

# 2017 Highlights Report



**I ILLINOIS**

Micro & Nanotechnology Laboratory

COLLEGE OF ENGINEERING

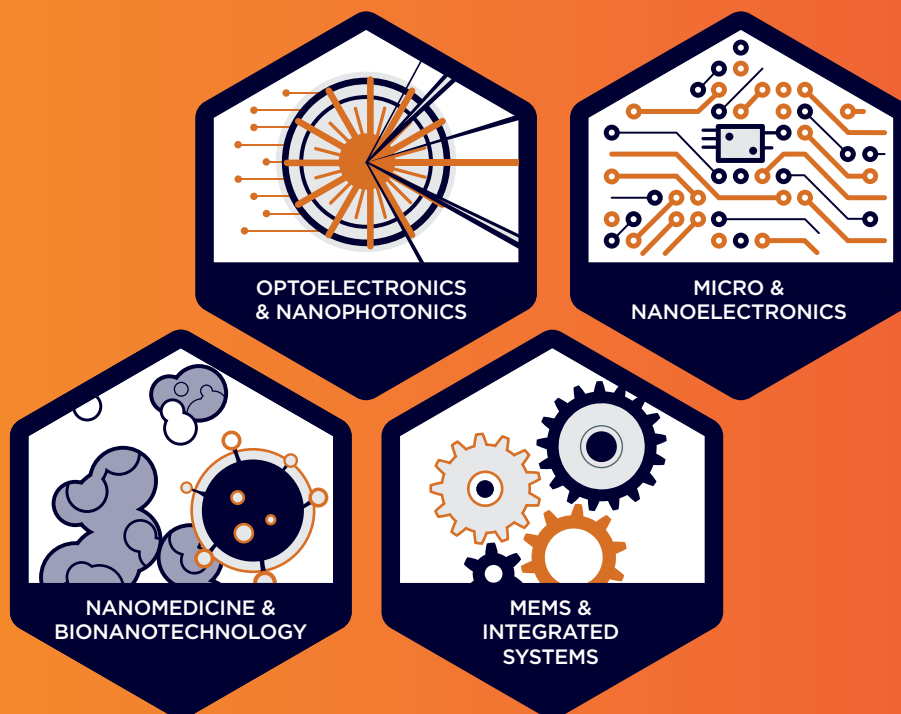
# InstruMNTL

“Nanoscience is impossible to do by yourself because all the tools and expertise we need are beyond any one professor’s budget. Being in a facility like MNTL makes a huge difference. The well-developed facilities and easy-to-use shared tools that are available influenced my decision to come here. I am also really excited to get to collaborate with all of the world-class scientists working here.”

Professor Arend van der Zande

*Assistant Professor, Mechanical Science & Engineering*

*Affiliated with the Beckman Institute for Advanced Science and Technology, Materials Research Lab, and Micro & Nanotechnology Laboratory*



Founded in 1989 as a lab unit of the College of Engineering, MNTL has grown to become one of the nation’s largest and most sophisticated university-based facilities for semiconductor, nanotechnology, and biotechnology research. It contains over 8,000 square feet of class 100 and class 1000 cleanroom laboratory space and state-of-the-art, ultra-high-speed optical, electrical device, and circuit measurements equipment. MNTL houses facilities that are available for use by university and industrial scientists from across the U.S. Our faculty, researchers, and students collaborate with educational institutions and industries from around the world.

# Director's Message

Welcome to the Micro & Nanotechnology Laboratory Highlights for the 2017 academic year. It was a year that witnessed the start of new research initiatives, welcoming new faculty to our family, and recognition of the accomplishments of our talented students. MNTL is among the most advanced academic research facilities in the world, supporting exploration of microelectronics, photonics, bionanotechnology, and micro-electromechanical systems. We work with applications that range from next-generation optics-based data communication, new forms of biomedical imaging, disease diagnostics, wireless communications, LED lighting and solar energy, to flexible electronics, and much more. The excellence of our faculty and students is matched by a dedicated staff of professionals who ensure laboratory safety, train students to use sophisticated lab tools, and support the business of performing research.

