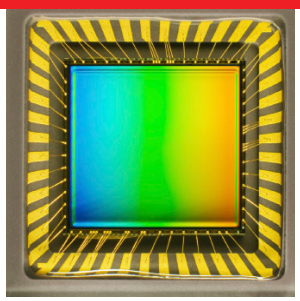
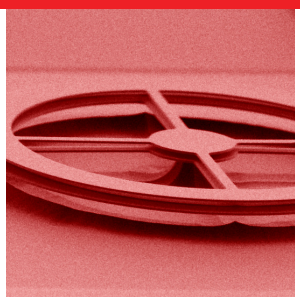
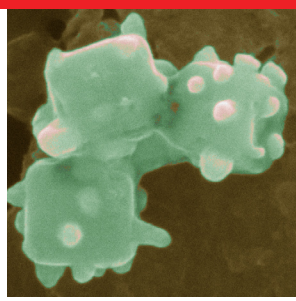
Center for Emerging & Innovative Sciences

University Technology Showcase

Thursday, April 5, 2012

Research Focus Areas:

Optics, Imaging, and Photonics

Biomedical

Microelectronics, Software, and Communications

Energy and Materials

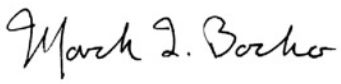
NYSTAR®

Empire State Development
Division of Science, Technology & Innovation

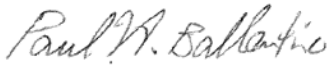
Welcome to the 2012 CEIS University Technology Showcase. We are delighted to present to you over 40 examples of the leading edge technology being developed at the region's universities that have the potential for being the source of innovative products for New York State companies. The goal of this showcase is to initiate and strengthen ties between these companies and universities that will help companies become more competitive and help grow the regional and statewide economy. This year's event showcases research at the University of Rochester, Rochester Institute of Technology, Cornell University, and Clarkson University. In addition we have two plenary oral sessions featuring leading technologists from around the State sharing how their companies and institutions innovate and providing examples of innovative products and services they have developed.

The opportunity for economic growth in the Rochester region and the amount of technology coming out of our region's universities make this event particularly important and timely. The region's economy is rapidly evolving in a number of ways. We are seeing a shift in the region's economy from being heavily dependent on a few large industrial corporations to having job growth driven by many small and mid-sized companies. Many of these companies do not have the resources to support in-house research, making university collaboration an attractive option. We are also seeing a diversification of the types of industries the region depends upon. While Rochester continues to be an international leader in optics, imaging, and photonics, other areas such as biomedical, food processing, energy, software, and a wide array of electronics products are playing an increasingly important role. This ties in very well with the breadth and depth of research at our universities. The posters at this showcase cover research in photonics, biotech, electronics, and energy. And this is just a small fraction of the research that is available for commercialization. Each year over 400 million dollars of sponsored research is carried out at the University of Rochester alone. Throughout Central and Western New York there is over one billion dollars in combined research conducted annually. For local and regional companies this represents a tremendous opportunity to acquire new technologies, develop new products, and expand their businesses.

CEIS is dedicated to facilitating close collaboration and technology transfer between our region's universities and companies. This showcase is one example of creating an environment of collaboration. CEIS also supports industry-sponsored research on campus. We are pleased to have numerous CEIS supported projects on display at this showcase. We are glad you are able to attend today and we hope that you are able to make connections that lead to increased business and economic expansion for our region and New York State.



Mark Bocko, PhD
Director, CEIS



Paul Ballentine, PhD
Deputy Director, CEIS

Sponsors

UNIVERSITY of ROCHESTER

NYSTAR®
Empire State Development
Division of Science, Technology & Innovation

R·I·T

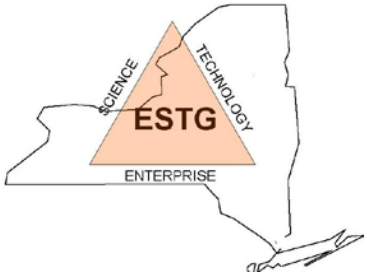
Supporters

the innovator's edge htr

STC SMART SYSTEM TECHNOLOGY & COMMERCIALIZATION CENTER
COLLEGE OF NANOSCALE SCIENCE & ENGINEERING

CNF Cornell NanoScale Science and Technology Facility

The Entrepreneurs Network



MedTech
CONNECTING THE UPSTATE NEW YORK BIOSCIENCES COMMUNITY

CEIS University Technology Showcase
Agenda

1:00 – 6:00 PM
Poster Session

1:45
Opening Remarks

2:00 – 2:30
Joseph Salvo
Manager, Pervasive Decisioning Systems, GE Global Research
"Industrial Internet in the Systems Age"

2:30 – 3:00
Alan Evans
Research Director of Optical Physics and Transmission, Corning, Inc.
"A 40 year perceptive on fiber innovation"

3:00
Break

4:00 – 4:30
Paul Tolley
Vice President, SUNY Albany College of Nanoscale Science and Engineering and Executive Director, Smart System Technology and Commercialization Center of Excellence in Canandaigua
"The Smart System Technology and Commercialization Center (STC)"

4:30 – 5:00
Santokh S. Badesha
Xerox Fellow, Manager of Open Innovation, Xerox Corporation
"Innovation at Xerox: Bridging University and Corporate Research"

Speakers

Santokh S. Badesha
Xerox Fellow and Manager of Open Innovation, Xerox Corporation

Badesha is responsible for leading inter-organizational efforts with both internal and external value chain partners, building academic and industrial partnerships, and providing critical technical support for product programs. These strategic partnerships design and execute front end research to design, develop and deliver functional materials, components, and marking subsystems. In addition, Badesha is a technical liaison for talent development and acquisition and collaborative research to a number of academic institutions including Clarkson University, Rensselaer Polytechnic Institute, Rochester Institute of Technology, PENN State, North Carolina State University and North Carolina Agricultural and Technical State University.

Badesha is also responsible for exploring external funding opportunities from the State and Federal sources with and without external collaborations that include academia and private businesses. In addition, he serves on a number of internal committees which are responsible for IP generation (IPC), IP evaluation (TAP), and IP management (MIP-COMIP)

Badesha joined Xerox in 1980 as a senior research scientist in the Xerox Research Center Webster. He conducted independent research programs to design novel materials for image generation devises. He was appointed principal scientist in 1990, and principal scientist and technical manager in 1994. As manager, he was responsible for providing direction and strategies for materials research and led cross-functional development efforts in high performance materials for component design for marking subsystems. Prior to joining Xerox Badesha was a teaching research fellow at Rensselaer Polytechnic Institute.

Badesha holds Bachelor and Master of Science degrees with honors in chemistry from Punjab University, India. In 1973, he received his Ph.D. in organic chemistry from the Punjab Agricultural University. He received a second Ph.D. in organic chemistry from the University of East Anglia, Norwich, and U.K in 1976. He received an Honorary Doctorate of Science from Clarkson University in 2007 for his contributions to science, technology, and intellectual property, building academic and industrial partnerships, and his help in shaping research programs.

Badesha holds 178 U.S. Patents which have also been filed in multiple foreign countries. This makes him the most prolific inventor ever in the history of Xerox

Dr. Alan Evans
Director of Optical Physics and Transmission, Corning, Inc.

Dr. Evans received his undergraduate degree in applied math, engineering and physics from the University of Wisconsin-Madison and his PhD in Optics from the University of Rochester, Institute of Optics. He joined Corning in 1992 as an optical physics research scientist where he has worked on optical nonlinearities, fiber optic devices, and optical amplification and transmission systems. He led Corning's development of Raman amplifiers and now leads Corning's research in optics with key programs in photovoltaics, optical fiber, laser processing techniques, lasers and bio-optics. Evans is the author of over 40 conference papers, journal articles, and has been awarded 28 patents.

Speakers

Dr. Joseph J. Salvo
Manager, Business Integration Technologies Laboratory GE Global Research

Dr. Salvo joined the GE Global Research Center in 1988. In the mid 1990ís he turned his group's efforts towards developing large-scale internet-based sensing arrays to manage and oversee environmental and manufacturing systems. Most recently, he and his team have developed a number of complex decision engines for GE businesses and their customers (e.g. GE Veriwise, Global Vendor Managed Inventory, Ener.GETM, E-Materials Management, Smart Asset Tracking NBC/Universal) that deliver near real-time customer value through system transparency and knowledge-based computational algorithms. Pervasive networked sensors deliver time-critical, high fidelity data to enable information analysis across business process boundaries. Total supply chain management, energy management and financial services can be integrated to create a virtual enterprise environment that encourages discovery and process improvement on a global basis. Electronic RFID tagging and distributed knowledge networks extend the reach of these systems with anywhere/anytime access to mission critical information. Dr. Salvo is on the board of the MIT Forum for Supply Chain Innovation. He has been awarded over 30 patents worldwide.

Paul Tolley
Vice President, SUNY Albany College of Nanoscale Science and Engineering and Executive Director, Smart System Technology and Commercialization Center of Excellence in Canandaigua

Paul Tolley is the CNSE Vice President for Disruptive Technologies and Executive Director of the CNSE Smart Systems Technology and Commercialization Center of Excellence (STC). Paul is a graduate of Clarkson University and has over 20 years of optics and photonics experience, including a strong custom manufacturing background for demanding programs. Paul's unique combination of strategic vision, technical depth and executive leadership is already paying dividends in terms of STC's increasing revenues and innovative focus on manufacturability in key MEMS markets. Before joining STC, Paul led Syntec Optics for nine years. In that time he spearheaded Syntec's transformation from a small, general-purpose injection-molding firm to an industry leader in the manufacture of custom polymer optic products. Revenues more than tripled because of demonstrated innovation in Bio-metrics, medical, defense, and LED illumination applications, as well as highly collaborative industry relationships. Under Paul's leadership, Syntec Optics was the 2008 recipient of the prestigious Frost & Sullivan Growth Excellence Award in the North American polymer optics market.

In the early years of his career, Paul gained broad experience in engineering, program management and strategic planning at several Fortune 500 companies Active in professional and community organizations, Paul is member of OSA, APOMA, and the Technical Advisory Committee for Homeland Security, as well as a Board Member of the Rochester Regional Photonics Cluster.

Last but not least, Paul holds a US patent for HRDT technology, solving the challenge of diamond- turning high refraction polyethermides, such as Ultem, to optical smoothness every time – without the previously inevitable fissures that were invisible to the naked eye but devastating to performance.

