



CENTER FOR EMERGING AND INNOVATIVE SCIENCES

UNIVERSITY TECHNOLOGY SHOWCASE

Thursday, April 10, 2014

RESEARCH FOCUS AREAS

OPTICS, PHOTONICS, AND IMAGING

BIOMEDICAL TECHNOLOGY

MICROELECTRONICS, SOFTWARE, AND
COMMUNICATIONS

ENERGY AND MATERIALS

WELCOME

Dear Colleagues,

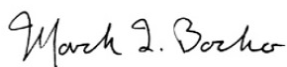
Welcome to the 14th annual University Technology Showcase sponsored by the Center for Emerging and Innovative Sciences at the University of Rochester, a New York State Center for Advanced Technology. This year's event features over 50 presentations representing a sampling of the high quality applied research being conducted at the University of Rochester, the Rochester Institute of Technology, Cornell University, and University at Buffalo. The purpose of this annual event is to provide a forum where people from the business community can learn about work taking place at these great research universities. This also provides an opportunity for members of the business and academic communities to meet and discuss topics of mutual interest. We hope that these discussions will lead to continued interactions that will allow companies to tap into the wealth of technology and expertise available at these institutions. The ultimate goal of today's event is to help the region and the State to incubate, grow, and attract businesses, resulting in job growth and economic expansion.

The format of this year's event is a bit different than in past years. We are kicking off the event today with a panel discussion of industry, government and university leaders on the topic, "How can Universities and Companies work together to rebuild manufacturing in the US?" This will be followed by the poster session. As in past years, we have broken up the research projects into four areas: optics, imaging, and photonics; energy and materials; biomedical technology; and IT. These groupings will help direct you to the areas that interest you the most, but we encourage you to spend time looking at posters in all areas because innovation often comes from applying knowledge in one area to solve problems in another. We're also very pleased to announce that this year due to the generosity of the Woods Oviatt Gilman Law Firm we are able to offer an award of \$500 to the best poster, as judged by a panel of experts from industry and economic development organizations.

The technology showcase is just one way that CEIS works to foster industry-university collaboration and technology transfer. Our primary role is to provide NYS matching funds for company-sponsored research on campus. Over the past 5 years CEIS has helped support collaborations with over 70 NYS companies at UR, RIT, Cornell, and other NYS Universities. We also sponsor workshops and seminars that bring people from industry and academia together to discuss opportunities for technology-driven economic development. This past year CEIS has also expanded our role in the community by leveraging federal funds to help grow the region's optics, photonics, and imaging cluster. Feel free to stop by the CEIS table to learn more about these efforts and discuss ways that CEIS can help you to achieve your objectives.

Finally, we greatly appreciate your feedback and encourage you to fill in one of the forms handed out at the registration table or to go on line and complete the survey.

Warm Regards,



Mark Bocko, PhD
Director, CEIS



Paul Ballentine, PhD
Deputy Director, CEIS

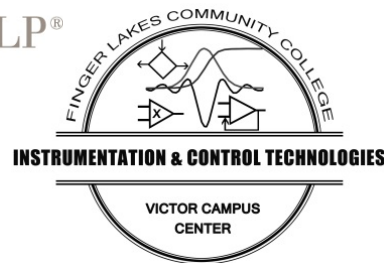
SUPPORTERS



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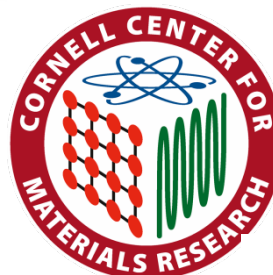
New York State Center of Excellence
in **Bioinformatics**
& Life Sciences



Maggie Brooks
County Executive



MASTER OF SCIENCE
TECHNICAL ENTREPRENEURSHIP AND MANAGEMENT



Economic
Development Center



URVentures



↑ Lobby ↑

T17
CEIS /
RRPC

Optics, Photonics,
Imaging and Displays
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Biomedical Engineering
23-37

Electrical Engineering, Computer
Engineering and Computer Sciences
38-45

Chemical Engineering, Mechanical
Engineering and Materials Science
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TECHNOLOGY SUPPORTERS

- T 1 **Woods, Oviatt, Gilman, LLP**
- T 2 **High Tech Rochester (HTR)**
- T 3 **Excell Partners, Inc.**
- T 4 **UR Ventures**
- T 5 **Monroe County Finger Lakes Procurement Technical Assistance Center, (PTAC) / Monroe County Economic Development**
- T 6 **Center for Integrated Research Computing (CIRC)**
- T 7 **Center for Medical Technology and Innovation (CMTI)**
- T 8 **CNSE's Smart Systems Technology & Commercialization Center (STC)**
- T 9 **Cornell Center for Materials Research (CCMR)**
- T 10 **RIT Offices of Research Relations and Technology Transfer**
- T 11 **Eastman Business Park**
- T 12 **Canandaigua National Bank & Trust**
- T 13 **University of Buffalo's Center for Excellence in Bioinformatics & Life Sciences**
- T 14 **University of Rochester Center for Entrepreneurship/ Technical Entrepreneurship and Management (TEAM) M.S. Program at the University of Rochester**
- T 15 **FLCC's Victor Campus Center Instrumentation and Control Technologies Program**
- T 16 **Genesee County Economic Development Center (GCEDC)**
- T 17 **Center for Emerging & Innovative Sciences / New York Photonics Rochester Regional Photonics Cluster**

TECHNOLOGY SUPPORTERS

T 1 **Woods, Oviatt, Gilman LLP**

Woods, Oviatt, Gilman LLP is a full-service law firm and has been serving the Rochester Community since 1852. Our Patent Attorneys represent companies in a variety of intellectual property matters. We have worked with companies in industrial, retail, and medical industries to obtain and protect intellectual property including trade secrets. Additionally, we assist companies in protecting their intellectual property from undesired exploitation by employees, independent contractors and third-parties.

T 2 **High Tech Rochester (HTR)**

High Tech Rochester (HTR) is a not-for-profit economic development organization and is an authorized center of the NIST funded Manufacturing Extension Partnership (MEP), a manufacturing assistance program. HTR Growth Services provides support in areas such as strategic planning, quality system development, sales and marketing, product development and productivity improvement to all types of manufacturers in the Finger Lakes Region. HTR also runs the Lennox Tech Enterprise Center and the Rochester Bioventure Center in Henrietta, business incubators for high tech start-ups.

T 3 **Excell Partners, Inc.**

Excell is a Seed Stage Venture Capital Fund investing in high-tech ventures across Upstate NY. In addition to generating returns to its investors, Excell focuses on economic development and job creation to support Upstate NY's growth.

Excell has \$10M under management and has been recently ranked as one of top 20 most active seed investors in the country - focused on investing in startups located between Buffalo and Albany, NY.

A tremendous research base exists in Upstate NY which generates commercializable technologies. Excell Partners, through its affiliation with the University of Rochester and partnership with UB, RIT, Syracuse University, Cornell University and other leading research institutions across Upstate NY, is positioned to tap into this research base, help identify promising technologies, and accelerate the creation of new technology-based businesses which offer high potential for commercial success. In particular, we provide the financing necessary to launch these companies and link them with the critical services, mentoring, and follow-on capital they need to become self-sustaining businesses.

T 4 **UR Ventures**

UR Ventures is the team that facilitates the protection of Intellectual Property and the commercialization — or transfer — of technologies resulting from the cutting-edge research being conducted by our world-class scientists, faculty, and staff here at the University of Rochester. We are here to translate scientific innovation into tangible products or methods that advance knowledge and serve the public good while returning income to the inventor and to the University to support further research.

TECHNOLOGY SUPPORTERS

T 5 Monroe County Finger Lakes Procurement Technical Assistance Center (MCFL PTAC) / Monroe County Economic Development

Monroe County Finger Lakes Procurement Technical Assistance Center (PTAC) serves as the official procurement technical assistance center for the Finger Lakes Region.

PTAC helps businesses sell their products and services to federal, state and local governments, and the military marketplace.

There is no fee for MCFL PTAC services:

- Assess Readiness
- Analyze Market Opportunities
- Assist with Registrations and Proposal Development
- Identify Bid Leads
- Connect with Government Buyers and Prime Contractors

www.monroecountyfingerlakesptac.org

Monroe County Economic Development's purpose is promoting and providing economic development opportunities within the County of Monroe, providing additional employment and job opportunities. Through the Monroe County Industrial Corporation (MCIDC), financial assistance is provided to small businesses demonstrating a need that cannot be met entirely from conventional financing sources. The County of Monroe Industrial Development Agency (COMIDA) provides assistance to qualified applicants/projects via tax exemptions and real property tax abatements.

T 6 Center for Integrated Research Computing (CIRC)

The University of Rochester established the Center for Integrated Research Computing (CIRC) to provide researchers with technology, software, training, and support necessary to utilize high-performance computing (HPC) and data science technology in research activities in all areas of academic scholarship. CIRC currently maintains systems with an aggregated computational performance of about 420 teraFLOPS (including a leadership-class IBM Blue Gene/Q supercomputer), 2.2 petabytes of disk storage, and a variety of scientific software applications and tools. CIRC hosts a number of collaborative events to help the research community learn how to use computing technology in research and development projects. Consultants and computing time are available to help enable research projects at the University and its business partners.

TECHNOLOGY SUPPORTERS

T 7 **Center for Medical Technology and Innovation (CMTI)**

The University of Rochester's CMTI provides a cross-campus collaborative environment that unites the talents and resources of the Edmund A. Hajim School of Engineering & Applied Sciences and the School of Medicine & Dentistry with industry partners to improve clinical care. At the heart of this mission is a one-year Medical Technology & Innovation Master's Degree Program in Biomedical Engineering focused on medical device development and commercialization. Students begin the program with an 8-week immersive clinical practicum where they shadow URMIC surgeons to identify unmet needs. In the remaining two semesters they create new devices that solve problems in the clinic, while traversing the processes of market analysis, device approval, and clinical trials. The benefits are twofold: we better prepare students for the medical device industry and we reduce the risk of commercializing technology by adopting an industry-based product development strategy.

T 8 **CNSE's Smart Systems Technology & Commercialization Center (STC)**

In 2010, Smart Systems Technology & Commercialization Center (STC) was created through a merger of New York State's Center of Excellence, the Infotonics Technology Center (ITC) in Canandaigua, with the SUNY College of Nanoscale Science and Engineering (CNSE). This allowed for a natural alignment of STC with CNSE's NYS Center of Excellence in Nanoelectronics and Nanotechnology.

This merger creates a vertically integrated "one-stop-shop" positioning New York State as the global leader in smart system and smart device innovation and manufacturing. These capabilities are unmatched the world over, providing the capacity, infrastructure and operational capabilities to create immediate job and investment opportunities in all areas of semiconductor and advanced manufacturing, covering a diverse number of markets including aerospace, biomed, display, communications, defense, and energy.

Located just outside of Rochester, NY, STC's 120,000-square-foot, state-of-the-art facility includes over 30,000 square feet of certified cleanroom space with 150mm and 200mm MEMS foundry services, complemented by a dedicated 8,000-square-foot MEMS and optoelectronic packaging facility. STC also maintains a facility-wide security clearance and is a Defense Department accredited "Trusted" supplier for post-CMOS processing/MEMS integration, microelectronics packaging and assembly, and aggregation services.