In the pages of this report, you will see a snapshot of the fundamental research that incorporates novel theory, material science, fabrication methods, devices, circuits, integrated systems, and instrumentation that truly spans the continuum from atoms to systems. You will also notice that MNTL continues on a path toward increasingly interdisciplinary research, with collaborations that extend outside the walls of our building to integrate the contributions of chemists, biologists, clinicians, and industrial partners. It is truly an exciting time to be a student at MNTL, as the campus plans to launch the new engineering-based Carle Illinois College of Medicine's inaugural class in Fall 2018, while at the same time a new Cancer Center, NSF-supported NanoManufacturing Node, and a new collaboration with the Carl R. Woese Institute for Genomic Biology on the topic of cancer diagnostics are all coming online.

Please keep in touch with us and consider subscribing to our InstruMNTL newsletter for news and regular updates.



*Brian T. Cunningham*

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“These simulation tools could save significant time and money while providing valuable insight on how to refine critical process steps in nanomanufacturing.”

## University Launches First U.S. Nanomanufacturing Node

Illinois researchers have been awarded a five-year, \$4 million grant by the National Science Foundation (NSF) to launch the nation’s first computational node aimed at developing nanomanufacturing simulation tools. The nanoMFG Node’s mission is to be the engine for design, simulation, planning, and optimization of highly relevant nanomanufacturing growth and patterning processes.

**Kimani Toussaint** (PI and Director), **Narayana Aluru** (Co-PI), **Elif Ertekin** (Co-PI), and **Placid Ferreira** (Co-PI), all faculty members from the Department of Mechanical Science & Engineering (MechSE) at Illinois, will lead this effort, along with Hayden Taylor (Co-PI) who is from UC, Berkeley.

Clarifying the Node’s goals, Toussaint said: “To make nanomanufacturing economically viable, we envision end-users getting onto the nanoHUB cyber platform and simulating every stage in the manufacturing of a nano-enabled product. These simulation tools could

save significant time and money while providing valuable insight on how to refine critical process steps in nanomanufacturing.”

The Node team aspires to create tools in areas ranging from nanoscale transport phenomena models to nanoscale self-assembly. The Node will provide many opportunities for student engagement through summer workshops that will be open to Illinois students as well as students from all over the country. There will also be engagement with industry in order to keep the tools developed relevant to industry needs.

The team plans to develop computational tools that have been validated by experiments by collaborating with many of the facilities and centers at Illinois, including the Materials Research Laboratory and the Micro-Nano-Mechanical Systems Cleanroom Laboratory. They also plan to collaborate with the National Center for Supercomputing Applications at Illinois for software development and design.

*MechSE professors Placid Ferreira, Kimani Toussaint, Narayana Aluru, and Elif Ertekin*