Technology Supporters

T1 **University of Rochester Office for Technology Transfer**

T2 **Smart Systems Technology & Commercialization Center (STC)**

T3 **University of Rochester Center for Entrepreneurship**

T3 **Technical Entrepreneurship and Management (TEAM) M.S. Program at the University of Rochester**

T4 **Cornell NanoScale Science & Technology Facility (CNF)**

T4 **The Cornell Center for Technology Enterprise and Commercialization (CCTEC)**

T5 **Cornell Center for Materials Research (CCMR)**

T6 **MedTech**

T7 **Excell Partners**

T8 **Monroe County Finger Lakes Procurement Technical Assistance Center, (MCFL PTAC)**

T8 **Monroe County Economic Development**

T9 **The Entrepreneurs Network -TEN**

T9 **HTR**

T10 **RIT Offices of Research Relations and Technology Transfer**

T11 **UB Center for Advanced Biomedical and Bioengineering Technology**

T12 **Center for Integrated Research Computing (CIRC)**

T13 **R. Kraft, Inc**

T14 **Hulsey IP Law**

T15 **Pfeiffer Vacuum**

T16 **PTL**

T17 **The Astronomical Telescope of New York (ATNY)**

T18 **TriState Industrial Laundries**

Technology Supporters

T1 **University of Rochester Office for Technology Transfer**

The URMC OTT's mission is to facilitate the transfer of technology arising from URMC research to industry for the benefit of the public good by creating new and useful products and promoting economic development. Successful transfers generate unrestricted funds to support future research, motivate inventors, attract and retain high quality faculty and industrial support for research

T2 **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 College of Nanoscale Science and Engineering (CNSE) of the University at Albany, State University of New York (SUNY). 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, communications, defense, and energy.
Located just outside of Rochester, NY, STC's 120,000-square-foot, state-of-the-art facility includes over 26,000 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 offers the largest array of world-class MEMS related solutions from design to fabrication, packaging and testing, all under one roof.

T3 **University of Rochester Center for Entrepreneurship**

At the University of Rochester, we understand entrepreneurship to mean the transformation of an idea into an enterprise that creates value—economic, social, or cultural. More than a discrete set of business skills or practices, entrepreneurship is a calling that can be pursued in many realms of experience and achievement. A core value of American culture, entrepreneurship uniquely combines the visionary and the pragmatic. It requires both individual initiative and knowledge and, through awareness of markets, attention to the needs of others. Entrepreneurship is a way of thinking, an approach to problems, an attribute of mind, and even a trait of character. It is a science and an art; entrepreneurship is a primary way in which a free society grows and improves not only its economy, but its cultural and social life as well.

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 University of Rochester has recently launched a new joint engineering/business 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 Edmund A. Hajim School of Engineering and Applied Sciences and the William E. Simon Graduate School of Business, students can complete the 32-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. We also provide students with a comprehensive career placement program.

Technology Supporters (con't)

T3 **University of Rochester Center for Entrepreneurship (continued)**

The program is designed for students with a background in engineering, the applied sciences, or mathematics. Prior business or full-time work experience is not required. TEAM students pursue graduate-level engineering courses in one of eight areas: Biomedical Engineering, Chemical Engineering, Computer Science, Electrical and Computer Engineering, Energy and the Environment, Materials Science, Mechanical Engineering, or Optics, while simultaneously learning business, leadership, and entrepreneurial skills. Additionally, TEAM students have the unique opportunity to choose an existing patented technology from the University of Rochester's Offices of Technology Transfer (OTT) and create a business plan for its commercialization. Students can compete for cash prizes in the Mark Ain Business Model Competition and apply for startup funding from angel investors, venture capital firms, and the University's Technology Development Fund. Graduates of this program have the potential to launch their own businesses based on University of Rochester technologies. Learn more about the TEAM program online at www.rochester.edu/team

T4 **Cornell NanoScale Science & Technology Facility (CNF)**

The Cornell NanoScale Science & Technology Facility (CNF) is one of the leading nanotechnology facilities in the country (http://www.cnf.cornell.edu/). Come and learn about the promise of nanotechnology and Cornell's role in this exciting field. We'll have hand-outs and nanofabrication materials to look at and discuss.

T4 **The Cornell Center for Technology Enterprise and Commercialization (CCTEC)**

The Cornell Center for Technology Enterprise and Commercialization (CCTEC) is Cornell University's technology transfer office. We manage technology for Cornell University, Weill Cornell Medical College and the New York State Agricultural Experiment Station in Geneva. Our goal is to support Cornell's land-grant and economic development mission and to promote public good by connecting Cornell technologies and plant varieties to industry product and business development efforts.

Reflective of Cornell's broad research endeavors, CCTEC manages inventions from disciplines including veterinary medicine, nanoscale engineering, chemistry, plant breeding, materials science, and medicine. CCTEC licenses Cornell technologies to industry partners from all 50 states and in Europe, Asia-Pacific, the Middle East, and Central and South America. Cornell inventions are patented in over forty countries.

T5 **Cornell Center for Materials Research (CCMR)**

The mission of the Cornell Center for Materials Research (CCMR) is to explore the science and engineering of advanced materials. Our aim is to be world leaders in the design, control and understanding of the behavior of both crystalline and disordered nanomaterials. CCMR leads also an active and growing Industrial Partnerships Program, designed to accelerate innovation and promote economic development. The program provides simple, flexible and cost-effective ways to industry to collaborate with Cornell University materials experts and to use a suite of sophisticated instruments. Specifically designed programs helped small businesses and startups from New York State develop new products, diversify their product line and enter new markets.

T6 **MedTech**

MedTech is the hub of the bioscience and medical technology industry in Upstate New York. We are an active association of pharmaceutical, biotech and medical technology companies, their suppliers and service providers, and research universities. MedTech boosts the success and growth of our members and the Bio/Med industry in Upstate New York through collaboration, information, education, advocacy, and by trumpeting the story. From its onset in 2004 by four founding members—Bristol-Myers Squibb, ConMed, Sensis, and Welch Allyn—MedTech has grown across Upstate New York and remains committed to the support and development of the region's vibrant Bio/Med industry.

Technology Supporters (con't)

T7 **Excell Partners**

Excell Partners is a unique regional economic development partnership established in cooperation with the University of Rochester and the State of New York to manage a state-supported fund which provides pre-seed and seed stage financing to high-tech start-up companies in the Upstate New York region.

Because of the high risks inherent in very early stage investing, few venture funds make seed investments, particularly in this region. Yet a tremendous research base exists in Upstate NY which generates commercializable technologies. Excell Partners 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.

The mission of the fund is to support regional economic development by **bridging the pre-seed and seed stage funding gap** in Upstate NY while generating sufficient returns so that, over time, the fund becomes self-sustaining.

T8 **Monroe County Finger Lakes Procurement Technical Assistance Center, (MCFL PTAC)**

MCFL PTAC is a program for government contracting guidance. Providing firms counseling on the steps required to sell their products/services to federal / military, state, and local entities.

Helping firms expand their markets to increase revenues and create jobs.

Visit http://www.MonroeCountyFingerLakesPTAC.org

T8 **Monroe County Economic Development**

Monroe County Economic Development's goals are to insure the growth of businesses and jobs in Monroe County. Monroe County's Economic Development division offers incentives through loans, interest subsidies, tax abatements and job training grants. The Division staffs the County of Monroe Industrial Development Agency and Monroe County Industrial Development Corporation. Monroe County Economic Development works closely with the City of Rochester, RG&E, and Greater Rochester Entrerpise to partner on job creating and retention projects in Monroe County.

T9 **The Entrepreneurs Network -TEN**

The Entrepreneurs Network -TEN - is one of Upstate New York's fastest growing initiatives designed to bolster new ventures (early stage technology; life sciences) *AND* established firms (scalable, high-revenue potential; family-owned; and/or ownership transitioning.) TEN members do better: winning government grants and contracts, increasing revenues by retooling sales & marketing strategy, and securing equity financing or traditional sources. If you want to improve your firm's performance, join TEN today!

T9 **HTR**

High Tech Rochester is a non-profit economic development organization driving growth in the Rochester/Finger Lakes region through the Creation, Mentoring, and Incubation of high-tech startup businesses, and through advanced consulting services provided to small manufacturing firms through its NYSTAR-funded Regional Technology Development Center, a member of the Department of Commerce Manufacturing Extension Partnership (MEP) System.

Technology Supporters (con't)

T10 **RIT Offices of Research Relations and Technology Transfer**

Welcome to RIT's Intellectual Property Management Office (IPMO), and Research Relations Offices (RRO); 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. RRO is responsible for connecting RIT's faculty to companies for sponsored research projects.

IPMO Functions:

Identification of inventions and other creations having commercial potential
Marketability assessments
Obtaining and maintaining intellectual property protection
Patents
Copyright
Trademarks
Technology transfer strategy development
Marketing Intellectual Property
Licensing Intellectual Property
Facilitating formation of start-up companies
Outreach and training

Research Relations Functions:

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

T11 **UB Center for Advanced Biomedical and Bioengineering Technology**

The State University of New York at Buffalo Center for Advanced Biomedical and Bioengineering Technology (UB CAT) supports university-industry collaboration in research, education and technology transfer, with a strong focus on helping New York State-based businesses gain a technological edge on their competition. Operating under the auspices of the New York State Office of Science, Technology and Academic Research (NYSTAR), the UB CAT focuses on biomedical and bioengineering research that can lead to development of useful products with commercial potential. By accelerating science and technology transfer, the UB CAT fosters the creation of new biotech start-up companies and helps existing biomedical businesses expand through new or improved product lines. Hand-in-hand with funding, the UB CAT also provides R&D resources and business development assistance, workforce development programming, and other outreach and networking opportunities. For more information, please visit www.bioinformatics.buffalo.edu/cat.php.

T12 **Center for Integrated Research Computing (CIRC)**

The University of Rochester established the Center for Integrated Research Computing (CIRC) in 2008 to provide researchers across the University with hardware, software, training, and support necessary to utilize computational science and computing technology in research activities in all areas of academic scholarship. CIRC supports faculty, staff, and students from over 30 departments and centers, including disciplines from medicine, engineering, and the biological and physical sciences. The Center currently maintains systems with an aggregated computational performance of 40 teraFLOPS, 240 terabytes of disk storage, and a variety of advanced scientific software applications and tools. CIRC hosts a monthly symposium where faculty and students showcase their research to the University community, learn about the application of computing technology to research problems, and participate in discussions that lead to collaborative opportunities. CIRC is available to partner with local businesses for research and development opportunities involving computationally demanding or data-intensive projects. For more information, please visit www.circ.rochester.edu or contact Brendan Mort (brendan.mort@rochester.edu).

Technology Supporters (con't)

T13 **R. Kraft, Inc**

R. Kraft Inc. has been servicing cleanrooms since 1977 with troubleshooting, certification, precision cleaning, training, clean manufacturing consulting, and construction/project management.

T14 **TriState Industrial Laundries**

TriState Industrial Laundries' cleanroom service offers just-in-time, inventory management programs for items meeting Class 10 (ISO 4)and higher cleanroom requirements - coveralls, gowns and shoe covers, as well as wipers, gloves, disposable caps and tacky mats are available. In addition, TriState can package and deliver these items ready for sterilization for your cleanroom facility.

T15 **The Astronomical Telescope of New York (ATNY)**

• New York Astronomical Corporation (NYAC), an NFP entity comprised of 23 New York public and private college and university partners seeks to construct a 12 Meter Optical/Near-Infrared Telescope.

• The telescope is similar to the Keck telescopes but is 1.75 X larger in collecting area.

o ATNY is lighter and simpler than Keck and hence is less expensive.

o ATNY can carry multiple scientific instruments and two are planned for First Light operation.

o If completed within 10 years, ATNY will most likely be the largest telescope in the world by a significant margin.