T 9 **Cornell Center for Materials Research (CCMR)**

The Cornell Center for Materials Research (CCMR) is funded by the National Science Foundation. While its primary mission is to perform cutting-edge materials research, the center also provides: educational outreach to undergraduates, as well as K–12 teachers and students; support for a broader Materials Science community through the availability of laboratory facilities and instruments; and industrial outreach. The NYSTAR-funded CCMR Industrial Partnerships Program promotes technology transfer and economic development by offering low-cost programs for NY State small businesses, enabling product development as well as expansion to wider markets.

TECHNOLOGY SUPPORTERS

T 10 **RIT Offices of Research Relations and Technology Transfer**

Welcome to RIT's Intellectual Property Management Office (IPMO), and Sponsored Research Offices (SRO); IPMO is responsible for managing RIT's intellectual property (IP) portfolio and bringing that IP to the marketplace through licenses and formation of start-up companies. SRO is responsible for connecting RIT's faculty to companies for sponsored research projects. We are happy to make connections to RIT research faculty across RIT's campus – Imaging, Computing, Sustainability, Microsystems, Engineering, Science and Biomedical topic areas plus many more – see our website at www.RIT.edu/research.

T 11 **Eastman Business Park**

Join Eastman Business Park and leverage our 100+ years of deep technical expertise in materials science and ground-breaking technologies in a variety of areas including thin films, coating, imaging, and specialty chemicals. Our center for clean technology features a comprehensive suite of pilot tools, technical and analytical support, low-cost facilities, self-generated utilities, and superior services and amenities — all available for the development and commercialization of your products. Leveraging the benefits of this incredible innovation ecosystem lets you focus your resources on speeding your materials to market.

T 12 **Canandaigua National Bank & Trust**

As the only local, full-service, community-owned financial institution in the Rochester area, Canandaigua National Bank & Trust is investing in you, your business, and your community through our products, personal service, technology, and community support. Our Core Values represent who we are and what we do, each and every day. That's what makes us different from our competitors. Before making any business decision, we carefully consider how it will affect the people who rely on us the most: our valued customers, the communities we serve, our employees, and shareholders. Visit CNBank.com for more information.

TECHNOLOGY SUPPORTERS

T 13 **University of Buffalo's Center for Excellence in Bioinformatics & Life Sciences**

The creation of the University at Buffalo's Center for Excellence in Bioinformatics & Life Sciences was proposed in 2001 by New York State Governor George Pataki as part of a statewide program to develop the region's technology resources and foster economic development by laying the foundation for a new life sciences economy in Buffalo Niagara and across the state. This mission is being achieved by connecting university resources with life sciences and high-tech industry. Through funding, research and development, programming and education, we help companies find business solutions to accelerate new innovative ideas and grow.

Established in 2012, the University at Buffalo's New York State Center of Excellence in Material Informatics plays a significant role in spurring economic development regionally and across the globe by connecting companies with UB'S vast research and development assets to facilitate relationships between private industry and the material scientists who are making the next great breakthroughs in technology with a focus on three key segments; advanced manufacturing, life sciences and clean energy.

To learn more about UB's NYS Center of Excellence in Bioinformatics & Life Sciences visit www.bioinformatics.buffalo.edu or contact Kim Grant, Business Development Executive at 716.888.4864. To learn more about UB's NYS Center of Excellence in Materials Informatics visit www.buffalo.edu/materials-informatics or call Christopher Janson, Business Development Executive at 716.888.4795.

T 14 **University of Rochester Center for Entrepreneurship/ Technical Entrepreneurship and Management (TEAM) M.S. Program at the University of Rochester**

The University of Rochester Center for Entrepreneurship, launched by a grant from the Ewing Marion Kauffman Foundation grant awarded to the University in 2003, serves to identify and create new partnerships with alumni, local businesses, and non-profit organizations; coordinates and publicizes school-based experiences, including courses and signature programming; informs faculty of grant and bridging fellowship opportunities; and encourages collaboration among the schools engaged in entrepreneurship education at the University of Rochester. Learn more online at www.rochester.edu/entrepreneurship. The Center also administers a joint business and engineering master's degree program, technical entrepreneurship and management (www.rochester.edu/team).

The University of Rochester offers a multidisciplinary engineering/business graduate program: the Master of Science in Technical Entrepreneurship and Management (TEAM). This program offers students the opportunity to immerse themselves in a technical concentration of their choice while receiving a strong foundation in entrepreneurial management. Through a fast-paced curriculum at the University's Hajim School of Engineering and Applied Sciences and the Simon School of Business, students can complete the 33-credit program in as little as one academic year. A three-semester option, which includes a summer internship, and part-time study are also available. Degree requirements include a one-semester practicum and written business plan and oral presentation. TEAM students also have access to a comprehensive career placement programming and staff.

TECHNOLOGY SUPPORTERS

T15 **FLCC's Victor Campus Center Instrumentation and Control Technologies Program**

In concert with businesses, the Instrumentation and Control Technologies program at FLCC Victor Campus Center is training adaptable technologists to help accelerate innovations critical for building a robust high-tech ecosystem.

T 16 **Genesee County Economic Development Center (GCEDC)**

The Genesee County Economic Development Center (GCEDC), formerly known as the Genesee County Industrial Development Agency, was formed in 1970 under Section 18-A of New York State's General Municipal Law and is the County's primary designated agency for the promotion of economic development and economic growth. The agency was reorganized to its current form in 1979. The GCEDC is governed by a seven member, non-compensated, Board of Directors that is made up of business and community leaders that are appointed by the Genesee County Legislature. GCEDC has shovel ready industrial sites:

Industry Focused Shovel-Ready Parks in Genesee County, NY

Agri-Business & Food Processing:

[The Genesee Valley Agri-Business Park](#)

Business Facilities: [Industry Focus: The Process of Food](#) touts Genesee County as the place to be for food processors

Life Sciences & Medical Device:

The 32 acres [Upstate MedTech Park and Dr. Bruce A. Holm Upstate Med & Tech Commercialization Centre](#)

Advanced Manufacturing & Nano-Technology:

The Buffalo East Tech Park and [Western New York Science Technology and Advanced Manufacturing Park](#)

Warehouse & Distribution:

[Apple Tree Acres, Gateway II, and O-AT-KA Hills](#)

T 17 **Center for Emerging & Innovative Sciences / Rochester Regional Photonics Cluster**

Center for Emerging & Innovative Sciences (CEIS)

The Center for Emerging & Innovative Sciences promotes economic development through industry-university collaboration and technology transfer. We are based at the Hajim School of Engineering & Applied Sciences at the University of Rochester. We are one of 15 Centers for Advanced Technology (CATs) funded by NYSTAR, a division of the New York State Department of Economic Development. We work primarily with faculty and scientists at the University of Rochester and the Rochester Institute of Technology although we do support some research at other universities in New York. And we work closely with small, mid-sized, and large companies in the Finger Lakes region and across the state.

#RochesterWinning; Authors: Ana Garcia, Rochester '13/KEY '14; Ervis Vukaj, Rochester '16; Nick Napolitan, Rochester '14/T5 '15

Abstract: The student research assistants at the Center for Emerging and Innovative Sciences have been conducting research into the Rochester region's business environment. Their research shows a thriving ecosystem with retained intellectual property, a robust Optics and Photonics cluster, an impeccable supply network for high-tech manufacturers, and an illustration of grant opportunities that our office annually works on. The research is eye opening and is crucial in presenting Rochester as a still strong business city. Our research also provides resources for investors and innovators alike to come together and grow their ideas and businesses.

The Rochester Regional Optics, Photonics, and Imaging Accelerator

The Rochester Regional Optics, Photonics, and Imaging Accelerator (or RRPA) is a program to help grow the Rochester cluster of companies in the OPI industries. The project is funded through an award from five different federal agencies with additional funding from New York State. The five federal agencies are the Economic Development Administration (EDA), NIST, DOE, the Employee and Training Administration (ETA) and the Small Business Administration (SBA).

These five agencies have teamed up in what is called the Advanced Manufacturing Jobs and Innovation Accelerator Challenge (AMJIAC). The purpose of this Challenge is to coordinate the governments' investments in economic development in some of the Nation's most important industrial clusters. Our proposal was one of only ten chosen and represents the federal government's strong commitment to the Rochester OPI cluster. The award is for \$1.9M over three years with an additional \$190K from the state. The RRPA brings together for the first time five leading regional organizations to help strengthen the region's OPI cluster of companies in a coordinated and comprehensive manner. The participating organizations are the University of Rochester, Rochester Institute of Technology, Monroe Community College, High Tech Rochester, and the Rochester Regional Photonics Cluster. The Accelerator program covers 4 key areas for the cluster: Cluster Development, Business Development, Technology Development, and Workforce Development.

New York Photonics / Rochester Regional Photonics Cluster (RRPC)

New York Photonics: Where entrepreneurial vision meets next-edge research.

New York has hundreds of optics, photonics and imaging companies clustered into active regional collaborations. These regions are home to hundreds of organizations and companies that can deliver complete R&D, engineering, and manufacturing capabilities providing you with synergy and efficiency.

The Rochester Regional Photonics Cluster (RRPC) is a not-for-profit organization founded to promote and enhance the New York State optics, photonics, and imaging industry by fostering the cooperation of business, academia and government. RRPC membership includes over 50 companies that supply optics, photonics, or imaging products and services and over 40 support companies. RRPC and CEIS work closely together with RRPC providing in depth knowledge and strong ties to the industrial community and CEIS providing the same with the academic community.

POSTER PRESENTATIONS

Optics, Photonics, Imaging and Displays

- 1 3-Dimensional Printing of Reflective Freeform Optics**
William E. Green¹, John C. Lambropoulos^{1,2} and Stephen J. Burns^{1,2}; ¹Department of Mechanical Engineering, University of Rochester, ² Center for Freeform Optics and Materials Science Program, University of Rochester
- 2 Impact of Annealing on Contact Formation and Stability of IGZO TFTs**
N. Walsh, T. Mudgal, and K.D. Hirschman, Rochester Institute of Technology, Electrical & Microelectronic Engineering Department; R.G. Manley, Corning Incorporated, Science and Technology
- 3 Slope-sensitive optical probe for freeform optics metrology**
Michael A. Echter, Precision Instrumentation Group, Mechanical Engineering, University of Rochester
- 4 Gabor-Domain Optical Coherence Microscopy and Applications**
Patrice Tankam, Jungeun Won, Ying-Ju Chu, Anand Santhanam, Cristina Canavesi, Jannick P Rolland, Institute of Optics, University of Rochester
- 5 Development of Glass Flat Panel Loudspeakers**
David Anderson, Stephen Roessner, Mark F. Bocko, Electrical and Computer Engineering, University of Rochester; (Research Sponsored by Corning Inc.)
- 6 Eikonal+: a computational research platform for freeform optical instrumentation**
Martin Huarte-Espinosa, Robert Gray, Daniel Nikolov, Miguel A. Alonso, Jon Petrucci, and Jannick P. Rolland, Institute of Optics, University of Rochester
- 7 Pulsed Terahertz Wave Emission from Thin Metal Films Excited by Two-Color Laser Fields**
Jianming Dai, and Xi-Cheng Zhang, Institute of Optics, University of Rochester
- 8 Efficient Terahertz Source**
Xuan (Betty) Sun, Xi-Cheng Zhang, Institute of Optics, University of Rochester
- 9 Terahertz-REEF Broadband coherent terahertz wave remote sensing spectroscopy**
Kang Liu, Fabrizio Buccheri, Xi-Cheng Zhang, Institute of Optics, University of Rochester
- 10 Cerium Oxide Polishing Slurry Reclamation: Process Improvements at Flint Creek Resources and Sydor Optics**
*Tess Jacobs^{1,4}, Mark Mayton², Zachary Hobbs³, Stephen Jacobs^{1,4}
¹Institute of Optics, University of Rochester, ²Flint Creek Resources, Inc., ³Sydor Optics, ⁴Laboratory for Laser Energetics, University of Rochester*
- 11 Measuring spatial coherence through the shadow of small obscurations**
James K. Wood, Katelynn A. Sharma, Miguel A. Alonso, Thomas G. Brown, Institute of Optics, University of Rochester
- 12 Confocal Microscopy in Turbid Media: Improving Contrast**
Andrew Vigoren, Physics & Astronomy and James Zavislan, Institute of Optics, University of Rochester