## New Plasmonic Sensor Improves Early Cancer Detection

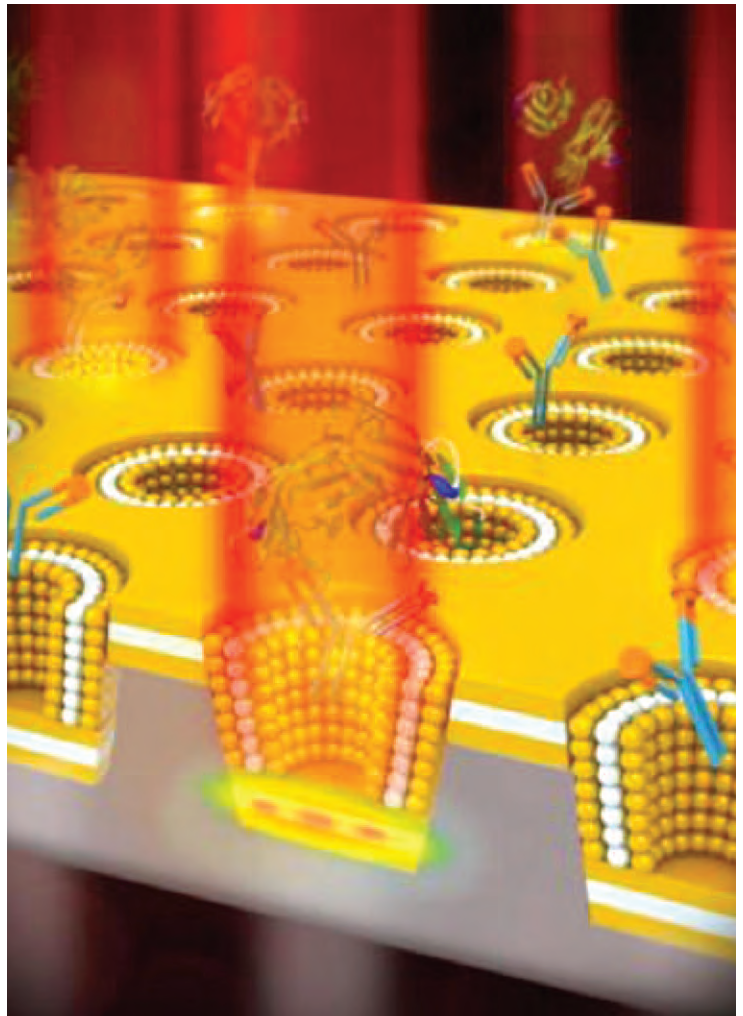
A new plasmonic sensor developed by Illinois researchers will serve as reliable early detection of biomarkers for many forms of cancer and eventually other diseases. The research team is led by Professor **Lynford Goddard** and Associate Professor **Logan Liu**, both of Electrical & Computer Engineering (ECE), with students **Abid Ameen** and **Lisa Hackett** carrying out the project.

The team published its results in *Advanced Optical Materials* as a cover article.

The sensor has been proven reliable to detect the presence of the cancer biomarker carcinoembryonic antigen (CEA) to the magnitude of 1 nanogram per milliliter. Most humans carry at least some amounts of CEA, with an average range of 3-5 nanograms per milliliter. The researchers chose to focus on CEA because its presence in higher concentrations is an early indicator of many forms of cancer, including lung and prostate cancers.

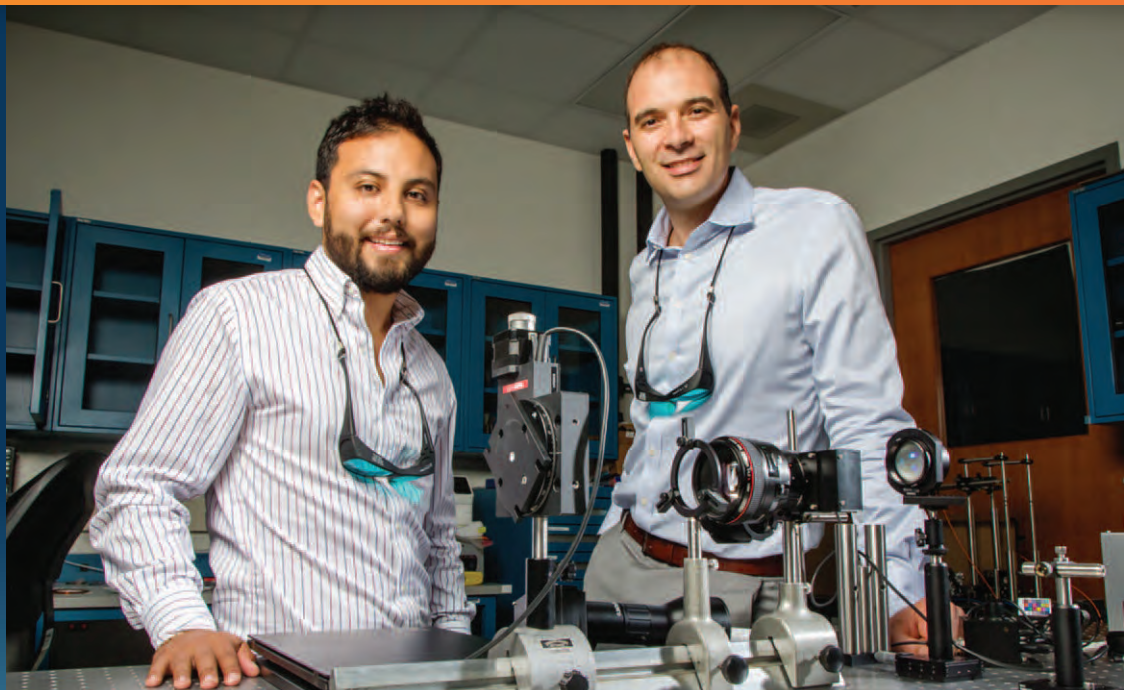
The device combines two sensing methods, which hadn't until this time been able to be used together. First, it uses a 3D multi-layer nanocavity in a nanocup array, and secondly, it uses plasmonic sensing.