• Sites under consideration for ATNY include Chile and Hawaii owing to excellence of observing conditions, existing infrastructure to support observatory development and operation and opportunities for collaboration with entities such as the US or Canadian National Observatories.

• Five NY based industrial partners have already partnered in development of concepts for ATNY: Corning Glass, ITT (now Excelis), EMF, Triodetic, and Toptica. As a goal, More than 50% of telescope development funds would remain in New York.

• ATNY would be built and operated for the use of all colleges and universities in NY State; (i) to advance astrophysics and technology in NY, (ii) to enable NY universities to substantially increase their federal grant funding, and (iii) to support growth of technology and science based jobs in NY.

• NYAC is currently initiating feasibility and concept design studies. Development from initiation to completion is anticipated to take 7 years. Pending success of fund-raising efforts, NYAC anticipates the Project to begin in earnest in 2013 and complete in 2020.

• ATNY is projected to cost $105 M based on estimates of early concept designs. The funding is required over a 7-year development period.

• NYAC anticipates securing funding from a number of sources including state government, private donors, partner institutions, and other potential partners including out-of-state institutions and foreign countries as needed.

• Early estimates predict that of order 580 Man-Years of NY State jobs will be created by the ATNY Project including the Project Team, industrial contracts, operations staff, increased faculty and staff at NY college and universities. This anticipates ~20 years of operations following construction.

• ATNY will provide a new major focus and impetus to astrophysics research and technology development in New York that will advance education, technology, science, the economy, and jobs over the next decades.

Contacts: Stefi Baum, Carlson Center for Imaging Science, RIT, 1 Lomb Memorial Drive, Rochester, NY, 585-309-5714 baum@cis.rit.edu and Fred Walter, Department of Physics and Astronomy, Stony Brook University, Stony Brook NY 11794-3800, 631-632-8232, fwalter@mail.astro.sunysb.edu

Technology Supporters (con't)

T16 **Pfeiffer Vacuum**

True to the motto **Vacuum is nothing, but everything to us!** we pride ourselves in finding the right vacuum technology solution for every customer and every application. You will receive high technology and reliable products, competent consulting as well as outstanding service.

T17 **PTL**

Representing the leading manufacturers of state-of-the-art vacuum technology

T18 **Hulsey IP Law**

HULSEY^{IP} is a broad ranging and worldwide practice that focuses on assisting our clients in the following efforts of identifying, protecting, commercializing, and enforcing their valuable IP rights. For a more complete understanding of the many facets of IP:

U. S. & International Patents
U. S. & International Trademarks
Venture Investment IP Due Diligence
Patent Transactions & Strategic Counseling
IP Rights Opinions & Counseling
Patent Mining & Mapping
Patent Portfolio Management
Export Control Counseling & Assistance
Government IP & Licensing Contracts
Licensing, Pooling, & Other Transactions
IP Valuation & Financial Analysis
IP Arbitration & Other ADR
IP Enforcement & Dispute Resolution
Copyright Protection & Licensing
ITC Section 337 Investigations
Patent Interferences
Pre-Trial Strategy & Settlement
Trade Secret Litigation
Trademark Litigation
Counterfeiting/Gray-Market Goods
False Advertising Protection & Prevention
TTAB Litigation

Posters

Energy & Materials

1 **Acid-Base Flow Batteries for Grid Scale Energy Storage**
Mitchell Anthamatten, Jacob Jorne, University of Rochester

2 **Condition Health Monitoring of Reciprocating Compressors for Energy-generation Applications**
Dr. Jason R. Kolodziej, Department of Mechanical Engineering, Rochester Institute of Technology

3 **Absorptive and superwicking materials produced by femtosecond laser technology**
A.Y. Vorobyev and Chunlei Guo, The Institute of Optics, University of Rochester

4 **Surface modification for rapid removal of enzymes from nucleic acid solutions**
Barbara Stwertka[1], Holly Reynolds[2] and Lewis Rothberg[1], 1 Department of Chemistry, University of Rochester 2 Diffinity Genomics

5 **UR Biodiesel**
Ellen Sadri, University of Rochester

Optics, Imaging & Photonics

6 **A Learning Based Framework for Depth Ordering**
Prof. Tsuhan Chen; Zhaoyin Jia, Ph.D, Electrical and Computer Engineering Department, Cornell University

7 **Measuring the MTF of a 2Kx2K Raytheon InSb Detector Array at wave lengths between 1 and 5 microns via Laser Speckle**
Craig McMurtry, Meridel Phillips, Judith L. Pipher (University of Rochester), Paul P. K. Lee, J. Daniel Newman (ITT Geospatial Systems/Exelis)

8 **Tracking on Synthetically Generated Thermal Video**
Kyle Ausfeld, David Rhodes, Zoran Ninkov, Paul P.K. Lee, J. Daniel Newman, Gregory Gosian

9 **Digital CMOS Image Sensors***
Zhe Gao, Mark F. Bocko, Department of Electrical and Computer Engineering, University of Rochester

10 **Using quantum dots to enable deep UV sensitivity for a standard imaging detector**
Ross Robinson, Zoran Ninkov (Both of RIT) Suraj Bhaskaran, Carey Beam (Both of Thermo Fisher Scientific)

11 **Steering of Solar Sails Using the Optical Lift Force**
Alexandra Artusio-Glimpse, Grover Swartzlander, Tim Peterson, Alan Raisane, Center for Imaging Science, Rochester Institute of Technology

Posters (con't)

Optics, Imaging & Photonics (con't)

12 Interplay of cleaning and de-doping in oxygen plasma treated high work function indium tin oxide (ITO)

Irfan Irfan[a], Sachiko Graber[b], Franky So[c], and Yongli Gao[a,d]
[a]*Physics and Astronomy, University of Rochester, Rochester, New York;* [b]*Physics, Grinnell College, Grinnell, Iowa;* [c]*Material Science and Engineering, University of Florida, Gainesville, Florida;* [d]*Institute for Super Microstructure and Ultrafast Process (ISMUP), Central South University, Changsha, Hunan, the Peoples Republic of China*

13 Image & Video Supper Resolution via Compressed Sensing

Survi Kyal[(1)], Sohail Dianat[(1,2)], Lalit K Mestha[(3)]
1. Department of Electrical and Microelectronic Engineering, Rochester Institute of Technology; 2. Center for Imaging Science, Rochester Institute of Technology; 3. Xerox Corporation, {sadeee, sxk8835}@rit.edu, lalit.mestha@xerox.com

14 Nanoscale Silicon Photonic Devices for Ultrasensitive Virus Detection

R. Sriram, D. Basu Roy, J. E. Baker, M. Lifson, A. R. Yadav, S. Pal, P. M. Fauchet, M. Yates, B. L. Miller

15 Coherence measurement through diffraction from a planar binary phase mask : Theory and Experimental result

Seongkeun Cho, Miguel A. Alonso, and Thomas G. Brown, University of Rochester

16 Terahertz Shoe Scanner

Jing Zhang[1], Brian Schulkin[2], Justin James[2], Thomas Tongue[2] and X.-C. Zhang[1,2]
[1]*University of Rochester,* [2]*Zomega Terahertz Corporation*

17 Terahertz Air Biased Coherent Detection

Jing Zhang[1], Jianming Dai[1], Brian Schulkin[2], Justin James[2], Thomas Tongue[2] and X.-C. Zhang[1,2,]
1University of Rochester, 2Zomega Terahertz Corporation

18 Bioelectronics: From Novel Concepts to Practical Applications

Evgeny Katz, Department of Chemistry and Biomolecular Science, and NanoBio Laboratory (NABLAB), Clarkson University

Biomedical

19 Protein Structure Prediction using Communication Theory Techniques

Na Yang and Wendi Heinzelman, University of Rochester

20 Real Time Continuous Monitoring of Blood Glucose

Jayanti Venkataraman, Department of Electrical Engineering, Rochester Institute of Technology
Benjamin Freer, Welch Allyn; Kelly Beam, Harris RF; Mathew Sidley, Harris RF

21 Investigating Presbyopic Corrections with Adaptive-Optics

Len Zheleznyak, Ramkumar Sabesan, Scott MacRae, Geunyoung Yoon, University of Rochester

Posters (con't)

Biomedical (con't)

22 **Using Information from the Face in Interactive Applications**
Yuqiong Wang (B. Thomas Golisano College of Computing and Information Sciences); Joe Geigel (Department of Computer Science) Rochester Institute of Technology

23 **A low-noise, actively compensated non-contact ECG sensor***
GuoChen Peng and Mark F. Bocko, University of Rochester, Department of Electrical and Computer Engineering

24 **Supramolecular Shape Memory Polymers for Biomedical Applications**
Mitchell Anthamatten, Christopher L. Lewis, University of Rochester

25 **Quantitative Tearfilm Imaging: Applications in Dry Eye Diagnosis and Treatment**
Jim Zavislan, Gheorghe Sulahura, Aizhong Zhang, Ranjini Kottaiyan, Geunyoung Yoon, and James Aquavella, University of Rochester

26 **Lateral gradient index microlenses written in ophthalmic hydrogel polymers by femtosecond laser micromachining**
Lisen Xu[1] and Wayne H. Knox[1,2] [1]The Institute of Optics, [2]Center for Visual Science, University of Rochester

27 **Non-damaging Refractive Index Changes in Cornea, Lens, and HydrogelsUsing a High-Repetition-Rate Femtosecond Laser**
Lisen Xu[1], Scott MacRae[2,3], Wayne H. Knox[1,3], Krystel R. Huxlin[2,3] [1]The Institute of Optics, [2]Flaum Eye Institute, [3]Center for Visual Science, , University of Rochester

28 **Calorics Pharmaceuticals: Towards dietary restriction mimetics**
Jonathan I. Millen, Michael S. Madejczyk, Bogdan Polevoda, Andrew Cannon, Matan Rapoport, and David S. Goldfarb Department of Biology, University of Rochester

29 **Illumination devices for photodynamic therapy**
Cristina Canavesi and Jannick P. Rolland, University of Rochester

30 **Bone Mineral Density Features and Support Vector Regression for Predicting the Biomechanical Strength of Proximal Femur Specimens**
Markus B. Huber[1], Chien-Chun Yang[1], Julio Carballido-Gamio[2], Jan S. Bauer[3], Thomas Baum[3], Mahesh B. Nagarajan[1], Felix Eckstein[4], Eva Lochmüller[4], Sharmila Majumdar[2], Thomas M. Link[2], Axel Wismüller[1]
[1]Departments of Imaging Sciences and Biomedical Engineering, University of Rochester
[2]Musculoskeletal and Quantitative Imaging Research, Department of Radiology and Biomedical Imaging, University of California San Francisco, San Francisco
[3]Institut für Röntgendiagnostik, Technische Universität München, Munich, Germany;
[4]Institute of Anatomy and Musculoskeletal Research, Paracelsus Medical University Salzburg, Salzburg, Austria

Posters (con't)

Biomedical (con't)

31 **Microstrip Antennas for Medical implants**
Gregory Moxam and Jayanti Venkataraman, Department of Electrical and Microelectronic Engineering, Rochester Institute of Technology

