE QUANTUM WELLS LAB
Research on the design, fabrication and testing of novel all-optical switching devices using III-V multi-quantum well semiconductors, and the integration of high-speed optical and optoelectronic devices to form monolithic integrated optical circuits for high data throughput optical networks. Patrick LikamWa

NANOPHOTONIC DEVICES LAB
Research in epitaxial growth and properties of oxide semiconductors, oxide and nitride-semiconductor light emitting diodes, self-assembled quantum dots, and e-beam nano-lithography. Winston Schoenfeld.

NANOBIOPHOTONICS LAB (NBPL)
Developing nanoaperture optical trapping based single molecule biophysics methods for studying protein dynamics, structure, and behavior; protein-protein and protein-small molecule interactions; drug discovery; and fundamental life sciences. Ryan Gelfand

NANOPHOTONICS CHARACTERIZATION LAB
Optical analysis tools for investigation of nanostructured devices including Near-field Scanning Optical Microscope, fiber-coupled microscope for single particle spectroscopy, leakage radiation setup for surface plasmon imaging, near-infrared waveguide analysis setup, and variable temperature photoluminescence setup. Projects include manipulation of surface plasmon dispersion in nanoscale thin films, enhancement of erbium excitation in semiconductor nanocrystal doped oxides, and enhancement of optical nonlinearities using plasmon resonances. Pieter Kik.

Nonlinear Optics Labs
Conducting research on a variety of nonlinear optical effects, materials, and devices including nonlinear interactions in waveguides, optical power limiting, and characterizing materials response at femtosecond, picosecond and nanosecond scales. Eric Van Stryland, David Hagan, MJ Soileau.

Nonlinear Waves Lab
Research in nonlinear optics, spatial and spatio-temporal solitons, discrete solitons in photonic lattices, and curved beams. Demetrios Christodoulides.

Optical Ceramics Lab
Conducting research on the synthesis of transparent ceramics, powder processing, ceramic casting, vacuum and pressure sintering, diffusion bonding, dopant diffusion, and crystal growth for laser and nuclear detector applications. Romain Gaume.

Optical Communication Lab
High-capacity optical communication through linear and nonlinear channels including free space and optical fiber using synergy of advanced optical and electronic techniques. Guifang Li.

Optical Glass Sciences & Photo-Induced Processing Lab
Conducting studies of new materials for high-efficiency, robust holographic optical elements; high power laser beam combining, glass spectroscopy, refractometry and interferometry; photo-induced processes in glasses; technology of optical quality and high-purity glasses. Leonid Glebov.

Optical Imaging System Laboratory
Creating novel imaging systems by integrating physical coding and computational methods for biological research, medical diagnosis, and industrial imaging applications in both visible and X-ray regimes. Shuo “Sean” Pang.

Optical Nanoscopy Lab
Developing and applying novel optical tools such as fluorescence nanoscopy (super-resolution imaging) and single-molecule imaging to study essential problems in biology and neuroscience. Kyu Young Han

Optical Imaging System Lab (OISL)
Research in OISL is focused on developing computational imaging platforms for biomedical research, medical diagnosis, and industrial imaging applications in both visible and X-ray regimes. Research topics include Computational Imaging, Coded Aperture, X-ray Tomography, X-ray Scatter Imaging, Fluorescence Microscopy, Lens-less Optical Imaging, Bio-sensor and Portable Imaging Devices. Shuo “Sean” Pang

Plasmonics and Applied Quantum Optics Lab
Developing nanoscale emitters using metallic structures, study the dynamic response of nanoscale lasers. Generation and characterization of non-classical light. (Mercedeh Khajavikhan) (PAQO).

Photonics Diagnostic of Random Media
Exploring different principles for optical sensing, manipulation of electromagnetic fields, and phenomena specific to optical wave interactions with complex media. Aristide Dogariu.

Quantum Optics Lab
Conducting research on the generation and detection of nonclassical light, such as entangled photons, and its quantum information applications, including quantum imaging and quantum communication. Bahaa Saleh, Ayman Abouraddy.

Semiconductor Lasers Lab
A III-V epitaxial growth facility used to research new types of semiconductor heterostructures and devices that include quantum dots, quantum dot laser diodes, vertical-cavity surface-emitting laser diodes, spontaneous light sources, and single quantum dots. A characterization laboratory is used to study the optical properties of the samples, including their light emission, microcavity effects, and laser diode characteristics. Dennis Deppe.

Thin-Film Optoelectronics Lab
Developing novel optoelectronic materials and devices for sensors, solar cells, lighting and

displays that are large area, flexible, cost-effective and efficient. Kyle Renshaw

ULTRAFAST PHOTONICS LABORATORY

Conducting research on ultrafast high power optical pulses from semiconductor diode lasers, for applications in applied photonic networks and laser induced materials modification. Peter Delfyett.

INSTRUCTIONAL LABORATORIES

APPLIED OPTICS LABORATORY

Laboratory techniques for observing optical phenomena and quantitative experimental study of geometrical optics, optical interferometry, diffraction, and image processing.

LASER ENGINEERING LABORATORY

Designing and device implementation of diode pumped solid state lasers, nonlinear frequency conversion, Q-switching, mode locking, and pulse second harmonic generation.