The plasmonic sensor is an improvement over the current state-of-the-art method as it is able to improve the limit of detection by at least two orders of magnitude. Secondly, because it works with much less instrumentation, it is less expensive and more portable. This aspect will be especially important for those who don't live close to an advanced medical facility, including those in developing nations.



*A plasmonic nanocavity biosensor design enables detection of clinically relevant concentrations of the cancer biomarker CEA.*

“The notion that we can detect early formation of cancer is what is driving this research forward. The cost of this technology is less than \$100, which will enable quality health care in resource-limited places around the world.”



*ECE Professor Viktor Gruev, right, and graduate student, Missael Garcia*

## Mantis Shrimp-inspired Camera Enables Glimpse Into Hidden World

By emulating the eye of the mantis shrimp, MNTL researchers have developed an ultra-sensitive camera capable of sensing both color and polarization. The bioinspired imager can potentially improve early cancer detection and help provide a new understanding of underwater phenomena, the researchers said. Findings were reported in the journal *Optica*. **Viktor Gruev**, Professor of Electrical & Computer Engineering, MNTL affiliate, and co-author of the study, in collaboration with graduate student **Missael Garcia**, led an effort to replicate the shrimp’s visual system using some basic physical concepts.

“The same laws of physics that apply to the mantis visual system also apply to silicon materials, the material used to build our digital cameras,” Garcia said. “By stacking multiple photodiodes on top

of each other in silicon, we can see color without the use of special filters. And by combining this technology with metallic nanowires, we effectively have replicated the portion of the mantis shrimp visual system that allows it to sense both color and polarization.”

Gruev further explained that “By mimicking the mantis shrimp visual system, we have created a unique camera that can be used to improve the quality of our lives. The notion that we can detect early formation of cancer is what is driving this research forward. The cost of this technology is less than \$100, which will enable quality health care in resource-limited places around the world.”

The National Science Foundation (NSF) and the Air Force Office of Scientific Research supported this study.

## van der Zande to Lead Team Studying Novel Nanomaterials in New NSF Center

The University of Illinois was awarded a Materials Research Science and Engineering Center (MRSEC) by the National Science Foundation in 2017. The NSF awards approximately eight to ten MRSECs at a time, many of them renewals. There are currently about 20 of these centers in the U.S. This marks the first time that Illinois has received such a center.

The new MRSEC is supported by a six-year, \$15.6M grant and will focus on two types of materials. One group will study new magnetic materials, where ultra-fast magnetic variations could form the basis of smaller, more robust magnetic memory storage. A second group, led by a team in the Department of Mechanical Science & Engineering (MechSE), will design materials that can withstand large mechanical deformations, like bending and