32 **Photoacoustic imaging of ex vivo prostate: Preliminary results**
Bhargava K. Chinni [a], Keerthi S. Valluru [a], Saugata Sinha [b], Navalgund A. Rao [b], Vikram S. Dogra [a]
[a]Department of Imaging Sciences, University of Rochester; [b]Center for Imaging Sciences, Rochester Institute of Technology

33 **Ultrasound Standing Wave Field Technologies for Engineering Tissues**
Kelley A. Garvin, Denise C. Hocking, Diane Dalecki
Department of Biomedical Engineering and the Rochester Center for Biomedical Ultrasound, University of Rochester

34 **Silicon membranes for microfluidic devices**
James McGrath (presenting), Dean Johnson, Hung Li Chung, Barrett Nehilla
Department of Biomedical Engineering, University of Rochester

35 **Biomedical Engineering Senior Design - Opportunities for Innovation and Collaboration**
Amy L. Lerner, Assoc. Professor, Biomedical Engineering, University of Rochester

36 **MS Program in Medical Technology Innovation**
Amy L. Lerner and Ankur Chandra, University of Rochester

Microelectronics, Software & Communications

37 **Using Software-defined Radios for Protocol Evaluation**
Bora Karaoglu, Surjya Ray and Wendi Heinzelman, University of Rochester

38 **Investigations on Metal-Oxide and Silicon-Based Semiconductors for Thin-Film Electronics**
Q. Li, B.R. Silkey, S. Slavin, T. Mudgal, N. Xiao, P.M. Meller and K.D. Hirschman, Electrical & Microelectronic Engineering Department, Rochester Institute of Technology; R.G. Manley and J.G. Couillard, Corning Incorporated, Science and Technology

39 **Time-resolved carrier relaxation dynamics in thin Si films for photovoltaics applications**
John Serafini,[1] Yuhan Wang,[1] Robert Bellman,[2] Carlo Kosik Williams,[2] and Roman Sobolewski[1]
[1]University of Rochester, Rochester, NY 14627-0231, [2]Corning Incorporated, Corning, NY 14831

40 **Temperature Sensing RRAMs for 3D-IC MPSoCs**
Cory Merkel and Dhireesha Kudithipudi, Rochester Institute of Technology

41 **Silicon Nanophotonics**
Stefan Preble, RIT Nanophotonics Group

Posters (con't)

Microelectronics, Software & Communications

42 On-Chip Power Delivery
Inna Vaisband, Selcuk Kose, Ioannis Savidis, Jonathan Rosenfeld, and Eby G. Friedman, University of Rochester

43 Microstrip Antennas for Medical implants
Gregory Moxam and Jayanti Venkataraman, Department of Electrical and Microelectronic Engineering, Rochester Institute of Technology

44 3D Surface mount Electronics Packaging with Lead-free Solders and Novel Anisotropic Conductive Adhesive
Dr. S. Manian Ramkumar Ph.D., Center for Electronics Manufacturing and Assembly, Rochester Institute of Technology

45 Anechoic Shielded Chamber for Automated Antenna Radiation Pattern and Gain Measurements
Sheldon Palmer, Danielle Walters, Jayanti Venkataraman and George Slack, Department of Electrical and Microelectronic Engineering, Rochester Institute of Technology

Energy & Materials

1 Acid-Base Flow Batteries for Grid Scale Energy Storage

Mitchell Anthamatten, Jacob Jorne, University of Rochester

Flow batteries offer feasible solutions to grid-scale storage of intermittent power. They can have enormous storage capacity since reactants and products are stored externally and, at the same time, offer potentially low cost per kWh. We propose to develop a new type of flow battery with ionomer membranes and porous electrode structures to control the acid and base reaction electrochemically. The flow battery is considered a hybrid between a battery and a fuel cell where hydrogen gas is produced at one electrode and immediately consumed at the other electrode. Major technical challenges include synthesis and fabrication of composite ionomer membranes with high ion conductivity and low ion-pair crossover and management of hydrogen gas.

2 Condition Health Monitoring of Reciprocating Compressors for Energy-generation Applications

Dr. Jason R. Kolodziej, Department of Mechanical Engineering, Rochester Institute of Technology

Compression equipment is a critical component in nearly all energy generation processes. Due to the need for continuous operation of this equipment in many industrial and energy applications there is strong desire by end users to minimize unit downtime for maintenance, or worse due to failed components. The primary purpose of this research is to classify, in a real-time environment, the state-of-health of wear components of a reciprocating compressor. Two subsystems are identified for investigation in this research: (1) the main crankshaft bearings and (2) discharge & suction valves. Prognostic and Health Management in engineering systems is a rapidly evolving field that has a strong application to the compression and energy industries. To date there have been several approaches to condition classification, but very few deal with live condition monitoring of the compressor while in use in an industrial setting. The focus of the work is on data-driven probabilistic approaches, namely various forms of Bayesian classification, that can be implemented on an industrial data acquisition system (online) using sensing common to reciprocating compressors (e.g. temperature, pressure, motor current, crank angle, etc.) The approach will utilize a seeded fault testing technique to derive a statistical basis for the health classification.

3 Absorptive and superwicking materials produced by femtosecond laser technology

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

We have developed a femtosecond laser technology for surface nano/microstructuring of various solids that allows controllably modify their optical and wetting properties. Using this technology, we produced highly absorptive metals and semiconductors, the so-called black metal and silicon. It was found that this femtosecond laser technology is also capable to produce materials with wetting properties ranging from superhydrophilic to superhydrophobic. Our technology is also capable of producing superwicking surfaces that can make liquids run vertically uphill over an extended surface area. The superwicking effect has been demonstrated on a variety of solid materials, including metals, silicon, glass, and biological hard tissues.
The femtosecond laser altering of optical properties may find applications in many areas such as photonics, plasmonics, optoelectronics, optofluidics, stealth technology, airborne/spaceborne devices, solar energy absorbers, and thermophotovoltaics. The materials with unique wetting and wicking properties produced by femtosecond laser processing can find applications in nano/microfluidics, optofluidics, lab-on-chip technology, fluidic microreactors, biochemical sensors, biomedicine, and thermal management.

4 Surface modification for rapid removal of enzymes from nucleic acid solutions

Barbara Stwertka[1], Holly Reynolds[2] and Lewis Rothberg[1], 1 Department of Chemistry, University of Rochester 2 Diffinity Genomics

Enzymes are frequently used to manipulate nucleic acids but typically must be removed after they perform their function. Traditional methods for doing this involve multiple step processes that impede workflow. We have functionalized silica surfaces to selectively adsorb enzymes rapidly from nucleic acid reactions such as restriction digestion in a single step. The surfaces are modified with mixtures of hydrophilic and hydrophobic moieties such that the particles having regions that attract enzymes through hydrophobic effects while remaining sufficiently hydrophobic to disperse well in solution. We have designed functional assays for several common restriction enzymes to assess whether exposure to the mixed functionalization silica particles for 1 minute is adequate to remove enzymes from model nucleic acid restriction digestion reactions.

5 UR Biodiesel

Ellen Sadri, University of Rochester

The community's recent awareness of their impact on the environment has increased the demand for renewable energies to be developed. For this to happen, the new generation of engineers and scientists must have the background and experience to tackle this issue. UR Biodiesel is a student run group at the University of Rochester whose goal is to teach students how to think sustainably and how to produce an alternative energy source. They are taught how to synthesize biodiesel from waste vegetable oil provided by the university dining halls, how to market and distribute it, and how to do quality testing on the product. This business like model allows the student to be prepared for continuing this work after graduation. UR Biodiesel assists the students in their future success and the community in ending their dependence on fossil fuels.

6 **A Learning Based Framework for Depth Ordering**

Prof. Tsuhan Chen; Zhaoyin Jia, Ph.D, Electrical and Computer Engineering Department, Cornell University

Depth ordering is instrumental for understanding the 3D geometry of an image. We as humans are surprisingly good at depth ordering even with abstract 2D line drawings. In this paper we propose a learning based framework for depth ordering inference.
Boundary and junction characteristics are important clues for this task, and we have developed new features based on these attributes. Although each feature individually can produce reasonable depth ordering results, they still have limitations, and we can achieve better performance by combining them. In practice, local depth ordering inferences can be contradictory. Therefore, we propose a Markov Random Field model with terms that are more global than previous work, and use graph optimization to encourage a globally consistent ordering. In addition, to produce better object segmentation for the task of depth ordering, we propose to explicitly enforce closed loops and long edges for the occlusion boundary detection.
We collect a new depth-order dataset for this problem, including more than a thousand human-labeled images with different daily objects in various configurations. The proposed algorithm gives promising performance over conventional methods on both synthetic and real scenes.

7 **Measuring the MTF of a 2Kx2K Raytheon InSb Detector Array at wave lengths between 1 and 5 microns via Laser Speckle**

Craig McMurtry, Meridel Phillips, Judith L. Pipher (University of Rochester), Paul P. K. Lee, J. Daniel Newman (ITT Geospatial Systems/Exelis)

Boreman, Sun and James (1990) provided the ground-work for a laser speckle technique which allows the measure of the modulation transfer function (MTF) of a detector array. Ducharme and Temple (2008) demonstrated the efficacy of a cross aperture for the generation of laser speckle at visible wavelengths with a flat power spectrum over spatial frequencies up to twice Nyquist. This technique allowed measurement of the MTF of a detector array without the need for expensive optics, numerous targets or knife edges in contact with the detector surface. We have adapted their method for infrared measurements at 1.55, 3.16 and 4.5 microns. The infrared optical train differs from that of the visible-wave optical train, because the use of cooled infrared detectors sensitive out to 5 microns necessitates a cooled aperture limiting the background irradiance on the detector array. Unfortunately, the cooled aperture's use affects the power spectrum. The infrared detector array that we used in our experiments was developed by Raytheon originally for the use in low background IR space telescopes for astronomy. We will discuss the results of this experiment and provide a comparison with our knife-edge MTF measurements on the same detector array.

8 **Tracking on Synthetically Generated Thermal Video**

Kyle Ausfeld, David Rhodes, Zoran Ninkov, Paul P.K. Lee, J. Daniel Newman, Gregory Gosian

Collecting data to test algorithms, be it tracking, anomaly detection, etc., is both time consuming and expensive. Here, we show that synthetically produced scenes in the infrared can be used for testing tracking algorithms. The scenes are produced using DIRSIG, TheroAnalytics MuSES, and SUMO. The frames rendered are then laced together as video to test various tracking algorithm on. The thermal target model in the resulting video was compared to collected truth image data for validation. Once generated, the target model in the synthetic video is tracked using various tracking algorithms.