POSTER PRESENTATIONS

- 13 Further Development of THz Imager Array in Support of ITT Exelis' Commercial THz Development**
Zeljko Ignjatovic, Electrical and Computer Engineering, University of Rochester
- 14 Terahertz emission from a laser induced micro-plasma: scaling down the power budget for broadband terahertz spectroscopy**
F. Buccheri and Xi-Cheng Zhang, Institute of Optics, University of Rochester
- 15 Gradient index lens writing in ophthalmic hydrogels using femtosecond micromachining**
Daniel Brooks¹, Daniel Savage¹, Jonathan D. Ellis¹, and Wayne H. Knox^{1,2}; ¹Institute of Optics, ²Center for Visual Science, University of Rochester
- 16 Determining the Effects of Varying Machine Stiffness in UltraForm Finishing**
Dennis Briggs, Mechanical Engineering, University of Rochester
- 17 Sub-resolution measurements using a vortex coronagraph**
Garreth J. Ruane, Prachyathit Kanburapa, Jiaxuan Han, and Grover A. Swartzlander, Jr., Chester F. Carlson Center for Imaging Science, Rochester Institute of Technology
- 18 Amplitude, phase, and polarization control with a single spatial light modulator**
Stephen Head, Institute of Optics, University of Rochester
- 19 Single Pixel and Array Tests of a THz Imager**
Greg Fertig¹; Craig McMurtry²; Kenneth Fourspring³; Zoran Ninkov¹; Judith Pipher²; Zeljko Ignjatovic²; Chao Zhang¹; Jagannath Dayalu²; Dan Newman³; Andrew Sacco³; Paul Lee³; Mark Bocko²; ¹Rochester Institute of Technology; ²University of Rochester; ³Exelis Inc.
- 20 Quantum Dot Coated CMOS CID Arrays for the UV and VUV**
*Ross Robinson,^a Zoran Ninkov¹,^a Denis Cormier,^b Alan Raisanen,^c Suraj Bhaskaran,^d Carey Beam,^d Herb Ziegler,^d Uwe Arp,^e Robert Veste;^a Center for Imaging Science, Rochester Institute of Technology
^b Department of Industrial and Systems Engineering, Rochester Institute of Technology; ^c Department of Manufacturing and Mechanical Engineering Technology, Rochester Institute of Technology; ^d Thermo Fisher Scientific – CIDTEC; ^e Ultraviolet Radiation Group of the Sensor Science Division, NIST*
- 21 Numerical Wave Propagation using Hamiltonian Optics and Symplectic Integrators**
Manuel Garcia, Tecnológico de Monterrey, Photonics and Mathematical Optics Group
- 22 Mirror Swarm based Space Telescope**
Xiaopeng Peng and Grover A. Swartzlander, Jr; Chester F. Carlson Center for Imaging Science, Rochester Institute of Technology

POSTER PRESENTATIONS

Biomedical Engineering

- 23 Semiconductor Quantum Dot Based Near-Infrared Photoluminescent Medical Devices**
Brett Swartz, Department of Chemistry, University of Rochester
- 24 Influenza Surveillance and Serology via Arrayed Imaging Reflectometry (AIR)**
Joseph Bucukovski and Ben Miller, Biomedical Engineering, University of Rochester
- 25 A collaboration between Micropen Technologies and the University of Rochester Center for Medical Technology and Innovation to develop of a testing platform for a radiofrequency balloon catheter for renal denervation**
Laura K. Hobbs, and Greg T. Gdowski, Ph.D., Biomedical Engineering, University of Rochester; Lori Shaw-Klein, Ph.D., William J. Grande, Ph.D., MicroPen Technologies
- 26 Refractive index shaping in live cat cornea *in vivo***
Daniel E. Savage^{1, 2}, Daniel R. Brooks¹, Margaret DeMagistris³ Jonathan D. Ellis¹, Wayne H. Knox^{1, 2}, and Krystel R. Huxlin²; ¹ Institute of Optics, ² Center for Visual Science, ³ Flaum Eye Institute, University of Rochester
- 27 Responses of the Ocular Surface Temperature and Lipid Layer Thickness to Stressed Environmental Conditions in Normal and Dry Eyes**
Ranjini Kottaiyan¹; Holly Hindman^{1, 2}; Gheorghe Salahura^{1, 2}; James M. Zavislan^{2, 1}; Geunyoung Yoon^{1, 2, 3}; James V. Aquavella¹; ¹ Flaum Eye Institute, University of Rochester ² Center for Vision Science ³ Institute of Optics
- 28 Sonoelastography to Measure Intrahepatic Fat**
Christopher Barry, Zaegyo Hah, Alex Partin, KuangHsiang Chuang, Robert Mooney, WenQing Cao, Deb Rubens and Kevin Parker, University of Rochester
- 29 Privacy-Preserving Medical Cloud Computing Using Homomorphic Encryption**
Tolga Soyata, Electrical and Computer Engineering, University of Rochester
- 30 Enhancing Neural Function of Presbyopia by Improved Optics and Perceptual Learning**
Len Zheleznyak and Geunyoung Yoon, Institute of Optics, University of Rochester
- 31 Non-Invasive Fault Detection in an Axial Flow Blood Pump Used as a Ventricle Assistive Device**
Rohit Rana and Jason Kolodziej, Mechanical Engineering, Rochester Institute of Technology; Karl Q. Schwarz, MD, Echocardiography Laboratory, University of Rochester
- 32 A Novel Elastic Squeeze Film Total Hip Replacement**
Dr. Stephen Boedo, Mechanical Engineering, Rochester Institute of Technology
- 33 Designing and Building an Intelligent Mobility Cane Prototype for People who are Blind and Deaf-Blind**
Tae H. Oh, Dept. of Information Sciences and Technologies, Golisano Computing and Information Sciences Rochester Institute of Technology; Patricia Iglesias-Victoria, Dept. of Mechanical Engineering, Kate Gleason College of Engineering, Rochester Institute of Technology; Gary Behm, National Technical Institute for the Deaf (NTID) Engineering Studies Department, NTID Center on Access Technology, Rochester Institute of Technology

POSTER PRESENTATIONS

- 34 Magnetically Levitated Implantable Blood Pump**
Steven W. Day, Mechanical Engineering, Rochester Institute of Technology
- 35 Optical Prediction of Time to Metastasis Using Invasive Ductal Carcinoma Biopsy Specimens**
Kathleen Burke, Edward Brown, Department of Biomedical Engineering, University of Rochester
- 36 Small Fragment Removal for Next Generation Sequencing**
Barbara Stwertka, William Begley and Lewis Rothberg, Department of Chemistry, University of Rochester (Industrial Sponsor – Diffinity Geonomics)
- 37 Wearable Electroactive Polymer Biosensors**
Kathleen Lamkin-Kennard and Wayne Walter, Department of Mechanical Engineering, Rochester Institute of Technology

Electrical Engineering, Computer Engineering, and Computer Sciences

- 38 Neuromemristive Systems for Neurally-inspired Information Processing**
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Optics, Imaging and Photonics

1 3-Dimensional Printing of Reflective Freeform Optics

William E. Green¹, John C. Lambropoulos^{1,2} and Stephen J. Burns^{1,2}; ¹Department of Mechanical Engineering, University of Rochester, ²Center for Freeform Optics and Materials Science Program, University of Rochester

INTRODUCTION

New, freeform optical designs [1] are ideally suited to additive manufacturing provided surface qualities are adequate for optical requirements [2-5]. Additive manufacturing thus has the potential for rapid, high fidelity prototyping of freeform shapes which is a major advantage over traditional optical manufacturing methods. 3-D printing especially of complex structures, with embedded optical shapes is typically no harder to create than simple geometries. Our research has concentrated on additive manufacturing of reflective surfaces for optical illumination in three progressive directions: first, making a mold that could be used in forming an optical surface; second, post-processing of a surface so the gaps and steps can be filled with a polymerizable wetted liquid to smooth the layers from the printed surface; third, making a fiducial trial mask that contains lined grooves, spherical hillocks, lined steps, parabolic shapes, dots and voids to evaluate selected printed parts for printer head paths with different additive printers. We have optically characterized the surfaces created. Curable photopolymers in the printing process show promise for achieving optical quality, not only because it is among the faster additive processes available, but also because the UV curing process involved will allow post-process smoothing to be integrated into the printing operation.

EXPERIMENTAL RESULTS

Additive Printing a Mold

A simple parabolic mirror made from an additive printed mold at the University of Rochester is shown in figure 1. The optic was pressed from a thin sheet of the thermoplastic, polypropylene, into an AM mold and subsequently coated with a wavelength of aluminum. The mirror was evaluated with a white light interferogram as seen in the figure. The mold can be significantly rougher than the molded part; the smoothness of this surface was further evaluated with a stylus profilometer.

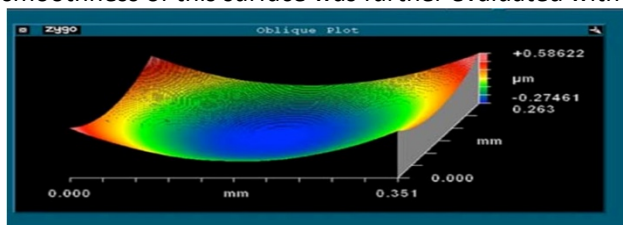


FIGURE 1. Zygo white light interferometry of a post-molded parabolic reflector surface.

Post-Processing of an Additive Surface

Rough surface steps were smoothed using an acrylic based crosslinked photopolymer cured with UV light. Resin drip coating of the photopolymer decreased RMS surface roughness from 10 to 5 μm . Optimization of the viscosity, Reynolds number and Weissenberg number of this photopolymer is expected to further improve the P-V and RMS surface.

Evaluation of Masked Additive Surface Profiles

A CAD file was created in *SolidWorks* and exported as a stereolithography file for prototyping on several printers. The purpose was to establish an empirical relation between topography step height, in-plane resolution and surface P-V and RMS performance. This relationship is intended to predict the z and x-y resolutions necessary to construct and manufacture freeform optical designs. It also provides insight to the unique characteristic flaws that different additive techniques produce.



FIGURE 2. Prototype model of a test part to characterize printed surface flaws.