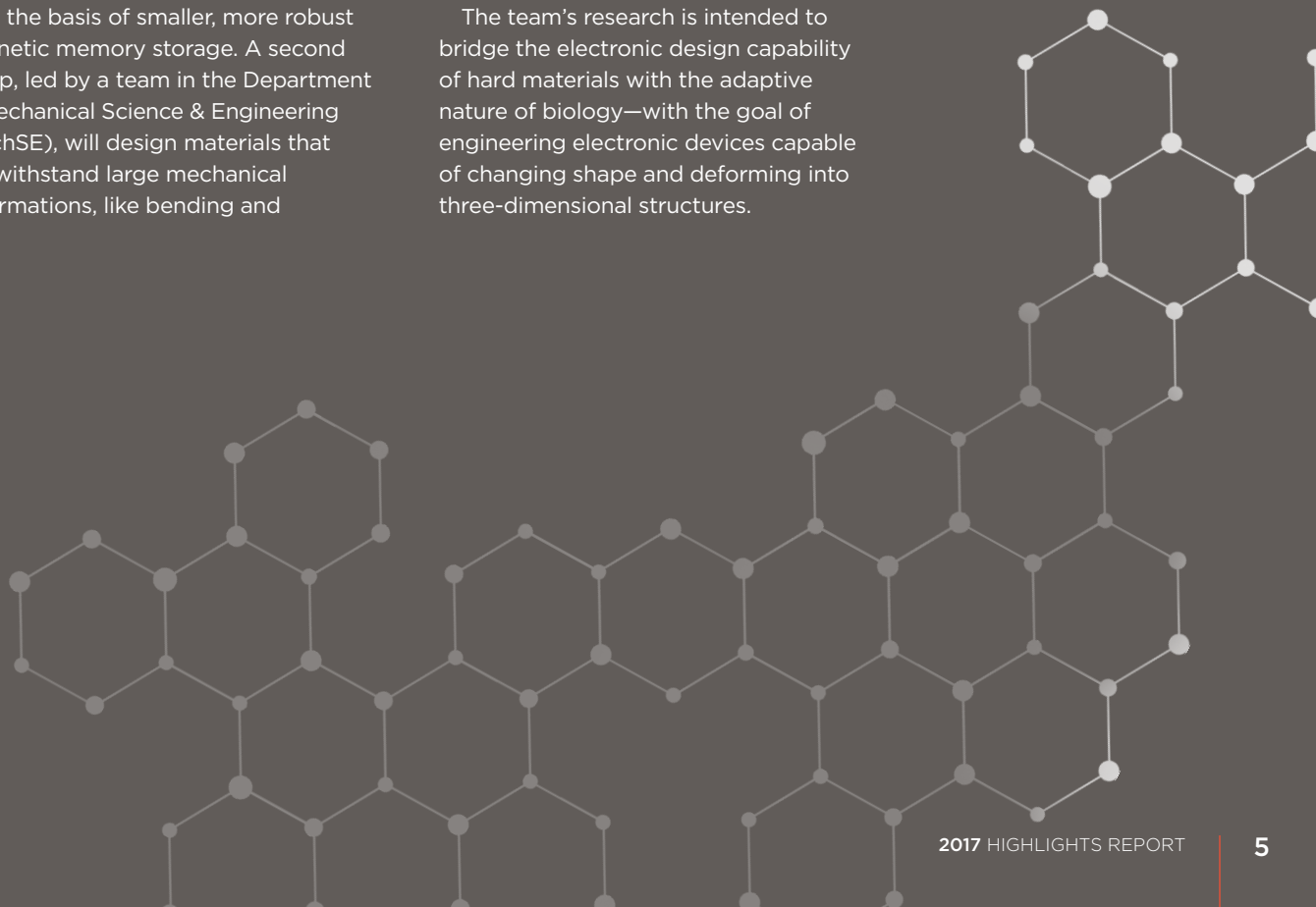
crumpling, that typically destroy the properties of those materials—and even create materials where the deformation enhances performance.

This interdisciplinary research proposal entitled “Active Interfaces and Highly Deformable Nano-Materials,” is co-led by MechSE Assistant Professor **Arend van der Zande** and Bioengineering Professor **Rashid Bashir**. MechSE professors **Narayana Aluru**, **Elif Ertekin**, **Pinshane Huang**, and **Sungwoo Nam**, along with **Nadya Mason** (Physics), and **Catherine Murphy** (Chemistry) are also part of the group.