9 Digital CMOS Image Sensors*

Zhe Gao, Mark F. Bocko, Department of Electrical and Computer Engineering, University of Rochester

In our poster, a new architecture for a CMOS image sensor that incorporates a delta-sigma analog to digital converter at each pixel is presented. An indirect-feedback readout architecture is employed in which the digital output of the delta-sigma (SD) modulator is accumulated by a digital counter and converted to an analog voltage that serves as the reference voltage in the modulator's comparator. We also present a time-domain pixel simulator that enables assessment of the major sources of noise in the imager. To increase sensitivity under low light illumination, gain control in the delta-sigma feedback loop is employed. To extend the DR under high illumination an additional comparator is employed to reset the photodiode when it is depleted. Moreover, in order to solve the startup issue of the delta-sigma modulator, a successive approximation (SAR) scheme is also integrated into the modulator, with minor changes to the accumulator in the column circuit design.
A time-domain simulation tool has been developed in the MATLAB programming environment. The simulator includes all relevant noise sources (photon shot noise, readout noise, quantization noise and photodiode reset noise). The simulator also includes the aforementioned pixel gain control and multiple reset capabilities. The simulation shows that with 8 gain settings the new method can achieve over-100dB dynamic range giving high signal to noise images from milli-lux to full daylight illumination. The simulator also enables determination of the optimal gain settings to ensure that the intrinsic photon shot noise is always the dominant source. Employing the adjustable gain scheme the full dynamic range of the imager may be represented with only 15 bits per pixel, with the bits variably allocated between the gain definition and the actual pixel readout value.
Measurements were made on the test chip MOSIS T9AM-AB. Both sigma-delta (SD) and SAR conversions are implemented. Test results show that SAR conversion can serve as the startup phase for SD conversion, but also the samples from the SAR phase can be used as the final readout under high-lighting conditions. The measured noise of the SD readout is 2.17e- (61.93uV) at the photodiode.
* Research supported by ITT Xelis

10 Using quantum dots to enable deep UV sensitivity for a standard imaging detector

Ross Robinson, Zoran Ninkov (Both of RIT) Suraj Bhaskaran, Carey Beam (Both of Thermo Fisher Scientific)

Sensitivity to ultraviolet (UV) light is becoming more important for imaging sensors. For example current generation lithography for integrated circuit production is exposed with 193nm light with future generations moving to even shorter wavelengths down to 13.5nm. Silicon based sensors have poor sensitivity to blue and UV light. Absorption by the gate and clock structures on the front surface prevents a significant portion of the UV light from reaching the active region of the detector. The standard and expensive method to improve blue and UV response is to polish the sensor until it is very thin and illuminate the detector through the back side. As an alternative to back thinning, the sensor may be coated with a fluorescent material to convert blue and UV light into a wavelength to which the underlying sensor is sensitive. The most common coating material is the organic dye used in highlighter pens, Lumogen. Being an organic dye, it can degrade with time, UV total dose and vacuum exposure.
Quantum dots offer a more robust alternative to Lumogen. The color at which they fluoresce is tunable and the dots can be fabricated so that the emitted light is at a wavelength close to that most efficiently detected by the sensor. A method has been developed to coat sensor chips with layers of quantum dots for UV light detection. Patents pending.

11 Steering of Solar Sails Using the Optical Lift Force

Alexandra Artusio-Glimpse, Grover Swartzlander, Tim Peterson, Alan Raisane, Center for Imaging Science, Rochester Institute of Technology

Optical lift is a transverse component of force exerted on a uniformly illuminated body. An "optical flying carpet" is being designed, fabricated, and tested for use as a propellantless component to steer solar sails in outer space. Solar sails are important space vehicles for uses ranging from near-Earth to deep space missions.
This is for the work being done at RIT under Dr. Grover Swartzlander on Optical Lift.

12 Interplay of cleaning and de-doping in oxygen plasma treated high work function indium tin oxide (ITO)

Irfan Irfan[a], Sachiko Graber[b], Franky So[c], and Yongli Gao[a,d]
[a]*Physics and Astronomy, University of Rochester, Rochester, New York;* [b]*Physics, Grinnell College, Grinnell, Iowa;* [c]*Material Science and Engineering, University of Florida, Gainesville, Florida;* [d]*Institute for Super Microstructure and Ultrafast Process (ISMUP), Central South University, Changsha, Hunan, the Peoples Republic of China*

Indium tin oxide (ITO) is extensively used as a transparent electrode in photovoltaic cells and organic light emitting diodes. High surface workfunction (WF) of ITO is a crucial parameter for enhanced device performance. The ITO WF is usually around 4.3 eV without any surface treatment. With surface treatments ITO WF, as high as 5.4 eV has been reported. We designed a surface treatment method with which we achieved substantially high ITO surface work function of over 6.1 eV. The mechanism of enhanced workfunction is explained on the basis of interplay of surface cleaning and de-doping of oxygen vacancies present on the ITO surface. We also investigated the interface formation with copper pthalocynine (CuPc). In the proximity of interface the highest occupied energy level of CuPc was observed to be almost pinned to the Fermi level. We fabricated two simple devices before and after the treatment and observed enhancement in the performance. The current density curve of the treated device is fitted with the Poole-Frenkel space charge limited current density, and a good agreement is observed.

13 Image & Video Supper Resolution via Compressed Sensing

Survi Kyal[(1)], Sohail Dianat[(1,2)], Lalit K Mestha[(3)]
1. Department of Electrical and Microelectronic Engineering, Rochester Institute of Technology; 2. Center for Imaging Science, Rochester Institute of Technology; 3. Xerox Corporation, {sadeee, sxk8835}@rit.edu, lalit.mestha@xerox.com

The goal of this research effort is to investigate and develop techniques for the generation of super-resolution single/multi/hyper-spectral video images using techniques based upon sparse signal representation or compressed sensing (CS). We will focus our algorithm development on the generation of the super-resolution of underlying data of different modalities such as RGB (spatial), thermal or multispectral type images (wavelength), and video (temporal). By training two dictionaries for the low-resolution and high-resolution image patches, one can use the similarities between low and high resolution patches to generate a super-resolution image from a single low-resolution image using the dictionaries and CS technique. The approach is extended to 3-D (video signals) and multi-dimensional signals such as multi/hyper-spectral images.

14 Nanoscale Silicon Photonic Devices for Ultrasensitive Virus Detection

R. Sriram, D. Basu Roy, J. E. Baker, M. Lifson, A. R. Yadav, S. Pal, P. M. Fauchet, M. Yates, B. L. Miller

Detection of biological targets in a rapid, sensitive and multiplexed approach has important applications in varied fields such as biosecurity, clinical diagnostics and basic biology. Established methods such as realtime polymerase chain reaction (rtPCR), enzyme-based immunosorbent assay (ELISA) and DNA microarrays require an external label such as a flurophore or enzyme, and are expensive and operationally complex. There is growing emphasis towards label free optical biosensing techniqes such as surface plasmon resonance (SPR), optical ring resonators and interferometry. Photonic crystal (PhC) based sensors have recently emerged as a promising alternative to the above existing optical sensing technologies. Here we present our design for a nanoscale silicon based two dimensional (2D) PhC biosensor which can detect ultra-low analyte volumes with high sensitivity.

15 Coherence measurement through diffraction from a planar binary phase mask : Theory and Experimental result

Seongkeun Cho, Miguel A. Alonso, and Thomas G. Brown, University of Rochester

A simple scheme is proposed for the measurement of the spatial coherence of paraxial stationary fields, based on the measurements of their radiant intensity following diffraction by a planar binary phase mask with a phase discontinuity. This technique is illustrated through numerical simulations and experimental implementations.

16 Terahertz Shoe Scanner

Jing Zhang[1], Brian Schulkin[2], Justin James[2], Thomas Tongue[2] and X.-C. Zhang[1,2]
[1]University of Rochester, [2]Zomega Terahertz Corporation

This project aims to develop a reliable device capable of retrieving the internal structure of a shoe and performing spectroscopic analysis to identify hazardous materials. Our goal is to develop a real-time shoe scanner that can inspect shoe soles without requiring the passengers to take off their footwear. The shoe scanner will ensure passenger safety, reduce passenger inconvenience, and maintain throughput levels within the current security architecture. We propose a shoe scanner that contains a continuous wave (CW) terahertz (THz) system and a THz Time-Domain Spectroscopic (TDS) system. This work is supported by Zomega Corporation.

17 Terahertz Air Biased Coherent Detection

Jing Zhang[1], Jianming Dai[1], Brian Schulkin[2], Justin James[2], Thomas Tongue[2] and X.-C. Zhang[1,2]
[1]University of Rochester, [2]Zomega Terahertz Corporation

This project aims to develop a suitable approach for remote terahertz (THz) sensing. THz air-biased-coherent-detection (ABCD) uses ambient air or selected gases for both generation and detection of THz waves. This approach allows us to produce a broadband THz wave at a great distance, eliminating a significant amount of propagation loss. Our goal is to develop a THz ABCD system with superior bandwidth, field strength, detection sensitivity, and frequency resolution, which can achieve standoff detection in explosives, weapons as well as non-destructive evaluation of products. This work is supported by Zomega Corporation.

18 **Bioelectronics: From Novel Concepts to Practical Applications**

Evgeny Katz, Department of Chemistry and Biomolecular Science, and NanoBio Laboratory (NABLAB), Clarkson University

The presentation will outline the conceptual foundations of the novel approach to biosensing and bioactuating based on multi-step processing of biochemical signals through biocatalytic/biorecognition processes, adapting ideas recently developed in the field of bioelectronics and biocomputing (biomolecular logic). Biomolecular computing is an emerging field of unconventional computing that attempts to process information with biomolecules and biological objects using digital logic. Enzymatic systems which involve biocatalytic reactions utilized for information processing will be exemplified. Extensive ongoing research in biocomputing, mimicking Boolean logic gates has been motivated by potential applications in biotechnology and medicine. Furthermore, novel sensor concepts have been contemplated with multiple inputs processed biochemically before the final output is coupled to transducing "smart-material" electrodes and other systems. These applications have warranted recent emphasis on *networking* of biocomputing gates. First few-gate networks have been experimentally realized, including coupling, for instance, to signal-responsive electrodes for signal readout. In order to achieve scalable, stable network design and functioning, considerations of noise propagation and control have been initiated as a new research direction. Optimization of single enzyme-based gates for avoiding analog noise amplification has been explored, as were certain network-optimization concepts. We review and exemplify these developments, as well as offer an outlook for possible future research foci. The latter include design and uses of non-Boolean network elements, e.g., filters, as well as other developments motivated by potential novel sensor and biotechnology applications.

Recent advances in **biomedical applications** of enzyme-based logic systems, particularly for the analysis of pathophysiological conditions associated with various injuries will be briefly reviewed. Novel biosensors digitally processing multiple biomarker signals produce a final output in the form of YES/NO response through Boolean logic networks composed of biomolecular systems. The biocomputing approach applied to biosensors leads to a high-fidelity biosensing compared to traditional single-analyte sensing devices. By processing complex patterns of multiple physiological biomarkers, such multi-signal digital biosensors should have a profound impact on the rapid diagnosis and treatment of diseases, and particularly can provide timely detection and alert of medical emergencies (along with immediate therapeutic intervention). The novel biosensing concept has been exemplified with the systems for logic analysis of various injuries, including soft tissue injury, traumatic brain injury, liver injury, abdominal trauma, hemorrhagic shock and oxidative stress. Analysis of cardiac dysfunctions based on the biocomputing approach is feasible.

Biofuel cell implanted in snail and operating *in vivo*.