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2 Impact of Annealing on Contact Formation and Stability of IGZO TFTs

N. Walsh, T. Mudgal, and K.D. Hirschman, Rochester Institute of Technology, Electrical & Microelectronic Engineering Department; R.G. Manley, Corning Incorporated, Science and Technology

Oxide semiconductors are candidate materials to replace amorphous silicon in thin-film transistors (TFTs) for LCD and OLED backplanes where the demand on performance is increasing. Indium-Gallium-Zinc-Oxide (IGZO) has shown promise because it exhibits high electron mobility and can utilize the existing fabrication infrastructure for flat-panel display manufacturing. However the acceptance of IGZO requires exceptional uniformity and stability in device performance. The necessity to anneal sputtered IGZO for improved device operation has been widely established; however the temperature, gas ambient, and process integration details vary.

In this work, bottom-gate top-contact TFTs are fabricated using sputtered IGZO. Molybdenum and aluminum were investigated as contact metals which defined the working source/drain electrodes. Annealing processes applied either before or after metal deposition were investigated. Annealing was done at 400 °C in various gas ambients including air, oxygen, nitrogen, forming gas (5% H₂ in N₂) and vacuum. Channel passivation materials including SiO₂ and Al₂O₃ were also investigated. The annealing ambient and arrangement of process steps was found to have a significant influence on the contact behavior and the uniformity and stability of electrical characteristics. These details have a significant impact on circuit operation, which will be discussed along with results of test circuits including inverters and ring oscillators.

3 Slope-sensitive optical probe for freeform optics metrology

Michael A. Echter, Precision Instrumentation Group, Mechanical Engineering, University of Rochester

Freeform and conformal optical components are rapidly becoming more pervasive in semiconductor, defense, space, and consumer electronics applications. Three critical aspects are needed for manufacturing freeform optics: optical design software to specify tolerances with freeform optics, manufacturing processes that can accommodate freeform surfaces such as magnetorheological finishing (MRF) and UltraForm Finishing (UFF), and accurate metrology for quality control to ensure specifications are met or error maps for iterative manufacturing.

This work addresses the third aspect with an optical probe to use in conjunction with a 5-axis optical coordinate measuring machine (OCMM) for freeform optics metrology. The interferometric-based optical probe uses high-speed line sensors to achieve a high bandwidth while measuring both surface topography changes and local slope variations. The probe has fiber delivery as well as fiber detection, utilizing a high-density fiber bundle for remote sensing. The optical probe concept, analysis algorithm, and preliminary measurements will be presented.

4 Gabor-Domain Optical Coherence Microscopy and Applications

Patrice Tankam, Jungeun Won, Ying-Ju Chu, Anand Santhanam, Cristina Canavesi, Jannick P Rolland, Institute of Optics, University of Rochester

We developed an optical imaging system with micron resolution that is capable to reconstruct the 3D images of the micro-structures beyond the surface. We investigated the capability of the system in different applications including skin imaging, ophthalmology and materials science. We showed the suitability of the system for skin cancer monitoring. We demonstrated the capability of the system to measure the edge-thickness of the contact lens, which is crucial in the evaluation of the performance of the lens and the comfort of the patient. We also examined the micro-structures of the human excised cornea and in particular endothelial cells microenvironment in order to provide insights into the mechanism of corneal diseases. We further showed that the system is a useful metrological tool in materials engineering and manufacturing. As a result, we showed that the imaging modality has the capability to observe the three-dimensional feature of the structure with micro resolution.

5 Development of Glass Flat Panel Loudspeakers

David Anderson, Stephen Roessner, Mark F. Bocko, Electrical and Computer Engineering, University of Rochester; (Research Sponsored by Corning Inc.)

The development of glass flat panel distributed mode loudspeakers (DML's) will enable compelling new applications such as flat panel displays that double as loudspeakers, or in architectural and automotive applications, window glass that can produce sound or actively cancel environmental noise. In this poster we discuss the acoustic response of glass flat-panel distributed mode loudspeakers.

The density of panel bending modes, their quality factors (Q 's), and the modal radiation efficiencies determine the frequency response of a DML. For example, a 0.55 mm thick cover glass for a 55" television has more than 10,000 bending modes in the audible frequency range. The density of modes increases with frequency and above a certain threshold frequency, determined by the panel dimensions and the mode Q 's, the mode spacing becomes less than the width of the individual mode peaks and the frequency response approaches the smooth, flat response of an ideal pistonic loudspeaker. However, below this frequency, discrete modes produce prominent peaks in the frequency response, which can lead to audio distortion.

A loudspeaker also must accurately reproduce signals with fast transients, such as percussion sounds in music and human speech. The transverse bending waves are the primary source of acoustic radiation in a DML; however they propagate across the panel at a finite speed so regions of the panel more distant from the panel driving point(s) radiate sound at later times, which smears the DML's acoustic impulse response. Furthermore, bending wave propagation in a rigid panel is dispersive, with a wave velocity that is proportional to the square root of the frequency, which creates additional audio distortions of signals with fast transients. We present simulated and measured glass panel frequency and transient responses and assess the prospects for recreating high quality audio with glass DML's.

6 Eikonal+: a computational research platform for freeform optical instrumentation

Martin Huarte-Espinosa, Robert Gray, Daniel Nikolov, Miguel A. Alonso, Jon Petrucci, and Jannick P. Rolland, Institute of Optics, University of Rochester

For the first time in over 30 years, a major source code that is enabled for advanced optical instrumentation including freeform surfaces has returned to an optics university research center. Eikonal®, developed and used by Juan Rayces of Perkin-Elmer (PE) has been donated by the Rayces family to Professor Rolland to form the basis for an open interface advanced optics research platform. The project's objective is to provide an interface between the Eikonal source code and other developed research codes, particularly in the last decade, at UR, by Professors Alonso, Fienup, and Rolland and at UNC-Charlotte by Professor Suleski, a close collaborator. Under the guidance of the PI – who worked with Rayces – this is an exciting opportunity for launching optics instrumentation research in the coming freeform optics decade on a completely new trajectory.

7 Pulsed Terahertz Wave Emission from Thin Metal Films Excited by Two-Color Laser Fields

Jianming Dai, and Xi-Cheng Zhang, Institute of Optics, University of Rochester

We demonstrated pulsed terahertz (THz) wave emission from thin metal (gold) films excited by two-color laser fields synthesized by an in-line phase compensator. By driving the electrons in thin metal films asymmetrically, THz wave emission is observed at normal incidence of the two-color pump beams in a transmission geometry. Similar to the air-plasma THz source excited by two-color laser fields, the generation process can be phenomenologically attributed to the 3rd-order nonlinear (four-wave mixing) process.

8 Efficient Terahertz Source

Xuan (Betty) Sun, Xi-Cheng Zhang, Institute of Optics, University of Rochester

Plasma-based Terahertz air photonics are essential for broad applications in ultrafast spectroscopy and stand-off material characterization. Efforts to explore different gases as Terahertz emitters, to search for the optimum wavelength and the best dual-color intensity ratio of femtosecond laser have yielded a number of ultrafast Terahertz generation techniques. However, current gas-based THz emitters generally exhibit relatively low efficiencies. The advance of THz air photonics to date imposes a critical quest for a bright THz source. Here, we explore the elements with the lowest ionization potential and demonstrate, for the first time to the best of our knowledge, significantly enhance THz generation in Cesium and Rubidium vapors. This technique accesses a great promise for a bright THz source and an ultrasensitive THz sensor that open a door towards probing THz dynamics inside the plasma filament.

9 Terahertz-REEF Broadband coherent terahertz wave remote sensing spectroscopy

Kang Liu, Fabrizio Buccheri, Xi-Cheng Zhang, Institute of Optics, University of Rochester

The combination of Terahertz-Radiation-Enhanced Emission of Fluorescence (THz-REEF) remote detection and our previous work demonstrated on long-distance terahertz wave generation up to 30m, makes broadband stand-off remote spectroscopy possible, due to the high atmospheric transparency and omnidirectional emission pattern of the fluorescence. So far, we demonstrated coherent terahertz wave detection at a distance of 30m and we are on our way to push the limit of this technology toward a further distance.

10 Cerium Oxide Polishing Slurry Reclamation: Process Improvements at Flint Creek Resources and Sydor Optics

Tess Jacobs^{1,4}, Mark Mayton², Zachary Hobbs³, Stephen Jacobs^{1,4}

¹Institute of Optics, University of Rochester, ²Flint Creek Resources, Inc., ³Sydor Optics, ⁴Laboratory for Laser Energetics, University of Rochester

Flint Creek Resources (FCR) has developed an economically viable, safe, and environmentally friendly process to reclaim the cerium oxide abrasive used to polish glass optics. Success from a collaboration with local Rochester, NY fabricator, Sydor Optics, is in its second year of a three-year effort to increase reclamation efficiency of spent polishing slurry from 20% to 95%. To achieve this goal, FCR is purchasing new equipment and is being supported by research currently being conducted at the University of Rochester Laboratory for Laser Energetics (LLE). Our group is assisting in these efforts by conducting polishing experiments to evaluate efficiency of reclaimed polishing slurries and new slurries. These experiments as well as the success at Sydor Optics, allows FRC to consider including other optics fabrication companies in this recycling effort. Sydor Optics is increasing its usage of FCR's services and products and could realize a total saving of up to \$100,000 in 2014.

11 Measuring spatial coherence through the shadow of small obscurations

James K. Wood, Katelynn A. Sharma, Miguel A. Alonso, Thomas G. Brown, Institute of Optics, University of Rochester

We present a simple method to measure the spatial coherence of a partially coherent field by analyzing measurements of the radiant intensity with and without a small, well-known obscuration. Our results are highly consistent with theoretical predictions.

12 Confocal Microscopy in Turbid Media: Improving Contrast

Andrew Vigoren, Physics & Astronomy and James Zavislan, Institute of Optics, University of Rochester

We describe optical enhancements to reflectance confocal microscopy (RCM) and optical coherence tomography (OCT) which we term non-reciprocal differential interference contrast (NR-DIC). NR-DIC increases the image fidelity of reflectance in vivo imaging by reducing speckle artifact by over 10X as well as enabling an imaging mode that objectively measures the polarization properties of the tissue within the image section. This imaging mode improves the quality of in-vivo images as well as providing label-free identification of birefringent tissues.

13 Further Development of THz Imager Array in Support of ITT Exelis' Commercial THz Development

Zeljko Ignjatovic, Electrical and Computer Engineering, University of Rochester

Terahertz imaging is a novel research field that has gained much traction in recent years both in academia and industry. The potential for using terahertz technologies in various applications such as medical imaging, airport/transit security, astronomy, communication and others is vast. The main goal of our research endeavor has been to evaluate the potential of using standard CMOS technologies for electronic detection of signals in terahertz range. In our study, we have conducted extensive simulations and device modeling of CMOS detectors using Synopsys TCAD tools. We compared different CMOS readout circuit topologies in terms of noise performance and responsivity for the purpose of detecting THz signals such as common-source amplifiers, source-follower amplifiers, and differential amplifiers. We have also designed and fabricated a prototype THz imager in 0.35 micron CMOS technology. The prototype imager includes four 12 x 12 pixel arrays with various combinations of bow-tie and spiral antennae, CMOS detectors, and circuit readout topologies. We are presently conducting experiments to verify and characterize performance of the prototype chip. Preliminary results indicate that the responsivity metric of the fabricated devices exceeds 10kV/W, which is a significant improvement over other CMOS detector technologies.