The team’s research is intended to bridge the electronic design capability of hard materials with the adaptive nature of biology—with the goal of engineering electronic devices capable of changing shape and deforming into three-dimensional structures.



*Arend van der Zande*



“MBE was ideally suited for this research because it enabled us to monitor the surface in situ—while we’re growing it—and we can control the germanium deposition down to the sub-monolayer level.”

## Growth Method May Enable New Properties for Next-Generation Semiconductor Devices



*Minjoo Larry Lee*

Electrical & Computer Engineering (ECE) faculty member and researcher at MNTL, **Minjoo Larry Lee**, and his students, have demonstrated a novel crystal growth method for making semiconductor nanocomposites that could one day lead to better-performing devices like integrated circuits chips and lasers. Nanocomposites are formed when nano-sized particles are embedded in a matrix in order to improve certain material properties.

Lee’s team used molecular beam epitaxy (MBE) to grow germanium (Ge) nanowires in a matrix made of indium aluminum arsenide (InAlAs), a well-studied semiconductor material used in telecom applications.

According to Lee, MBE provides a great deal of control and is easier to monitor than other crystal growth methods. “MBE was ideally suited for this research because it enabled us to monitor the surface in situ—while we’re growing it—and we can control the germanium deposition down to the sub-monolayer level,” said Lee about the growth innovation known as spontaneous phase separation.

The nanocomposites enable strain engineering at the nanoscale, resulting in novel and enhanced optoelectronic properties. Strain engineering is widely used to make quantum well lasers for long-haul telecommunications, and silicon chips for digital electronics products. In both cases, strain induces changes to the active material’s bandgap and “density of states,” leading to properties and performance that would be otherwise unattainable. “This growth mechanism allows us to impose new strain states that are difficult to get to in almost any other way,” said Lee. In the coming months, Lee will try to extend the phase separation technique to other semiconductor materials—both for the matrix and the nanostructure. This research was supported by a grant from the National Science Foundation (NSF).



## New Physics Laws May Enhance Performance of Widely Used Lasers

A team of University of Illinois researchers at MNTL recently applied new theoretical physics concepts to enhance the performance of a well-established semiconductor laser technology. Electrical & Computer Engineering (ECE) Professor **Kent Choquette** and students in his group have reported parity-time (PT) symmetry breaking in an electrically injected, room temperature vertical-cavity surface-emitting laser (VCSEL) array for the first time.

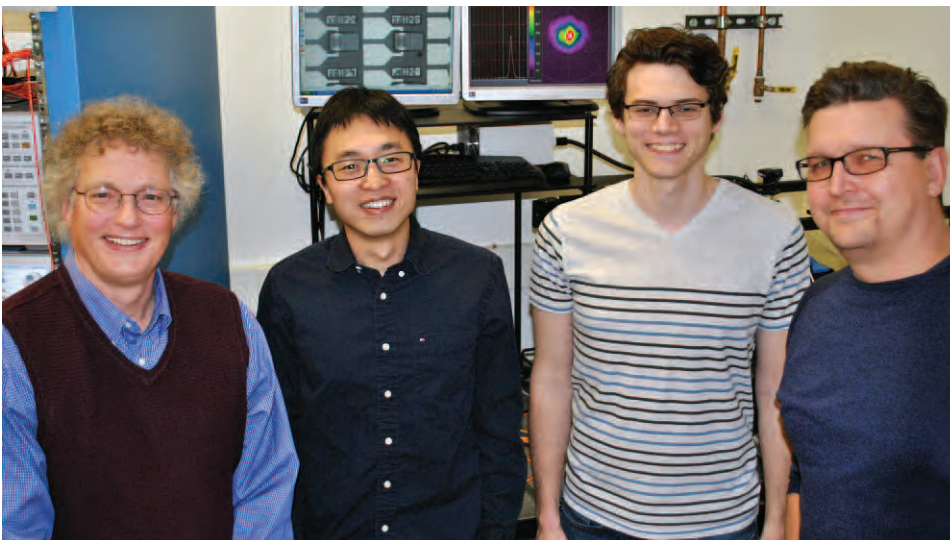
Choquette's group demonstrated a viable VCSEL platform to showcase PT symmetry phenomena; the foundation has been set to explore significant advances in VCSEL technology, such as higher single-mode power, electronic beam steering, and faster data-transmission rates.