Other developments in the general area of bioelectronics include novel **biofuel cells operating *in vivo***. The first fully implanted biofuel cell continuously operating in a snail and producing electrical power over long period of time using physiologically produced glucose as a fuel will be discussed. The "electrified" snail, being a biotechnological living "device" was able to regenerate glucose consumed by biocatalytic electrodes, upon appropriate feeding and relaxing, and then produce a new "portion" of electrical energy. The snail with the implanted biofuel cell will be able to operate in a natural environment producing sustainable electrical micro-power for activating various implantable bioelectronic devices.

Overall, integration of bioelectronics, biocomputing, materials science, and bionanotechnology resulted in the novel "smart" bioelectronic systems for **medical, environmental and homeland security applications**. The recent advances in this rapidly developing research area will be outlined.

Biomedical

19 **Protein Structure Prediction using Communication Theory Techniques**
Na Yang and Wendi Heinzelman, University of Rochester

Protein structure prediction has a broad appeal in medication design and side-effect studies, among other medical applications. Though this problem has been studied for years, new methods are needed to further increase the prediction accuracy, as well as to reduce the computation complexity. We investigate backbone-dependent side-chain prediction, using a rotamer library as the score function. Methods in wireless communications are explored for faster protein structure enumeration and validation.

20 **Real Time Continuous Monitoring of Blood Glucose**
Jayanti Venkataraman, Department of Electrical Engineering, Rochester Institute of Technology
Benjamin Freer, Welch Allyn; Kelly Beam, Harris RF; Mathew Sidley, Harris RF

The present work demonstrates real time monitoring of blood glucose using a microstrip antenna in a wireless system where the antenna is strapped on the patient's arm. The antenna is connected to a network analyzer that is automated to make measurements every 15 seconds. The measured shift in the resonant frequency with changes in the glucose level has been interpreted in a Clarke error grid to demonstrate the feasibility of this method. Similar measurements have also been made using blood phantoms primarily because these can be constructed for a wider range of glucose levels. An analytical model is being developed to relate the frequency shift to the glucose level. The insertion loss provides an interesting possibility for including a parameter related to glucose level in the Cole-Cole model that describes the dielectric properties of tissues.

21 **Investigating Presbyopic Corrections with Adaptive-Optics**
Len Zheleznyak, Ramkumar Sabesan, Scott MacRae, Geunyoung Yoon, 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. Current strategies for correcting presbyopia include bifocal and progressive spectacles, multifocal contact lenses and surgically implanted premium intraocular lenses. Our aim is to gain an understanding of the limitations of existing strategies and propose novel methods for overcoming presbyopia. Adaptive-optics is a powerful tool for the manipulation of ocular wavefront aberrations and investigating the impact of presbyopic corrections on through-focus visual performance.

22 **Using Information from the Face in Interactive Applications**
Yuqiong Wang (B. Thomas Golisano College of Computing and Information Sciences); Joe Geigel (Department of Computer Science) Rochester Institute of Technology

Upon seeing a face, our brain automatically processes the facial image and extracts information such as identity, gender, ethnicity, age, emotions, sometimes even more hidden cues including psychological activities, medical status and personality. How do computers interpret the face? How can such information be used in interactive applications?
This poster introduces current advances in facial image analysis and highlights some of the applications that we have been working on in our laboratory which utilize facial information as input.

23 A low-noise, actively compensated non-contact ECG sensor*

GuoChen Peng and Mark F. Bocko, University of Rochester, Department of Electrical and Computer Engineering

Non-contact ECG monitoring is an attractive option in a number of applications such as long-term health monitoring where traditional adhesive ECG sensors would cause skin irritation and require frequent replacement. Also, integrating ECG sensors into furniture, automobile seats and elsewhere in the environment will enable non-invasive sensing of cardiac signals. However, subject-electrode motion is the cause of spurious signals and significant signal distortion. Both the signals of interest, as well as unwanted electromagnetic interference are modulated by changes in the coupling capacitance between the electrodes and subject, which leads to significant distortions. To deal with this issue, we developed and implemented 1st and 2nd order gradiometer electrode designs and integrated these with a very low noise preamplifier to compensate for the loss of signal strength due to the gradiometer structure. The 2nd order gradiometer design shows better performance at reducing motion artifacts over the 1st order gradiometer design on a human subject.
Even with the use of an optimized 2nd order gradiometer electrode design, subject-electrode relative motion still creates signal distortions. Thus, we have developed a further method in which the subject to electrode gap is continuously monitored by a secondary sensing circuit. This secondary circuit uses the same ECG electrodes, the electrodes are multiplexed between the ECG readout and the secondary readout, and its output can be used to correct the gain of the primary ECG monitoring circuit. Preliminary lab demonstrations of this method are presented.
* This research was supported by grants from Blue Highway and the New York State Foundation for Science, Technology and Innovation.

24 Supramolecular Shape Memory Polymers for Biomedical Applications

Mitchell Anthamatten, Christopher L. Lewis, University of Rochester

We are developing polymer networks bearing reversibly associating side-groups that exhibit novel and tunable shape memory properties. Synthesized materials could fulfill a range biomedical roles including programmable sutures, biomedical implants, vibration dampers, and surgical tools. Recently, our studies have focused on modifying hydrogel properties using reversible hydrogen bonding groups. We have examined how reversible binding affects viscoelastic properties of poly(hydroxy ethyl methacrylate), a commercially important biomaterial.

25 Quantitative Tearfilm Imaging: Applications in Dry Eye Diagnosis and Treatment

Jim Zavislan, Gheorghe Sulahura, Aizhong Zhang, Ranjini Kottaiyan, Geunyoung Yoon, and James Aquavella, University of Rochester

We have developed and built a prototype clinical ocular imaging system that measures the thickness of the lipid layer of the human ocular tear film. The system images across an annular region (2 mm inner diameter to 7 mm outer diameter) of the ocular surface at 4.5 measurements per second for up to 45 seconds in red, green and blue regions of the visible spectrum with a lateral resolution at the cornea of 60 µm. Images from the instrument can analyzed to derive the lipid layer thicknesses from 20 nm to over 250 nm with uncertainty of +/- 15 nm. The instrument is operated in a climate controlled room where the relative humidity can be continuously varied from 20 % to 90% and the temperature from 60 °F to 95 °F to explore the eyes response to environmental conditions. This instrument is used to understand the behavior of the lipid layer in various dry eye conditions and also the response of the lipid layer to different environmental conditions and to over-the-counter treatments of dry eye.

26 Lateral gradient index microlenses written in ophthalmic hydrogel polymers by femtosecond laser micromachining

Lisen Xu[1] and Wayne H. Knox[1,2] [1]The Institute of Optics, [2]Center for Visual Science, University of Rochester

Femtosecond laser pulses have been used to change the refractive index inside ophthalmic polymers, up to ~ 0.055. With a complete calibration of refractive index change versus scanning speed, a novel gradient index structure was designed and implemented with a parabolic wavefront. Shack-Hartmann wavefront measurement and Twyman Green interferometry both confirmed the expected parabolic wavefrontin the micromachined region, with an average cylindrical power of 0.64 diopters.

27 Non-damaging Refractive Index Changes in Cornea, Lens, and HydrogelsUsing a High-Repetition-Rate Femtosecond Laser

Lisen Xu[1], Scott MacRae[2,3], Wayne H. Knox[1,3], Krystel R. Huxlin[2,3] [1]The Institute of Optics, [2]Flaum Eye Institute, [3]Center for Visual Science, , University of Rochester

We demonstrated large, refractive index (RI) changes in living corneas, lenses, and hydrogel materials, using femtosecond laser micromachining with laser pulses at both 400 nm and 800 nm wavelength, 100 fs duration, 80 MHz repetition rate, and scanning speeds at 0.1 to 400 mm/s. Changes in wavefront aberrations, RI, and cell biology were measured. The most effective results were found using 400 nm femtosecond laser, increasing RI by 0.02 and 0.04 ± 0.001 at 15 and 5 mm/s, respectively. Such RI change could alter spherical or cylindrical power, without significant damage or shape changes. No corneal wound healing response was seen 10 days post-lasering.

28 Calorics Pharmaceuticals: Towards dietary restriction mimetics

Jonathan I. Millen, Michael S. Madejczyk, Bogdan Polevoda, Andrew Cannon, Matan Rapoport, and David S. Goldfarb Department of Biology, University of Rochester

Calorics Pharmaceuticals is a VC funded early stage drug development company focused on the discovery and development of small molecule drugs with potential to treat diseases associated with aging, including chronic inflammatory and metabolic disorders. Dietary restriction (DR) regimens extend lifespan in model organisms and have numerous health benefits in primates and humans. DR mimetics are drugs that target DR pathways and induce the physiological benefits of DR without altering diet. One class of DR mimetic will target core regulatory pathways that lie upstream of the immune responses that are responsible for the pathogenesis of chronic inflammatory diseases.

Our approach has been to turn the usual target-based approach to drug discovery on its head. The engine of Calorics' drug discovery program is a unique, proprietary high throughput assay that enables the screening of large chemical libraries for small molecules with dietary restriction mimetic-like properties. Using this approach we discovered structurally distinct small molecules that extend yeast lifespan and are active in mammalian disease models. This strategy has led us to proprietary molecules that link increases in longevity to core metabolic pathways and mammalian disease. Our current efforts are aimed at elucidating the physiologically relevant targets of our molecules.

29 Illumination devices for photodynamic therapy

Cristina Canavesi and Jannick P. Rolland, University of Rochester

To date, the lack of light delivery mechanisms remains a barrier to the treatment of cancerous and pre-cancerous conditions with photodynamic therapy (PDT). In this research, we present the design of illumination devices for a targeted delivery of light for PDT, which will facilitate administration of PDT in the clinic.

30 Bone Mineral Density Features and Support Vector Regression for Predicting the Biomechanical Strength of Proximal Femur Specimens

Markus B. Huber[1], Chien-Chun Yang[1], Julio Carballido-Gamio[2], Jan S. Bauer[3], Thomas Baum[3], Mahesh B. Nagarajan[1], Felix Eckstein[4], Eva Lochmüller[4], Sharmila Majumdar[2], Thomas M. Link[2], Axel Wismüller[1]
[1]Departments of Imaging Sciences and Biomedical Engineering, University of Rochester, NY, United States;
[2]Musculoskeletal and Quantitative Imaging Research, Department of Radiology and Biomedical Imaging, University of California San Francisco, San Francisco, United States;
[3]Institut für Röntgendiagnostik, Technische Universität München, Munich, Germany;
[4]Institute of Anatomy and Musculoskeletal Research, Paracelsus Medical University Salzburg, Salzburg, Austria

To improve the clinical assessment of the osteoporotic hip fracture risk, recent computer-aided diagnosis systems explore new approaches to estimate the local trabecular bone quality beyond bone density alone to predict femoral bone strength. In this context, statistical bone mineral density (BMD) features extracted from multi-detector computed tomography (MDCT) images of proximal femur specimens and different function approximation methods were compared in their ability to predict the biomechanical strength. MDCT scans were acquired in 146 proximal femur specimens harvested from human cadavers. The femurs' failure load (FL) was determined through biomechanical testing. An automated volume of interest (VOI)-fitting algorithm was used to define a consistent volume in the femoral head of each specimen. In these VOIs, the trabecular bone was represented by statistical moments of the BMD distribution and by pairwise spatial occurrence of BMD values using the gray-level co-occurrence (GLCM) approach. A linear multi-regression analysis (MultiReg) and a support vector regression algorithm with a linear kernel (SVRlin) were used to predict the FL from the image feature sets. The prediction performance was measured by the root mean square error (RMSE) for each image feature on independent test sets; in addition the coefficient of determination R^2 was calculated. The best prediction result was obtained with a GLCM feature set using SVRlin, which had the lowest prediction error (RSME = 1.040±0.143, R^2 = 0.544) and which was significantly lower that the standard approach of using BMD.mean and MultiReg (RSME = 1.093±0.133, R^2 = 0.490, p<0.0001). The combined sets including BMD.mean and GLCM features had a similar or slightly lower performance than using only GLCM features. The results indicate that the performance of high-dimensional BMD features extracted from MDCT images in predicting the biomechanical strength of proximal femur specimens can be significantly improved by using support vector regression.