14 Terahertz emission from a laser induced micro-plasma: scaling down the power budget for broadband terahertz spectroscopy

F. Bucchieri and Xi-Cheng Zhang, Institute of Optics, University of Rochester

A micro-plasma generated by focusing a femtosecond laser pulse with a high NA objective in air is studied as a source of broadband terahertz radiation. For this configuration, the laser pulse energy threshold for terahertz (THz) generation is less than 3μJ, which is more than a ten-fold decrease compared to the standard technique. This approach will make possible to perform broadband THz spectroscopy employing cheaper and more reliable high repetition rate laser systems.

15 Gradient index lens writing in ophthalmic hydrogels using femtosecond micromachining

Daniel Brooks¹, Daniel Savage¹, Jonathan D. Ellis¹, and Wayne H. Knox^{1,2}; ¹Institute of Optics, ²Center for Visual Science, University of Rochester

Last year, a refractive structure was inscribed into a flat ophthalmic hydrogel sample using femtosecond laser micromachining, a technique that uses tightly focused laser pulses to cause refractive index changes in a material without damage. The inscribed structure was shown to have a cylinder power of -2.4 ± 0.4 Diopters. While this was a significant step forward, the scanning system used to translate the focal spot had serious limitations that restricted its application, namely a small stroke and inability to sufficiently control the motion. More recently, a new, custom flexure scanning system has been developed that addresses these limitations. This new flexure scanner, presented here, has a stroke of approximately 9 mm and a natural frequency of 27 Hz.

16 Determining the Effects of Varying Machine Stiffness in UltraForm Finishing

Dennis Briggs, Mechanical Engineering, University of Rochester

UltraForm Finishing (UFF) is a deterministic, subaperture, computer numerically controlled, optical grinding and polishing platform designed by OptiPro Systems. UFF is used to grind and polish a variety of optics from simple spherical to fully freeform shapes, and numerous materials from glasses to optical ceramics. The UFF system uses an abrasive belt wrapped around a compliant wheel that rotate and contact the part to remove material. This work aims to measure the stiffness variations in the system over time and how it can affect material removal rates. The necessary variables needed to evaluate stiffness are measured using a triaxial load cell for the forces and a capacitance sensor for deviations in height. Using our current testing apparatus, we will demonstrate stiffness measurements for a single UFF belt during different states of its lifecycle and assess the material removal function from spot diagrams as a function of wear. This investigation will allow us to make better estimates of Preston's coefficient over time and, in turn, more accurately predict instantaneous material removal rate functions throughout the lifetime of a belt.

17 Sub-resolution measurements using a vortex coronagraph

Garreth J. Ruane, Prachyathit Kanburapa, Jiaxuan Han, and Grover A. Swartzlander, Jr., Chester F. Carlson Center for Imaging Science, Rochester Institute of Technology

An optical scheme for extracting spatial information from an unresolved source distribution is demonstrated. The angular location of the centroid and the angular extent of an unresolved pinhole source are experimentally measured using a broadband high contrast vortex coronagraph (VC). The VC is an optical instrument, originally devised for high-contrast astronomical imaging to observe exoplanets and other difficult-to-observe celestial bodies. We demonstrate that the spatial filtering operation of a VC allows for sub-resolution detection via simple pupil plane power measurements. This approach offers sub-resolution detection advantages over conventional imaging systems for unresolvable objects.

18 Amplitude, phase and polarization control with a single spatial light modulator

Stephen Head, Institute of Optics, University of Rochester

Point spread function engineering is usually accomplished by controlling the amplitude, phase and/or polarization of the pupil fields. We analyze and test an optical design for full amplitude, phase, and polarization control of the pupil fields using a single spatial light modulator. In our scheme, the beam is spatially split into four components that represent the in-phase and quadrature components of two orthogonal polarizations. The approach can be used either with state-of-the-art reflective spatial light modulators or using the transmission modulators from retired liquid crystal projectors.

19 Single Pixel and Array Tests of a THz Imager

Greg Fertig¹; Craig McMurtry²; Kenneth Fourspring³; Zoran Ninkov¹; Judith Pipher²; Zeljko Ignjatovic²; Chao Zhang¹; Jagannath Dayalu²; Dan Newman³; Andrew Sacco³; Paul Lee³; Mark Bocko²; ¹Rochester Institute of Technology; ²University of Rochester; ³Exelis Inc.

A group consisting of Exelis engineers, RIT scientists, UR engineers and scientists have designed and manufactured a first generation room temperature silicon imager, to be operated in plasmonic mode at THz frequencies. There are several pixel varieties to test with varying design dimensions, including with and without antennas.

The RIT group from the Chester F Carlson Center for Imaging Science has developed a testing system for terahertz single pixel characterization. This effort will determine the ideal pixel structure and configuration for optimal responsivity, allowing the imaging array design to move forward. A custom low noise enclosure and cabling setup, along with a source measurement unit perform MOSFET voltage and current sweeps for transconductance, channel conductance and resistance measurements, and terahertz radiation responsivity. A 188GHz Gunn diode is the current primary radiation source under test, with plans to move toward a tunable source with multiple bands from 0.1 to 1.0 terahertz. Results from these tests will be presented along with best practices and methods for future pixel designs.

The UR group from the Department of Physics and Astronomy has modified an existing array controller, provided appropriate clock and data acquisition programs, built a fanout board for the chip to house it in one of our cryogenic dewars (to act as a Faraday cage). An ultrapure Si window eliminates the silicon chip's response to intrinsic radiation, but passes THz radiation. Extensive noise measurements of the chip have been obtained. Previously, the device was irradiated with 1.6 THz radiation, and more recently with the Gunn diode mentioned above. Results from these tests will be discussed.

20 Quantum Dot Coated CMOS CID Arrays for the UV and VUV

*Ross Robinson,^a Zoran Ninkov¹,^a Denis Cormier,^b Alan Raisanen,^c Suraj Bhaskaran,^d Carey Beam,^d Herb Ziegler,^d Uwe Arp,^e Robert Veste;^a Center for Imaging Science, Rochester Institute of Technology
^b Department of Industrial and Systems Engineering, Rochester Institute of Technology; ^c Department of Manufacturing and Mechanical Engineering Technology, Rochester Institute of Technology; ^d Thermo Fisher Scientific – CIDTEC; ^e Ultraviolet Radiation Group of the Sensor Science Division, NIST*

A technique has been developed for coating commercial off the shelf (COTS) detector arrays with a thin, uniform layer of quantum dots. The quantum deposition is accomplished using an Optomec Aerosol Jet rapid prototyping system. When illuminated by UV and vacuum UV (VUV) the quantum dots will fluoresce and those emitted photons will be detected by the underlying detector array. The size of the quantum dots used determines the fluorescence wavelength and that would be matched to the peak sensitivity of the underlying detector array. The devices have been tested at the NIST synchrotron facility in Gaithersburg and have shown sensitivity down to 150nm. Performance at wavelengths below 150nm is limited by absorption by solvent residues from deposition process.

21 Numerical Wave Propagation Using Hamiltonian Optics and Symplectic Integrators

Manuel Garcia, Tecnológico de Monterrey, Photonics and Mathematical Optics Group

Rays provide an intuitive and tractable description of light, both mathematically and computationally. However, traditional ray models are not able to describe all optical phenomena of interest. The breakdown becomes apparent in situations where the wave nature of light makes itself manifest or dominant. It is the case that ray models may be extended and conciliated with wave-like behavior. Such models may then be used in situations that cannot be treated with geometrical optics while still retaining an attractive geometric interpretation. In particular, the Stable Aggregates of Flexible Elements model (safe), starting from Hamiltonian optics, describes the propagation of light with rays carrying a weight estimate such that their aggregate yields a remarkable approximation to the field, together with an estimate of the error. Additional noteworthy features of safe, of a deep geometric character, is that ray amplitude is conserved and that the model is able to approximate the fields even at position or momentum caustics. To take full advantage of having a powerful Hamiltonian framework for the description of light propagation, it behooves us to propose numerical methods tailored to observe its natural geometric structure. Specifically, deviations in symplectic or symmetry properties of the numerical solution with respect to the mathematical solution should be kept under strict control.

Numerical schemes for the solution of initial-value problems that preserve properties of symplectic systems of differential equations do exist. Historically, they constitute a third generation of numerical methods for solving systems of differential equations, coming after methods for non-stiff and stiff systems. They are most useful when tailored according to features exhibited by the Hamiltonian of the system, since they are designed to closely replicate the features of the solution phase space. They are better suited for explorations of phenomena that may manifest over long propagation distances, like wave-packet revivals, or near critical points like position or momentum caustics.

22 Mirror Swarm based Space Telescope

Xiaopeng Peng and Grover A. Swartzlander, Jr.; Chester F. Carlson Center for Imaging Science, Rochester Institute of Technology

An effectively large mirror diameter in a space telescope may be achieved by swarms of controlled mirrors. We explore this concept, imagining a swarm of randomly placed small mirrors. Toward this end, we have experimentally recorded the resulting speckle pattern. Deconvolution techniques were successful at retrieving high-resolution images, equivalent to the diffraction limit of a large aperture system.

Biomedical Engineering

23 Semiconductor Quantum Dot Based Near-Infrared Photoluminescent Medical Devices

Brett Swartz, Department of Chemistry, University of Rochester

Advanced Quantum Imaging's mission is to create safe, efficient, cost effective medical devices that provide real-time placement visualization. We aim to establish the gold standard in this area using visualized placement with infrared light. Advanced Quantum Imaging (AQI) is a pre-incorporated high tech startup formed out of the Chemistry Department of the University of Rochester by Prof. Todd Krauss in 2013. AQI has developed an improved method to synthesize robust and bright infrared active materials called colloidal nanocrystal quantum dots (QDs), for significantly lower costs than methods that are commonly used. The speed and economy of AQI's patented production method allows for the novel use of QDs in numerous fields, including medical devices, safety, and military applications. The Medical Division of AQI will concentrate on the application of our infrared QDs to improve the safety and accuracy of, as well as reduce the associated costs with, placement of minimally invasive medical devices.

24 Influenza Surveillance and Serology via Arrayed Imaging Reflectometry (AIR)

Joseph Bucukovski and Ben Miller, Biomedical Engineering, University of Rochester

Rapid and sensitive detection platforms for biomolecular targets play a prominent role in clinical diagnostics, surveillance, and high-throughput drug screening applications. Arrayed Imaging Reflectometry (AIR) uses chip-based optical sensing strategies that rely on the perturbation of a near-zero reflectance condition upon target molecule binding. This technology is ideal for influenza serology as it is easy to multiplex, requires no label, and uses minimal sample volumes as compared to other traditional methods. Besides the need for an external label, ELISA, PCR, and HI assays are costly and labor intensive. In this AIR application, influenza hemagglutinins are covalently immobilized to the chip surface and function as capture probes for anti-hemagglutinin antibodies found in human and animal sera. Here, we will outline the arrangement of our system in detail and validate its use as a surveillance sensor and, in the future, a sensitive diagnostic tool.