**Zihe Gao**, the lead author of the research study, was inspired to apply

the PT symmetry concepts to VCSEL technology after attending the IEEE Photonics Conference (IPC) in 2015. "While prior work demonstrated the physics, I realized that we may have the right technology platform to bring the physics to applications," noted doctoral student Gao, whose work has opened up a new field of interdisciplinary research. Until now, researchers had explored PT symmetry phenomena using either optically pumping or at cryogenic temperatures, neither of which are practical for real-world applications.

The Illinois team reported these findings in the journal *Optica*. Other team members included: ECE graduate students **Stewart T.M. Fryslie**, **Bradley J. Thompson**, and ECE Professor **Scott Carney**. Their work was supported by the National Science Foundation.

"While prior work demonstrated the physics, I realized that we may have the right technology platform to bring the physics to applications."



Left to right: ECE Professor Kent Choquette, graduate students Zihe Gao and Brad Thompson, and ECE Professor Scott Carney



Milton Feng

“Building a transistor with electrical and optical bistability into a computer chip will significantly increase processing speeds because the devices can communicate without the interference that occurs when limited to electron-only transistors.”

## Researchers Develop Transistors that Can Switch Between Two Stable Energy States

Modern computers are limited by a delay formed as electrons travel through the tiny wires and switches on a computer chip. To overcome this electronic backlog, engineers would like to develop a computer that transmits information using light, in addition to electricity, because light travels faster than electricity.

Having two stable energy states, or bistability, within a transistor allows the device to form an optical-electric switch. That switch will work as the primary building block for development of optical logic—the language needed for future optical computer processors to communicate, said **Milton Feng**, the Nick Holonyak Jr. Emeritus Chair in Electrical and Computer Engineering and the team lead in a recent study.

In their study, the researchers describe how optical and electrical bistable outputs are constructed from a single transistor. The addition of an optical element creates a feedback loop

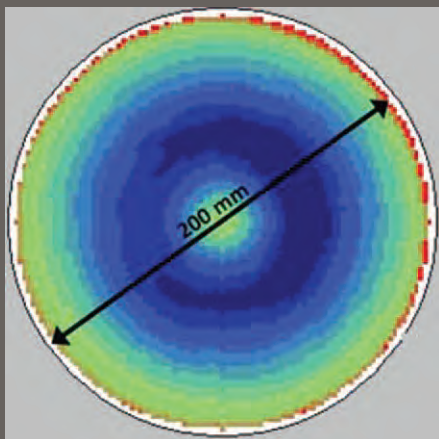
using a process called electron tunneling that controls the transmission of light. The team published its results in the *Journal of Applied Physics*.

In 2004, Feng and Nick Holonyak, the Bardeen Emeritus Chair in Electrical and Computer Engineering and Physics, discovered that light—previously considered to be a byproduct of transistor electronics—could be harnessed as an optical signal. This paved the way for the development of the transistor laser, which uses light and electrons to transmit a signal.

“Building a transistor with electrical and optical bistability into a computer chip will significantly increase processing speeds,” Feng said, “because the devices can communicate without the interference that occurs when limited to electron-only transistors.”

The U of I Department of Electrical & Computer Engineering supported this research.

## Team Advances GaN-on-Si Technology Toward Scalable High Electron Mobility Transistors



GaN on 200-mm Si wafer thickness mapping image.

A research team led by **Can Bayram**, Assistant Professor of Electrical & Computer Engineering (ECE) at MNTL has advanced gallium nitride (GaN)-on-silicon transistor technology by optimizing the composition of the semiconductor layers that make up the device. Working with industry partners Veeco and IBM, the team created the high electron mobility transistor (HEMT) structure on a 200-mm silicon substrate with a process that will scale to larger industry-standard wafer sizes.