31 Microstrip Antennas for Medical implants

Gregory Moxam and Jayanti Venkataraman, Department of Electrical and Microelectronic Engineering, Rochester Institute of Technology

The objective of this work is to design antennas for medical implants that communicate with external monitoring devices operating in the Medical Implantable Communications Service (MICS) band, 402-405MHz. As the trend continues to make implants ultra-small, the antenna also needs to be small and compact without compromising its gain and radiation efficiency. In addition, the optimization of the design, with the antenna embedded in a hostile medium such as the body, is extremely challenging. In the present work, a serpentine microstrip antenna is chosen because of its small footprint which can fit, for example, on the battery housing of implants such as pacemakers, cochlear implants etc. A successful design for a reduced size antenna has been achieved using the software tool, CST, with the antenna embedded in an accurate human torso model with frequency dependent tissue characteristics defined by the Cole-Cole model. A communication link has been established between the antenna placed in the human torso and an external receive dipole antenna. As further validation of the design, a study of the impact on the antenna performance has been done, for different locations of the antenna, such as near the heart, in the head, in the forearm etc. In each case, the dielectric permittivity and conductivity of the tissues have been changed accordingly and the received power versus separation distance has been analyzed.

32 **Photoacoustic imaging of ex vivo prostate: Preliminary results**

Bhargava K. Chinni [a], Keerthi S. Valluru [a], Saugata Sinha [b], Navalgund A. Rao [b], Vikram S. Dogra [a]
[a]Department of Imaging Sciences, University of Rochester; [b]Center for Imaging Sciences, Rochester Institute of Technology

Prostate cancer is the second leading cause of death only behind lung cancer. For the year 2012, it is estimated that about 241,740 new cases of prostate cancer will be diagnosed and 28,170 men will die of prostate cancer (Source: American cancer Society). In patients suspected with prostate cancer, the physician first performs Digital Rectal Exam (DRE) and Prostate Specific Antigen (PSA) test followed by Transrectal Ultrasound (TRUS) guided biopsy if needed. However, all these tests suffer from a high rate of false positives and false negatives and most importantly, neither of them can detect the cancer at early stages thus paving a way for a new and accurate diagnostic modality. Photoacoustic (PA) imaging is a new technique that combines both optics and ultrasound and has a tremendous potential in detecting tissue malignancies noninvasively. We have developed a system that implements PA imaging and can provide focused two-dimensional images of the prostate. The design incorporates a high energy tunable laser (700 – 1000nm) as the source and a linear array transducer to detect the acoustic-lens-focused photoacoustic signals generated from the prostate. The design of an in vivo transrectal PA imaging probe is under way.

33 **Ultrasound Standing Wave Field Technologies for Engineering Tissues**

Kelley A. Garvin, Denise C. Hocking, Diane Dalecki
Department of Biomedical Engineering and the Rochester Center for Biomedical Ultrasound, University of Rochester

The field of tissue engineering strives towards the repair or replacement of diseased or damaged tissues and organs. Achieving the ultimate goal of whole tissue and organ regeneration in vitro could save tens of thousands of lives each year by decreasing the need for tissue and organ transplantations. Currently, the fabrication of fully functional, complex, three-dimensional tissues and organs is hindered by numerous challenges, two of which include the reconstruction of complex tissue organization and the development of a vascular system within the engineered tissue to support cell viability and function. We have developed an ultrasound standing wave field-based technology as a novel cell and extracellular matrix patterning technique for the field of tissue engineering (Garvin et al. 2010). Using our ultrasound technology, we have successfully created various spatial patterns of cells and extracellular matrix proteins in a rapid, non-invasive, and non-destructive manner within three-dimensional engineered tissue constructs. Furthermore, we have demonstrated that our ultrasound standing wave field-based technology holds promise as a novel in vitro tissue vascularization method for the field of tissue engineering. Utilizing this technology, we have successfully formed complex vascular networks throughout three-dimensional engineered tissues (Garvin et al. 2011). Therefore, our ultrasound standing wave field technology has the potential to advance progress in the field of tissue engineering by providing the field with a novel strategy to address two current challenges; reconstructing complex tissue organization, and developing a vascular system within engineered tissue.

References:

Garvin KA, Hocking DC, Dalecki D. Controlling the spatial organization of cells and extracellular matrix proteins in engineered tissues using ultrasound standing wave fields. Ultrasound Med Biol 2010; 36: 1919-1932.
Garvin KA, Dalecki D, Hocking DC. Vascularization of three-dimensional collagen hydrogels using ultrasound standing wave fields. Ultrasound Med Biol 2011; 37: 1853-1864.

34 Silicon membranes for microfluidic devices

James McGrath (presenting), Dean Johnson, Hung Li Chung, Barrett Nehilla
Department of Biomedical Engineering, University of Rochester

Porous nanocrystalline silicon (pnc-Si) is a recently invented nanoporous material that is fabricated into 7-30 nm thick freestanding membranes. Because of this nanoscale thickness, pnc-Si membranes have exceptional properties when used as sieves for molecular separations. Recently our efforts have focused on the integration of pnc-Si membranes in to fluidic devices as electroosmotic pumps, as filters for blood dialysis, and as screens for cellular studies. This presentation will provide an overview of these devices and the applications they support.

35 Biomedical Engineering Senior Design - Opportunities for Innovation and Collaboration

Amy L. Lerner, Assoc. Professor, Biomedical Engineering, University of Rochester

The Biomedical Engineering Senior Design Program at the University of Rochester introduces students to a systematic, customer-driven design and problem solving approach resulting in development of prototype medical devices or research instruments. The program includes a two-semester sequence of courses for which students receive 6 credits. In the fall, students start by benchmarking and analyzing existing medical devices, before joining teams to solve a problem posed by a customer from the University of Rochester faculty, clinicians from our medical center, the local community, or local industry during the remainder of the year. In solving these problems, students generate a formal design proposal, participate in formal design reviews, develop physical prototypes, and test their devices. Following several guest lectures throughout the year, all design teams are expected to thoroughly consider many realistic constraints, including: ethical, economic, manufacturing, social, and regulatory issues. Over the last eight years, our students have completed over 100 projects including: clinical devices, assistive technology, and biomedical research instruments and protocols. We have worked with several corporate partners, both well-established firms and new start-ups, in evaluating new technology and developing novel solutions. Our student teams are supervised by members of the Biomedical Engineering faculty, who provide both technical and project management guidance. Students deliver both prototypes and extensive reports to document all results of testing and considerations for further implementation. Several teams have entered projects in local entrepreneurship and national design competitions, with great success. Other teams have worked with our Office for Technology Transfer to disclose their inventions and develop patent applications. We look forward to conversations with the CEIS community to describe some successful projects and discuss new project possibilities.

36 MS Program in Medical Technology Innovation

Amy L. Lerner and Ankur Chandra, University of Rochester

Recognizing the critical need for advanced training in the design of medical devices, the University of Rochester has just launched a new MS degree focused on Medical Technology Innovation. In our pilot year, students have participated in an 8-week clinical practicum during the summer, followed by one year of coursework including a design practicum. The clinical practicum, in which students shadowed vascular surgeons, cardiologists and cardiac surgeons, allowed an unprecedented view of the clinical environment with clinician-engineer conversations that led to an ideal setting for needs identification. Through extended interactions with clinicians, the students have screened several needs for further consideration and selected key challenges for the two-semester design practicum. Interdisciplinary coursework in device design, cardiovascular science, technical entrepreneurship, and engineering has guided their design process with a goal for the development and testing of proof-of-concept prototypes and generation of intellectual property. Following this pilot year, we plan to increase participation as we broaden and expand the medical device design program to include multiple medical specialties such as orthopaedics and general surgery. For this program, we are looking for potential students as well as interested industry partners.

37 Using Software-defined Radios for Protocol Evaluation

Bora Karaoglu, Surjya Ray and Wendi Heinzelman, University of Rochester

In wireless communications, we oftentimes use software simulators to test new protocols for the Medium Access Control (MAC), Routing or Network layers. Such simulations cannot reflect many of the challenges for real implementation of these protocols, such as clock-drift, synchronization, imperfect physical layers, and interference from different transmissions. Such issues may cripple a protocol that otherwise performs very well in software simulations. Thus, hardware implementation is essential for testing a protocol before any practical deployment. The goal of this project is to set up a reusable hardware framework to evaluate the performance of wireless protocols, in particular the TRACE protocol for real-time communication in mobile ad hoc networks.
The physical (PHY) and the medium access control (MAC) layers of a conventional wireless communication system are implemented in Application Specific Integrated Circuits (ASICs) due to their intensive computational requirements. The algorithms controlling these layers are embedded and thus cannot be changed or upgraded. On the other hand, Software defined radios (SDRs) implement these functions on special re-programmable hardware that allow flexibility for design changes. SORA (Software Radio), developed by Microsoft Research Asia in Beijing, is a SDR platform that satisfies the throughput and timing requirements of modern wireless protocols while utilizing the rich general purpose PC development environment. In this project we use SORA radios to implement the TRACE protocol and determine the challenges in implementing this protocol in a real world communication system.