25 A collaboration between Micropen Technologies and the University of Rochester Center for Medical Technology and Innovation to develop a testing platform for a radiofrequency balloon catheter for renal denervation

Laura K. Hobbs, and Greg T. Gdowski, Ph.D., Biomedical Engineering, University of Rochester; Lori Shaw-Klein, Ph.D., William J. Grande, Ph.D., MicroPen Technologies

Radiofrequency (RF) ablation is currently being developed for renal denervation, a medical procedure used to treat resistant hypertension. This treatment involves the local heating of renal arterial tissue to a temperature sufficient for nerve ablation without causing irreversible damage to arterial tissue. We aim to develop a testing platform to quantify design device specifications such as power delivery, target temperature, and power duration in a porcine arterial model. In order for new devices to be safe and effective, it is necessary to understand the magnitude of heat delivered as well as the spatial distribution of heat radiating from the RF electrode region. This study mimics the *in vivo* conditions of a bipolar electrode on a balloon catheter in the renal artery during an ablation procedure, allowing for calculation of the spatial thermal profile at the site of RF ablation. Temperature measurements were taken at the exterior surface of a porcine renal artery and the longitudinal and circumferential space constants were determined after fitting the data to a decaying exponential curve. This testing platform allows for the precise measurement of RF ablation temperature profiles to optimize electrode design and power delivery in developing innovative new designs.

26 Refractive index shaping in live cat cornea *in vivo*

Daniel E. Savage^{1,2}, Daniel R. Brooks¹, Margaret DeMagistris³, Jonathan D. Ellis¹, Wayne H. Knox^{1,2}, and Krystel R. Huxlin²; ¹ Institute of Optics, ² Center for Visual Science, ³ Flaum Eye Institute, University of Rochester

The purpose of the present experiment was to determine the efficacy of intra-tissue refractive index shaping ("IRIS") using 400 nm femtosecond laser pulses (blue light) for writing refractive structures directly into live cat cornea *in vivo*. In addition, our goal was to investigate the longevity of these structures in the eye of living cats. We inscribed Blue-IRIS patterns into the corneas of four cat eyes. The optical effects of the patterns were then tracked using optical coherence tomography (OCT) and a custom-built Shack-Hartmann wavefront sensor. We found that Blue-IRIS can be used to inscribe refractive structures into live cat cornea *in vivo* that are stable for at least 12 months, and are not associated with significant alterations in corneal structure. This result is a critical step towards establishing Blue-IRIS as a promising refractive surgery technique for non-invasive vision correction.

27 Responses of the Ocular Surface Temperature and Lipid Layer Thickness to Stressed Environmental Conditions in Normal and Dry Eyes

Ranjini Kottaiyan¹; Holly Hindman^{1, 2}; Gheorghe Salahura^{1, 2}; James M. Zavislan^{2, 1}; Geunyoung Yoon^{1, 2, 3}; James V. Aquavella¹; ¹ Flaum Eye Institute, University of Rochester ² Center for Vision Science ³ Institute of Optics

Purpose: To study the tear film effects by stressing the ocular surface in low relative humidity (RH) and high temperature conditions and to elicit the different responses between normal and dry eye subjects using thermal imaging and tearscope, quantifying two-dimensional distribution of temperature and lipid thickness, respectively.

Methods: A Thermal camera and a quantitative tearscope were used to measure a total of 14 eyes comprising 5 normal and 9 aqueous deficiency (ADDE) dry eyes before (baseline) and after 30 minutes of acclimation to three different environmental conditions; 40% RH and 75 °F (C1), 20% RH and 75 °F (C2), and 40% RH and 85 °F (C3), in our controlled chamber. Thermal data was analyzed to calculate the average ocular surface temperature (OST) in the central 9 mm of the cornea, while the average lipid thickness (LT) and uniformity were calculated from the central one-third of the cornea. Changes in OST and LT were compared between the two groups.

Results: The average OST/LT at baseline was $34.9 \pm 0.2^\circ\text{C}/40.4 \pm 8.3 \text{ nm}$ and $33.8 \pm 0.3^\circ\text{C}/57.9 \pm 30 \text{ nm}$ in normal and ADDE subjects, respectively. After 30 min of acclimation, normal subjects did not show a significant change in OST under any condition. ADDE, however, showed a significant change in OST in C1 (mean difference = -0.65°C , $P= 0.022$) and C3 (mean difference = -0.63°C , $P= 0.003$). On the lipid thickness, ADDE showed an increase by $8.77 \pm 10.95 \text{ nm}$ in C1 while a decrease of $14.47 \pm 29.04 \text{ nm}$, in C3.

Conclusions: Normal subjects were able to maintain their OST in response to environmental changes, while the ADDE was sensitive to environmental changes and changed more in response to temperature than humidity challenges. This may be, because of the greater evaporation occurring in the temperature challenge than the humidity challenge in the ADDE patients.

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28 Sonoelastography to Measure Intrahepatic Fat

Christopher Barry, Zaegyoo Hah, Alex Partin, KuangHsiang Chuang, Robert Mooney, WenQing Cao, Deb Rubens and Kevin Parker, University of Rochester

Fatty liver disease has become the main cause of liver dysfunction in the United States, resulting in increased incidences of cirrhosis, liver cancer, and end stage organ failure requiring liver transplant. Liver biopsy, which is painful and carries risks of complications, remains the definitive diagnostic tool. A noninvasive imaging test for fatty liver disease would have significant clinical utility. We show that sonoelastographic measurement of shear speed dispersion accurately measures the amount of fat accumulation ("steatosis") within the livers of diet-manipulated animals.

We employ an ultrasound based elastography method using mechanically generated vibration sources to measure shear wave dispersion in fatty livers. Dispersion is the slope or increase of shear speed with increasing frequency and is a consequence of adding a viscous element (i.e., fat) to a tissue. We demonstrate that dispersion correlates with triglyceride content and histologic findings over a wide range of steatosis.

Seventy C57BL/6J mice were fed high fat diets and sacrificed for hepatectomy at weeks 0, 4, 8, 11, 12, 13, 14, 15, 20, and 25 to capture a range of hepatic steatosis. Livers were subjected to triglyceride (TG) assay, H&E analysis, histomorphometry of adipophilin immunostained sections, and ex vivo sonoelastography of gelatin suspended livers.

Group analysis of livers containing <0.1 mg TG/mg liver ("low fat", n=30), 0.1-0.25 mg TG/mg liver ("moderate fat", n=21), and >0.25 mg TG/mg liver ("high fat", n=17) revealed mean dispersion values of 0.05 cm/s/100 Hz, 0.28 cm/s/100 Hz, and 0.35 cm/s/100 Hz respectively. These triglyceride groupings corresponded to visual H&E assessments of 19%, 69%, and 78%. Using a linear fixed effects model, dispersion slope curves are statistically different between low and high fat groups ($p=0.01$). The average dispersion for livers with 0-10% fat = 0, 15-40% fat = 0.25, and 40-70% fat = 0.43. Preliminary analysis of individual histomorphometric fat area measurements versus dispersion revealed a high correlation ($R^2=0.90$).

Sonoelastographic dispersion measurements correlate with intrahepatic fat content as measured biochemically and histologically. The wide dynamic range allows distinction of clinically relevant degrees of steatosis. These results provide impetus to further study this technique in larger animals, in vivo, and in humans.

29 Privacy-Preserving Medical Cloud Computing Using Homomorphic Encryption

Tolga Soyata, Electrical and Computer Engineering, University of Rochester

The ability to remotely monitor a patient using a portable ECG system would in many cases enable earlier discharges from the hospital, benefitting the patient, the physician, and the hospital itself. However, the need to preserve patient privacy is so critical that it prevents such systems from being practical. This research describes a system that solves the privacy issues of remote monitoring, through the use of end-to-end encryption. This solution also allows for data analysis in the cloud, without making patient information available to the cloud provider. A proof-of-concept system is implemented for a representative application, LQTS detection. Finally, a long-term research path is defined to improve the speed (and available number) of operations that can be performed on encrypted data, which will expand the capabilities of this system.

30 Enhancing Neural Function of Presbyopia by Improved Optics and Perceptual Learning

Len Zheleznyak and Geunyoung Yoon, Institute of Optics, University of Rochester

As the eye ages, it loses the ability to accommodate, or to change power to bring objects of varying distances into focus on the retina. This age-related loss of accommodation is known as presbyopia. Our lab has developed a novel binocular approach to overcoming presbyopia: modified monovision. In modified monovision, the depth of focus of each eye is independently optimized to provide a full range of useful binocular vision, while minimizing the interocular difference in image quality. Thus, binocular visual function such as stereopsis and binocular summation is preserved.

We aim to further improve visual performance by using a perceptual learning protocol. Perceptual learning is a process of repeated practice of a demanding visual task. The effect is to increase the gain of neuronal signals, thereby improving visual performance. A binocular adaptive optics vision simulator was used to correct and induce wavefront aberrations of modified monovision in both eyes, while simultaneously using computer-generated psychophysical visual tasks for perceptual learning. When paired with the appropriate optical correction strategy, perceptual learning is a promising approach to non-invasively improve visual performance beyond the limits imposed by retinal image quality.

31 Non-Invasive Fault Detection in an Axial Flow Blood Pump Used as a Ventricle Assistive Device

Rohit Rana and Jason Kolodziej, Mechanical Engineering, Rochester Institute of Technology; Karl Q. Schwarz, MD, Echocardiography Laboratory, University of Rochester

A Ventricular Assistive Device (VAD) is a mechanical pump used to assist the functioning of a weak heart. A catastrophic obstruction in the VAD system could cost the patient their life. This paper discusses a fault detection approach using the commercially available Jarvik 2000 Flowmaker® VAD in a closed loop circuit that incorporates the ability to alter common causes of VAD congestion. Principal Component Analysis, a data compression technique used to discover patterns in data of high dimension, is implemented using frequency analysis of the VAD's acoustic signature. This was followed by a health classification based on Bayes theorem. The classification results indicate that this technique is accurate to a high degree in detecting three levels of obstruction in the VAD system.

32 A Novel Elastic Squeeze Film Total Hip Replacement

Dr. Stephen Boedo, Mechanical Engineering, Rochester Institute of Technology

This poster describes a new approach to the design of total hip replacements with the goal of enhancing lubrication and reducing wear. Elastic elements and ellipsoidal cup surface geometry are incorporated into the new design to promote and enhance 'squeeze-film' action over 'wedge-film' action employed in conventional artificial hip joints. Employing an established finite element lubrication model with a realistic gait cycle and realistic ball-to-cup clearance specifications, it is found that significantly larger minimum film thicknesses and significantly smaller maximum film pressures are predicted over the stance-phase portion of the gait cycle when compared with conventional designs.

- 33 Designing and Building an Intelligent Mobility Cane Prototype for People who are Blind and Deaf-Blind**
*Tae H. Oh, Dept. of Information Sciences and Technologies, Golisano Computing and Information Sciences
 Rochester Institute of Technology; Patricia Iglesias-Victoria, Dept. of Mechanical Engineering, Kate
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Navigating through the physical world is a tremendous challenge for people who are blind. While use of computing technology assists blind people in navigating through virtual environments to access information, there has been little progress in developing technology to help blind people navigate through the real world. Canes and service animals offer low-technology solutions. This project will engage advanced technology to solve the age-old problem of assisting blind and deaf-blind people as they move about in their daily lives.

The goal of this project is to design and develop a low cost, light weight “Intelligent Mobility Cane” prototype that will aid **deaf-blind** and **blind** persons in navigating surroundings via real-time tactile and directional force feedback and guidance. To accomplish the goals, the following list of objectives will be accomplished.

1. Develop the detection system, which creates an optimal interpretation of the physical environment. The detection system includes obstacle detection, front and side drop-off detection, stair case detection, and head obstacle detection.
2. Design and develop a sensitive pad which gives a directional force feedback when it senses an oncoming obstacle or drop-off, with the force feedback getting more intense as it approaches.
3. Integrate the rumble unit with the detection system and calibrate.
4. Test, and evaluate the Intelligent Mobility cane with deaf-blind people as well as improve the Intelligent Mobility cane using the feedback from deaf-blind.