PHOTONICS LABORATORY

Experimental study of photonic devices and systems including liquid crystal displays, fiber-optic sensors, laser diodes, electro optic modulation, acousto-optic modulation, lightwave detection, optical communications, and photonic signal processing.

OPTOELECTRONIC DEVICE FABRICATION LABORATORY

Design and micro-fabrication of semiconductor optoelectronics devices including passive waveguides, light emitting diodes (LEDs), laser diodes (LDs), photodetectors. Prerequisite Course: Graduate standing or consent of the instructor.

UNDERGRADUATE LABORATORY

A multipurpose space that accomodates laboratory courses for Optoelectronics, Fiber Optics, Introduction to Photonics, Laser Engineering, and Imaging and Display. The space includes basic instrumentation necessary to conduct experiments.

SENIOR DESIGN LABORATORY

Comprised of six laboratory benches, the Senior Design laboratory space is designed to permit students with flexibility to design, test, and contstruct their Senior Design projects. Students have access to this space in the semester in which they are enrolled in OSE 4951 and OSE 4952, the Senior Design Courses. They are able to work in this space at any time, day or night.

Building Map

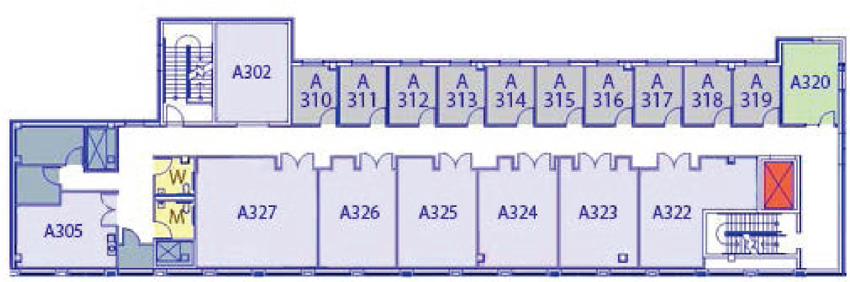
First Floor

Building Map

Second Floor

Building Map

Third 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 Symposium
- 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 Symposium
- 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

ALIO Industries
Breault Research
Coherent, Inc.
Newport Corporation
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Futurewei Technologies
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LAS-CAD GmbH
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Optimax Systems
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Zygo Corporation

Affiliate Members

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HORIBA Jobin Yvon
IRadiance Glass, Inc.
JENOPTIK Optical Systems Inc
Laser Institute of America
LightPath Technologies Inc.
Menlo Systems, Inc.
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Ophir-Spiricon
Optigrate Corp.
OSA IDA
Photon-X
Photonics Media
Photonics Online
Plasma-Therm
Plasmonics
Princeton Instruments
QPeak, Inc.
SPIE- The Int'l Society for Optics & Photonics
The Optical Society
Thorlabs
Tower Optical Corporation
TwinStar Optics, Coatings & Crystals
ULVAC Tech. Inc.
Yokogawa Corp. 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.org) is dedicated to serving the industry and to making Florida the place to go for photonics solutions.

Innovation Economy

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

Top Quality of Life & Great Place for Photonics

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

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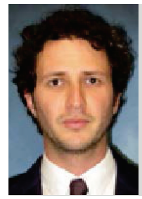

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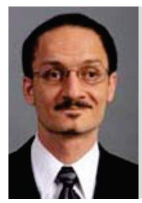

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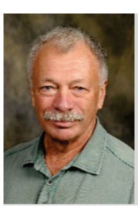

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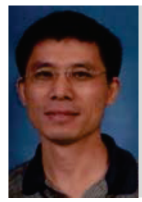

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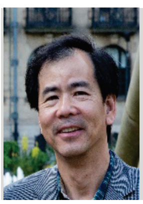

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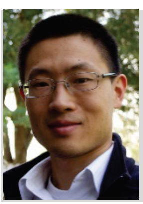

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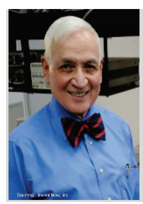

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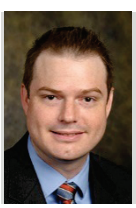

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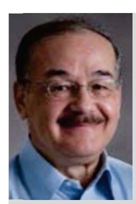

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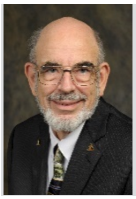

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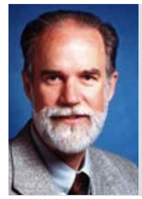

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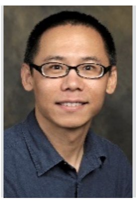

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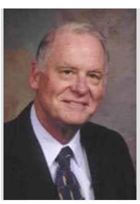
Faculty Emeritus



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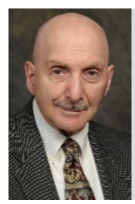

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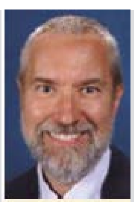

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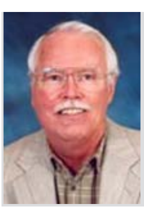

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George I. Stegeman
In Memorium

Thank you for attending!

We look forward to seeing you at our next
CREOL Industrial Affiliates Symposium
March 14-15, 2019

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