38 Investigations on Metal-Oxide and Silicon-Based Semiconductors for Thin-Film Electronics

Q. Li, B.R. Silkey, S. Slavin, T. Mudgal, N. Xiao, P.M. Meller and K.D. Hirschman, Electrical & Microelectronic Engineering Department, Rochester Institute of Technology; R.G. Manley and J.G. Couillard, Corning Incorporated, Science and Technology

Metal-oxide thin-film transistors (TFTs) are of high interest in display and imaging array applications which require higher performance over amorphous silicon (a-Si) TFT processes. These materials have demonstrated significantly higher electron mobility than hydrogenated amorphous silicon (a-Si:H), without the added process complexity required by low-temperature polycrystalline silicon (LTPS) manufacturing. Zinc-oxide (ZnO) and indium-gallium-zinc-oxide (IGZO) are metal-oxide semiconducting materials that are candidates for TFT channel layers. Both of these materials are under investigation using sputtering as the deposition method. Material properties and the device performance of fabricated TFTs will be presented.
Low-temperature polysilicon (LTPS) has emerged as a dominant technology for high performance TFTs used in LCD and OLED display products, however there are challenges in scaling excimer-laser annealing (ELA) techniques for backplane manufacturing on large glass panels. Solid-phase crystallization (SPC) offers an alternative method of forming LTPS without the complexity of ELA. While CMOS devices can be realized in SPC-LTPS, there are noted tradeoffs in transistor performance due to inferior carrier mobility. Recent interest in using LTPS for large-format displays has provided the motivation to develop process enhancements for improved SPC-LTPS transistor performance. This work presents a study on the influence of process parameters on both the source/drain and channel regions of TFTs. Factors include dopant ion-implant recipes and annealing conditions using furnace and rapid-thermal processing systems.
Corning Incorporated has developed a bonded silicon-on-glass (SiOG) substrate technology, which can greatly enhance the level of integrated electronics for system-on-panel applications. The CMOS process technology that has been developed for SiOG is compatible with flat-panel display manufacturing, and has demonstrated the highest performance TFTs realized. Process enhancements and device modifications are currently under investigation in the efforts to minimize short-channel effects (SCE) as the device dimensions are scaled well into the submicron regime.

39 Time-resolved carrier relaxation dynamics in thin Si films for photovoltaics applications

John Serafini,[1] Yuhan Wang,[1] Robert Bellman,[2] Carlo Kosik Williams,[2] and Roman Sobolewski[1]
[1]University of Rochester, Rochester, NY 14627-0231, [2]Corning Incorporated, Corning, NY 14831

We have developed a novel, time-resolved spectroscopy system for characterization of amorphous silicon (a-Si) thin films grown on glass substrates for possible applications as absorbers for solar cells. We have implemented a femtosecond all-optical pump–probe spectroscopy method and collected a large family of normalized reflectivity change ($\Delta T/T$) waveforms, measured at room temperature. Carrier lifetime characterization of the individual, ~300-nm-thick, absorber layer provided the much needed feedback on optimization of the Si growth process. The studied Si absorbers exhibited carrier lifetimes on the order of 10s of picoseconds to nanoseconds; thus, any traditional technique would not be capable of accurately resolving their carrier lifetime dynamics. In order to understand the physical mechanisms behind the observed phenomena, we have derived a theoretical model based on three, coupled rate equations, describing time relaxation of photo-excited carriers. The main two channels of relaxation were identified as the carrier trapping and the Shockley-Read-Hall recombination and were implemented in the model. The model fitted the measured $\Delta T/T$ transients very well, suggesting a correlation between the hydrogen content in the film and the trap concentration, as in a-Si, hydrogen can be present as both Si-H and Si-H_2 species.

40 Temperature Sensing RRAMs for 3D-IC MPSoCs

Cory Merkel and Dhireesha Kudithipudi, Rochester Institute of Technology

This work proposes a hybrid temperature sensing resistive random access memory (TSRRAM) architecture composed of traditional CMOS components and emerging memristive switching devices. The architecture enables RRAM-based on-chip memories to also function as area-distributed temperature sensors in 3D-IC multiple processor systems on chip (MPSoCs). The TSRRAM was integrated into an Alpha 21364 processor as an L2 cache, and its accuracy and performance were simulated using SPEC2000 benchmarks and a customized simulation framework. We also propose active and passive sensing mechanisms as means for DTM algorithms to determine on-chip thermal profiles using data from the TSRRAM. The TSRRAM architecture yields a 2.14 K mean absolute temperature error during passive sensing, which is well within the useful range of dynamic thermal management (DTM) algorithms. Furthermore, the design is shown to have only an 8-cycle performance overhead.

41 Silicon Nanophotonics

Stefan Preble, RIT Nanophotonics Group, Email: sfpeen@rit.edu, Website: nanophotonics.rit.edu

Integrated photonic circuits hold the promise to revolutionize fields from computing to biology. The RIT Nanophotonics group (nanophotonics.rit.edu) uses the ubiquitous integrated circuit technology in place today to leverage the ultra high-bandwidth, sensitivity and low power of light. In particular, we are developing all aspects of photonic circuits, from light sources to detectors, and seamlessly integrating them together all on one low-cost platform to make computers communicate faster and realize sensors that can detect minute changes in the environment.

42 On-Chip Power Delivery

Inna Vaisband, Selcuk Kose, Ioannis Savidis, Jonathan Rosenfeld, and Eby G. Friedman, University of Rochester

Supply voltage, current density, and parasitic impedance scale aggressively with each technology generation, making the design of the power delivery system highly challenging. To provide a high quality power delivery system, the power needs to be regulated on-chip close to the load circuitry. With point-of-load power delivery, new design challenges arise that require advanced analog circuit design solutions and accurate, computationally efficient methods for power grid analysis. This paradigm shift in power delivery depends upon the on-chip power management strategy to efficiently utilize the power resources, supporting billions of loads within the design methodology framework. Emerging nanoscale 2-D and 3-D technologies provide the foundation for future high performance, high complexity state-of-the-art ICs. With 3-D nanoscale circuits, in particular, many design challenges arise that require new solutions and novel design methodologies.

Our group has recently produced research that addresses these power generation and delivery challenges. Several integrated circuits has been designed, fabricated, and successfully tested. A 3-D power grid noise test chip and a related design methodology for a distributed rectifier has been examined in a 150 nm three metal layer SOI 3-D circuit. Three wafers are vertically bonded to form a 3-D stack. Noise analysis of three different power delivery topologies is presented. Generation of a 1.2 volt power supply delivering 700 mA peak current is demonstrated using the distributed filter with a switching converter for application to 3-D integrated circuits.

An active filter based hybrid on-chip DC-DC voltage converter was designed and fabricated with a Kodak/TSMC 110 nm CMOS process. The area of the proposed on-chip DC-DC converter is as small as 0.015 mm2, and the converter delivers up to 80 mA with a transient response of 72 ns to 192 ns. This on-chip power supply is appropriate for point-of-load voltage regulation for the noise sensitive portions of an integrated circuit. A novel distributed amplifier-based voltage converter/regulator has recently been designed with Qualcomm and being currently manufactured with TSMC, targeting aggressive transient and phase margin specifications in a 28 nm CMOS technology. The distributed power converter will supply current and voltage demands of up to 600 mA and 600 to 900 mV, respectively, with a transient response of about 10 ns. The converter is designed to provide a stable response under aggressive PVT variations and for a wide range of load impedances.

43 Microstrip Antennas for Medical implants

Gregory Moxam and Jayanti Venkataraman, Department of Electrical and Microelectronic Engineering, Rochester Institute of Technology

The objective of this work is to design antennas for medical implants that communicate with external monitoring devices operating in the Medical Implantable Communications Service (MICS) band, 402-405MHz. As the trend continues to make implants ultra-small, the antenna also needs to be small and compact without compromising its gain and radiation efficiency. In addition, the optimization of the design, with the antenna embedded in a hostile medium such as the body, is extremely challenging. In the present work, a serpentine microstrip antenna is chosen because of its small footprint which can fit, for example, on the battery housing of implants such as pacemakers, cochlear implants etc. A successful design for a reduced size antenna has been achieved using the software tool, CST, with the antenna embedded in an accurate human torso model with frequency dependent tissue characteristics defined by the Cole-Cole model. A communication link has been established between the antenna placed in the human torso and an external receive dipole antenna. As further validation of the design, a study of the impact on the antenna performance has been done, for different locations of the antenna, such as near the heart, in the head, in the forearm etc. In each case, the dielectric permittivity and conductivity of the tissues have been changed accordingly and the received power versus separation distance has been analyzed.

44 **3D Surface mount Electronics Packaging with Lead-free Solders and Novel Anisotropic Conductive Adhesive**

Dr. S. Manian Ramkumar Ph.D., Center for Electronics Manufacturing and Assembly, Rochester Institute of Technology

The continued desire to utilize an alternative to lead-based solder materials for electrical interconnections has led to significant research interest in Anisotropic Conductive Adhesives (ACAs). The use of ACAs in electrical connections creates bonds using a combination of metal particles and epoxies to replace solder. The novel ACA discussed in this paper allows for bonds to be created through aligning columns of conductive particles along the Z-axis. These columns are formed by the application of a magnetic field, during the curing process. The benefit of this novel ACA is that it does not require precise printing of the adhesive on pads and also enables the mass curing without creating shorts in the circuitry, at a considerably lower temperature when compared to solders.
The novel ACA's applicability for PCB-level assembly has been successfully demonstrated by the Center for Electronics Manufacturing and Assembly at RIT. The research at RIT has also characterized the base material properties, analyzed the effect of various process parameters, identified failures, and investigated the ACA's long-term reliability for surface mount PCB assembly. Reliability testing included an investigation of the assembly performance in temperature and humidity aging, thermal aging, air-to-air thermal cycling, and drop testing conditions. For example, it has been shown that by modifying the filler particle size and coating, reliability of >1500 hours in high temperature, high humidity aging (HTHH), and 100 hours in highly accelerated stress testing (HAST) can be successfully achieved.
This poster will highlight the research using the Novel ACA material and findings of the experimentation and reliability analysis that has been completed, including the assembly of Package-on-Package (PoP) 3D stacked components. Mechanical adhesion of the ACA material is found to be comparable and can even exceed the strength of solder. The novel ACA shows considerably uniform performance even after being subjected to multiple solder reflow cycles. The novel ACA's performance and wide range of applicability has shown tremendous promise for future RoHS compliant electronics packaging.

45 **Anechoic Shielded Chamber for Automated Antenna Radiation Pattern and Gain Measurements**

Sheldon Palmer, Danielle Walters, Jayanti Venkataraman and George Slack, Department of Electrical and Microelectronic Engineering, Rochester Institute of Technology

With the rapid advances in wireless technology at frequencies in the low gigahertz region, the assessment of an antenna's design and performance has become very challenging. The objective of this project is to design, construct and calibrate a shielded anechoic chamber (8ft x 12ft x 8ft) that will minimize reflections of the source antenna, shield the test antenna from spurious electromagnetic radiation and be capable of making automated measurements of the antenna gain and radiation pattern in the frequency range 2GHz to 6 GHz. The RF absorber that ranges from 4" to 12" cones glued to the walls, has been placed judiciously to ensure higher absorption in the specular regions of the chamber that define the first reflection from the sides, roof and floor, and on the walls behind the transmit and test antennas with lower absorption in the corners. The transmit antenna is an elliptical dish powered by the Agilent N5181A signal generator. A rotating platform has been designed and constructed, that allows for different heights and widths of test antennas. The angular position of the test antenna placed on the rotating platform with respect to the transmit antenna is determined by synchronizing a DC motor with an Agilent spectrum analyzer using LabVIEW. The gain and radiation pattern of some antennas have been measured successfully. This chamber resides in the Electromagnetic Theory and Applications (ETA) Lab in the Electrical Engineering Department at the Rochester Institute of Technology. It was constructed with support and guidance provided by SRC Syracuse and Kodak, Rochester.

Center for
Emerging & Innovative
Sciences

P.O. Box 270194
Rochester, NY 14627-1094
(585) 273-2642
(585) 276-0200
www.ceis.rochester.edu