The prototype cane will be based on a standard long white cane shaft that is familiar to users. The user handle of the cane has a built-in sensitive tactile pad, and a detection system is mounted toward its tip. The sensitive tactile pad includes an integrated directional force feedback rumble unit which causes the tactile pad of the cane to vibrate in selected obstacle situations. The directional force feedback informs the user where and how far an obstacle or object is in real time.

The object detection system uses infrared ray (IR) and ultrasonic wave sensors, which when combined, offer the optimal potential for interpretation of a physical environment. A small embedded microcontroller with I/O interface will be used to collect data from the detection system, compute the optimal interpretation of the physical representation, and control the sensitive tactile pad based on the physical representation (characteristics of the object). The microcontroller will be integrated inside of the Smart Cane and operated by light-weight battery. As the user encounters an obstacle, the force feedback rumble unit will guide the user away from an object based on the distance. The nearer the user to an obstacle, the sharper the force feedback rumble produced by the cane. As a result, the user will experience an enhanced sense of awareness of the environment through which they move.

34 Magnetically Levitated Implantable Blood Pump

Steven W. Day, Mechanical Engineering, Rochester Institute of Technology

The **LEV**itated impeller, left **Ventricular Assist Device** (LEV-VAD) is a magnetically suspended axial flow rotary blood pump intended for long term (15+ years) implantation. The pump uses a novel large-gap magnetic bearing system. In contrast to currently available blood pumps, this pump has a single unobstructed blood flow path and no mechanical bearings, thus eliminating retrograde flow, stagnant areas, and high fluid stresses.

We have successfully fabricated and assembled functional prototypes of the pump. They have been tested extensively on the bench and in animal implant experiments up to 4 weeks duration. These prototypes have achieved and exceeded the design operating point of 6 l/min at 80mmHg while operating at or slightly above 5,500rpm.

The pump 1) has no wearing parts (bearingless and sealess), 2) exerts extremely low shear stresses on the fluid and 3) has excellent fluid compatibility. While advantageous for blood pumping applications, it's quite likely that these attributes would be useful in other applications. The design could easily be scaled to suit other performance specifications.

35 Optical Prediction of Time to Metastasis Using Invasive Ductal Carcinoma Biopsy Specimens

Kathleen Burke, Edward Brown, Department of Biomedical Engineering, University of Rochester

After a breast cancer patient's primary tumor is removed a significant treatment decision must be made: should the patient receive additional systemic chemo- and/or radio-therapy to attack tumor cells that have escaped the primary? In the fraction of patients whose cancer has spread to the lymph nodes (classified as N1, N2, or N3 depending upon the extent of spread), the choice is clear and virtually all are treated systemically. However, in the majority of cases the cancer has not yet spread to the lymph nodes ("N0"), and the choice is less clear. Current data suggests that ~70% of N0 patients that are systemically treated would not have experienced metastases, did not need to suffer the toxic side effects of systemic therapy, and were "overtreated". Hence there is a pressing clinical need to predict exactly who will, and will not, metastasize in this group, in order to minimize overtreatment. We have developed an optical signature that is an independent prognostic indicator of time to metastasis in a cohort of 267 N0 breast cancer patients, independent of age, tumor size, menopausal status, and hormone receptor status. Our method is based upon intrinsic optical signals and hence requires no reagents or alteration of traditional histopathology specimens, and is easily automatable, requiring no assessment of morphology by trained observers. We believe this technique will significantly reduce the extent of "overtreatment" in the patient population, leading to improved quality of life and reduced treatment costs.

36 Small Fragment Removal for Next Generation Sequencing

Barbara Stwertka, William Begley and Lewis Rothberg, Department of Chemistry, University of Rochester (Industrial Sponsor – Diffinity Geonomics)

Next generation sequencing is growing rapidly and revolutionizing high-throughout DNA sequencing. A key part of the process is to attach oligonucleotide "adapters" to various places in fragmented genomic DNA (the "library") and chemically amplify the library prior to reading the sequences and pasting them together using informatic methods. Removal of unattached adapters prior to amplification is critical to obtaining high quality sequence information. Operationally, this involves removal of fragments in the range from 80 – 130 base pairs (bp) and retention of the libraries that are in the range 200 – 300 bp. Our project is aimed at developing rapid chromatographic methods that will accomplish this task. We will report our progress in making nanoporous silica with differential functionalization to accomplish this separation quickly and efficiently.

37 Wearable Electroactive Polymer Biosensors

Kathleen Lamkin-Kennard and Wayne Walter, Department of Mechanical Engineering, Rochester Institute of Technology

Electroactive polymers (EAPs) are a class of polymeric smart materials that change physical properties in response to an external stimulus. EAPs are inherently lightweight, flexible, easy to manufacture, and provide repeatable electrical signals. Although the global market for EAPs is projected to exceed \$3.4 billion by 2017, the use of EAPs for biosensing applications is still in its infancy. Wearable biosensors offer significant potential for non-invasive and non-obtrusive monitoring of a variety of physiological conditions and the novel integration of EAPs into textile biosensors could potentially transform the field of wearable biosensors. One area, in particular, in which robotic biosensors have significant potential to empower individuals in monitoring of their own health, is in the area of peripheral edema monitoring. Lower extremity edema can be a consequence of a variety of disease states, such as heart disease, liver disease, diabetes, arthritis, or lymphedema, or can occur due to pregnancy, injury, medications, or clinical treatments, such as hemodialysis. Left untreated, edema can become painful and lead to skin and circulatory damage or life-threatening conditions, such as deep venous thrombosis. Individuals with lower extremity edema also have a higher risk for infection, injury due to falls, or tissue cancer. Our current research seeks to address this clinical need by characterizing and optimizing the design of a low-cost capacitive biosensor for edema monitoring using dielectric electroactive polymer materials. The primary aims of our research involve experimental characterization of flexible electrode and dielectric materials, material selection and modeling of all individual sensor components, and integration of the flexible components into a wearable garment configuration.

Electrical Engineering, Computer Engineering, and Computer Sciences

38 Neuromemristive Systems for Neurally-inspired Information Processing

Cory Merkel, Microsystems Engineering, Rochester Institute of Technology

A neuromemristive system is a set of neurally-inspired modular circuits, hardware adaptation algorithms, and architectures based on the integration of CMOS and memristor technologies for complex hierarchical computation. These systems offer a promising new approach to a decades-old problem which still lies at the frontiers of computing: How can we integrate human-like characteristics such as intelligence, adaptation, learning, etc. into small, energy-efficient computational systems? Such systems would be transformative in application domains such as anomaly detection, autonomous surveillance, and robotics, among others. In this presentation, we provide an overview of our work related to circuit-level building blocks for neuromemristive systems, including CMOS/memristor hybrid neuron and synapse circuits, as well as hardware training algorithms that allow these systems to learn and adapt.

39 Wireless Sensor Placement Optimization Inspired Protein Side Chain Structure Prediction

Na Yang, Electrical and Computer Engineering, University of Rochester

We conduct an interdisciplinary study that combines the research fields of structural bioinformatics and communications to provide a novel solution to the problem of protein side chain prediction, which offers information critical to pharmaceutical research, such as structure-based drug discovery and rational drug design. We map an approach for sensor coverage optimization for a fixed set of sensors to the problem of protein structure prediction. Rotamer preference and spatial density are taken into consideration when optimizing the atom placement in the three-dimensional space. Preliminary results show that for a testing set of proteins, the proposed algorithm can effectively orient side chains and solve atomic collisions.

40 Superwicking materials and their application in high-performance cooling devices for computer CPU and microelectronics

A.Y. Vorobyev and Chunlei Guo, Institute of Optics, University of Rochester

Recently, we have discovered a superwicking effect in surface nano/microstructures produced by femtosecond laser surface nano/microstructuring technology and created novel superwicking surfaces capable of transporting a large amount of liquid at a high speed even against the gravity due to strong capillary pumping. The enhanced liquid transport rate and mechanical robustness of these materials are beneficial for application in liquid cooling systems. In our presentation, we report a miniature device for cooling computer CPU and microelectronics. The cooling device we developed is a heat pipe, where the circulation of cooling liquid is driven by our novel superwicking materials.

41 Distributed Computing and Network Management in Mobile Ad Hoc Networks Using a Cloudlet Approach and Distributed-Cloud Computing to Support Computationally Complex Bio-Applications

Colin Funai, He Ba, Cristiano Tapparello, and Wendi Heinzelman, Electrical and Computer Engineering, University of Rochester

As the cost of energy continues to rise, it is important to develop energy efficient high performance computing. As previously explored in the volunteer computing platform GEMCloud, mobile devices offer an energy efficient alternative to cloud computing, especially for highly parallelizable applications. However, current mobile device-based volunteer computing systems are limited to devices with Internet connectivity. In this project, we introduce extensions to GEMCloud to enable any device that can network through ad-hoc communications to participate in the volunteer computing platform.

42 Distributed-Cloud Computing to Support Computationally Complex Bio-Applications

He Ba^a, Wendi Heinzelman^a, Jiye Shi^{b, a} University of Rochester, ^b UCB Pharma, United Kingdom

Cloud computing provides an approach to access shared computing resources as a service. Traditionally, the cloud is a group of powerful computers, i.e., servers, personal computers, laptops, etc. However, the traditional cloud computing system usually focuses on performance rather than energy efficiency. As the use of energy resources has raised global concerns, looking for more energy efficient approaches to provide computing power is an urgent task for researchers.

We design and develop a mobile computing system prototype, namely GEMCloud (Green Energy Mobile Cloud), that utilizes distributed mobile devices to cooperatively accomplish large parallelizable computational tasks. The main purpose of designing such a system is to find a green approach by making use of the massive amount of idle computing power on mobile devices. We conduct a public study to analyze the practical operation of our GEMCloud computing infrastructure and to evaluate the feasibility of using mobile devices for volunteer computing.

43 An Interactive Music Editor

Xiaoxi Yang and Zhiyao Duan, Department of Electrical and Computer Engineering, University of Rochester

Music signal processing techniques are now playing a vital role in today's music production. In order to beautify the performance or to achieve special effects, musicians may want to post-process a piece of music after recording, e.g., modify the volume, pitch, and timbre of some note(s) played by some instrument(s). This requires music audio source separation techniques. Soundprism, an online system for score-informed source separation of music audio, has recently shown promising results in separating single-channel music audio sources when the MIDI score is available. This project builds a computer interface for Soundprism, to make it into an interactive music editor. Provided with the MIDI score of a music recording, it allows users to modify the volume, pitch, and timbre of each note of each source of the audio in an intuitive way. After modification, users can remix the sound sources and listen to the results right away. Compared to existing commercial music audio editing software such as Adobe Audition and GoldWave, this is, to our best knowledge, the first editor that allows users to edit each individual source of a music audio recording. During the presentation, we will show some demos of the system, including changing music dynamics, transposing music to another key, and changing instrumentation of some tracks (e.g., making the clarinet track sounds like an oboe). We will also welcome users to play around with this software during the presentation.

44 Weak measurements applied to process monitoring using focused beam scatterometry

Thomas G. Brown, Miguel A. Alonso, Anthony Vella, Michael J. Theisen, Stephen Head, Institute of Optics, University of Rochester

We present a novel strategy for the simultaneous estimation of several structural parameters of deep subwavelength structures, based on the use of the scatterometry of focused beams with spatially-varying polarization distributions. In this technique, the polarization distribution of the illumination is designed such that, following scattering by the structure and filtering by a uniform analyzer, the resulting measured intensity distribution allows the accurate estimation of the desired structure parameters. Numerical simulations and early experimental results will be given to support the validity of the new approach.

The capacity to measure nanoscale features rapidly and accurately is of central importance for the monitoring of manufacturing processes in the production of computer integrated circuits. Parameters of interest include, for example, trench depth, duty cycle, wall angle and oxide layer thickness. The measurement method proposed here uses focused beam scatterometry, in which the illumination consists of a focused field with a suitably tailored spatially-varying polarization distribution. In an analysis that is analogous to classical off-null measurements as well as weak measurements in quantum mechanics, we predict that four or more parameters can be measured and distinguished with an accuracy consistent with the needs laid out in the semiconductor roadmap.

45 **RIT Microelectronic Engineering: Education and Research on Semiconductor Devices**

Michael A. Jackson, Santosh K. Kurinec, Robert E. Pearson, Electrical and Microelectronic Engineering, Rochester Institute of Technology

The Microelectronic Engineering (MicroE) Program at RIT was created in 1982 to meet the workforce needs of the emerging semiconductor industry. Innovative for its focus on photolithography and IC manufacturing, the program remains the only ABET accredited BS degree program of its kind in the nation. Over its 32 year history, the program has placed over 800 undergraduate and 200 graduate (ME and MS) engineers in the semiconductor industry worldwide. With IC technology spawning emerging fields such as MEMS (Micro Electro Mechanical Systems), PV (Photovoltaics or Solar Cells), Solid State Imagers, Displays, and Solid State Lighting, there is no better resource for your educational or research needs. The Microelectronic Engineering faculty collaborated with industry and government to create a 10,000 Sq. Ft. cleanroom facility which enables a range of activity from developmental work of prototype devices on a range of substrate materials and sizes to a complete fabrication of CMOS devices on 150mm silicon substrates. Capabilities include IC Layout, Maskmaking, G and I line photolithography, simulation and modeling, and ion implant, as well as traditional processes of oxidation, diffusion, wet and plasma etch, PVD and CVD, electrical characterization, and metrology.

This poster will familiarize attendees with the current Microelectronic Engineering program. A sampling of the research within the program will include recent work with IBM on Phase Change Memory and an NSF funded project through SiSoC (Silicon Solar Consortium) on Si PV. In addition to its well-established BS and MS programs, MicroE offers short courses on IC Processing and Photovoltaics Science and Technology for engineers and scientists in industry who need a rapid introduction into the basics of micro/nano electronics. Custom versions of these classes are offered to K-12 teachers for their professional development, and to build a network of educators to enhance the STEM pipeline. Because of its innovativeness and alignment to the needs of IC manufacturers, the RIT MicroE program was the partner of choice for regional economic development officers with GCEDC and GRE in their efforts to bring the WNY STAMP initiative to fruition. MicroE at RIT is here to partner with you.

Chemical Engineering, Mechanical Engineering and Materials Science

- 46 Development of Advanced Lubricants to Increase Energy Efficiency and Durability of Wind Turbines**
Dr. Patricia Iglesias Victoria, Mechanical Engineering Department Kate Gleason College of Engineering, Rochester Institute of Technology

Wind resources are a proven source of clean, affordable and sustainable energy. Wind as a fuel source is free, and with modern technology it can be captured efficiently. Wind energy releases no pollution into the environment, and does not contribute to global warming. Also, wind power is a free and inexhaustible ("renewable") source of energy. Unlike fossil fuels such as coal and oil, which exist in a finite supply and which must be extracted from the earth at great environmental cost, wind turbines harness a boundless supply of kinetic energy in the form of wind.

While the wind energy industry has seen rapid growth within the last decade, the cost of maintain the turbines is a major drawback. Wind turbine gearboxes present one of the more challenging current practical tribological problems. Contact failures in gear and bearing components have been the source of costly repairs and downtime of the turbine's drivetrain and actuator [1]. The high cost of maintaining both land-based and off-shore wind turbines is a critical aspect of lowering the cost of wind energy and achieving the US Department of Energy (DOE) scenario of generating 20% of the nation's electricity from wind energy in 2030 [2]. In order to be able to achieve this goal, several lines of action can be followed: improvement of the overall gearbox design, use of surface treatments or coatings to improve the wear resistance of the materials used for the contacting gearbox components, and development of advanced lubricants for wind turbine gearbox applications. Room-temperature ionic liquids (ILs) are potential high-performance lubricants for engineering tribology and precursors of surface protective coatings [3,4]. ILs are salts with melting points lower than 100 °C and have the ability to form stable ordered layers on the contact area between the materials, reducing friction and wear. Recent literature has suggested potential for using room-temperature ionic liquids as lubricants; however, studies on the tribological performance of ILs as additives or neat lubricants for wind turbine applications are still very scarce. For this reason the goal of this project is to investigate the potential tribological benefits of the use of ionic liquids (IL) as neat lubricants and additive of lubricants, in mineral and synthetic oils, on the friction and wear of wind turbine gearboxes.

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47 Optics Rocks Refractive Wings

Alexandra B. Artusio-Glimpse, Daniel G. Schuster, Mario W. Gomes, and Grover A. Swartzlander Jr., Mechanical Engineering and Chester F. Carlson Center for Imaging Science, Rochester Institute of Technology

Radiation pressure and radiation torque on an "optical wing" having a semicircular cross-section allows the rocking frequency to be controlled by an illuminating beam of light. Such cambered refracting particles (optical wings) provide a potential for a wide range of applications from microscopic probes to large-scale space structures such as solar sails. This work explores the dynamics of optical wings rocking on a horizontal surface. The theoretical opto-mechanical dynamics of the system is explored by use of analytical and numerical techniques. When uniformly illuminated from below, a semi-cylindrical wing placed curved side down on a flat surface rocks due both to the gravitational pull and the radiation pressure push. The semicylinder is found to behave as a parametrically driven nonlinear harmonic oscillator such that radiation pressure changes the frequency of rocking oscillation. What is more, we find that above a critical intensity the equilibrium orientation of the wing bifurcates so that the wing stably oscillates about some raised orientation. Solutions to the equation of motion are given for both constant and time varying illumination conditions.

48 Opto-Mechanical Response of a Semi-Cylindrical Rod

Daniel G. Schuster, Alexandra B. Artusio-Glimpse, Mario W. Gomes, and Grover A. Swartzlander Jr., Mechanical Engineering and Chester F. Carlson Center for Imaging Science, Rochester Institute of Technology

Radiation pressure on large solar sails in space may become increasingly viable owing to advances in nano-scale technology. One major area of application is applying high-powered lasers to nano-scale cambered objects to generate optical lift as a result of radiation pressure. It has previously been shown theoretically, and through experiment, that semi-cylindrical rods can move in response to optical lift forces through the refraction and reflection of light. The dynamic response of a semi-cylindrical rod rolling on a surface when exposed to radiation pressure has been analyzed, and was seen to exhibit a classic pitchforking bifurcation in regards to the stable angles of oscillation. It was also determined that when compared to numerical results, an analytical linearization can accurately characterize the response of the system giving a better understanding of the dynamics of this opto-mechanical system.

49 Fluid Dynamics of Liquid Metal Batteries

Douglas H. Kelley, Mechanical Engineering, University of Rochester

Many energy technologies can be understood as far-from-equilibrium fluid systems, including flow batteries, fuel cells, and liquid metal batteries. In such systems, understanding flow dynamics and mixing is key for optimizing performance. We specifically consider magnetoconvection in liquid metal batteries, where mixing in the liquid metal electrode is known to be the rate-limiting step for battery operation. Using laboratory experiments to characterize the flow in terms of operating parameters, we find that flow substantially affects performance by altering the electrode mixing time. Above a critical electrical current density, the convective flow organizes and gains speed, which promotes mixing and would yield improved battery efficiency.

- 50 Cementless High Early Compressive Strength Concretes Based on Blast Furnace Slag**
Ashley Waldron, Valeria Gonzalez, Pablo Santizo, Benjamin Varela; Kate Gleason College of Engineering, Rochester Institute of Technology

Traditionally the Cement and Concrete industries have been a fertile ground for experimentation with the beneficial use of industrial wastes. Some successful examples include the use of shredded rubber tires as lightweight filler in roadway construction and the use of fly ash and ground granulated blast furnace slag as partial substitution for clinker and cement.

This leads to not only environmental benefits but also to economic and performance benefits. The substitution of virgin raw materials by less expensive industrial wastes saves energy, reduces construction costs and it yields concretes with enhanced performance.

- 51 Manipulating Nanoscale Objects from a Remote Location**
Michael Schrlau, PhD, Mechanical Engineering, Rochester Institute of Technology

The multidisciplinary nature of nanoscale science necessitates global collaboration in order to realize the significant societal benefits of nanotechnology. Unfortunately, instrument costs and geographical restrictions hinder progress towards realizing these benefits. Of specific concern is the inaccessibility of nanomanipulators: ultrahigh-precision positioning instruments used in conjunction with high magnification optical and electron microscopes to maneuver objects a thousand times smaller than thickness of a human hair. The goal of this project is to broaden participation in nanoscale science by creating remotely accessible instrumentation that enables a person in one location to perform nanoscale manipulations in another. The objective of this project is to build a low cost telenanomanipulator: a high precision, three-axis manipulator controlled through the Internet; capabilities not currently available.

- 52 Digital Microfluidics: Characterization and Control in Diagnostic Applications**
Michael J. Schertzer, Mechanical Engineering, Rochester Institute of Technology

Although traditional medical diagnostic tests provide reliable results, they often suffer from low throughput, long cycle times, and high labor and material costs. Access to adequate facilities for these traditional tests is also a limiting factor for medical diagnostic applications in remote or developing areas. Lab-on-a-chip devices automate biological protocols to increase throughput while reducing cycle times and labor and material costs. The small size of these devices will also lead to portable solutions that improve service in the health care industry by performing tests at the point of care (i.e. doctor's offices, developing world, field hospitals, etc.). The demand for these technologies is evidenced by the growth of the global point of care molecular diagnostic market which increased from \$360M in 1995 to \$4.8B in 2011 and is projected to reach \$8.0B by 2016.

Digital microfluidics (DMF) is a promising platform for lab-on-a-chip devices. DMF devices can create, move, merge, and mix nanoliter sized droplets by applying electric fields. These devices have low power consumption and high compatibility with biological fluids. Because DMF devices leverage physical phenomena that are important on small scales, they eliminate the need for complex components like channels, pumps, and valves. This reduces fabrication complexity which is attractive for protocols that use many fluids. Furthermore, the geometry of these devices allows for automated real-time sensing of fluid composition without optical access or increased fabrication complexity.

This exhibit will showcase current research in Dr. Schertzer's newly formed Discrete Flow Laboratory (DFL). Highlights include (i) microfabrication of DMF devices, (ii) commissioning a test facility for DMF devices, and (iii) demonstration of droplet creation, manipulation, mixing and splitting on DMF devices. The exhibit will also include results for real time characterization of composition and chemical reactions as well as a novel method to wash particles on DMF devices.



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