After studying three different buffer layer configurations, Bayram's team discovered that thicker buffer layers

made of graded AlGaN reduce threading dislocation, and stacking those layers reduces stress. With this type of configuration, the team achieved an electron mobility of 1,800 cm<sup>2</sup>/V-sec.

"The less strain there is on the GaN layer, the higher the mobility will be, which ultimately corresponds to higher transistor operating frequencies," said **Hsuan-Ping Lee**, an ECE graduate student researcher leading the scaling of these devices for 5G applications.

According to Bayram, the next step for his team is to fabricate fully functional high-frequency GaN HEMTs on a silicon platform for use in the 5G wireless data networks.

When it's fully deployed, the 5G network will enable faster data rates for the world's 8 billion mobile phones and will provide better connectivity and performance for Internet of Things (IoT) devices and driverless cars.

The team, in collaboration with Veeco and IBM, conducted their research with support from the Air Force Office of Scientific Research. Their work can be found at *J. Phys. D: Appl. Phys.* 50 (2017) 055103.



Can Bayram

After studying three different buffer layer configurations, Bayram's team discovered that thicker buffer layers made of graded AlGaN reduce threading dislocation, and stacking those layers reduces stress.

The technology will enable clinicians to rapidly diagnose disease in their office or in the field, resulting in earlier, more informed patient management decisions, while markedly improving the control of disease outbreaks.

## Integrated Lab-on-a-chip Uses Smartphone to Quickly Detect Multiple Pathogens

A multidisciplinary group that includes the University of Illinois at Urbana-Champaign and the University of Washington at Tacoma has developed a novel platform to diagnose infectious disease at the point-of-care, using a smartphone as the detection instrument in conjunction with a test kit in the format of a credit card. The group is led by Illinois Electrical & Computer Engineering (ECE) Professor and MNTL Director **Brian T. Cunningham**; Illinois Bioengineering Professor **Rashid Bashir**; **Dr. Ian Brooks**, a research scientist affiliated with the School of Information Sciences at Illinois; and, University of Washington at Tacoma Professor **David L. Hirschberg**, who is affiliated with Sciences and Mathematics, division of

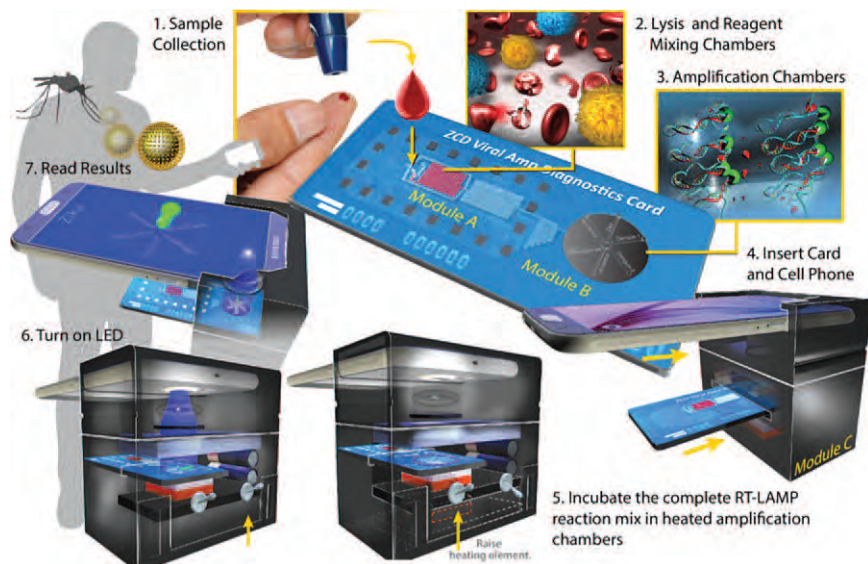
the School of Interdisciplinary Arts and Sciences. Dr. **David Nash**, a private practice equine expert and veterinarian in Kentucky, was an additional collaborator.

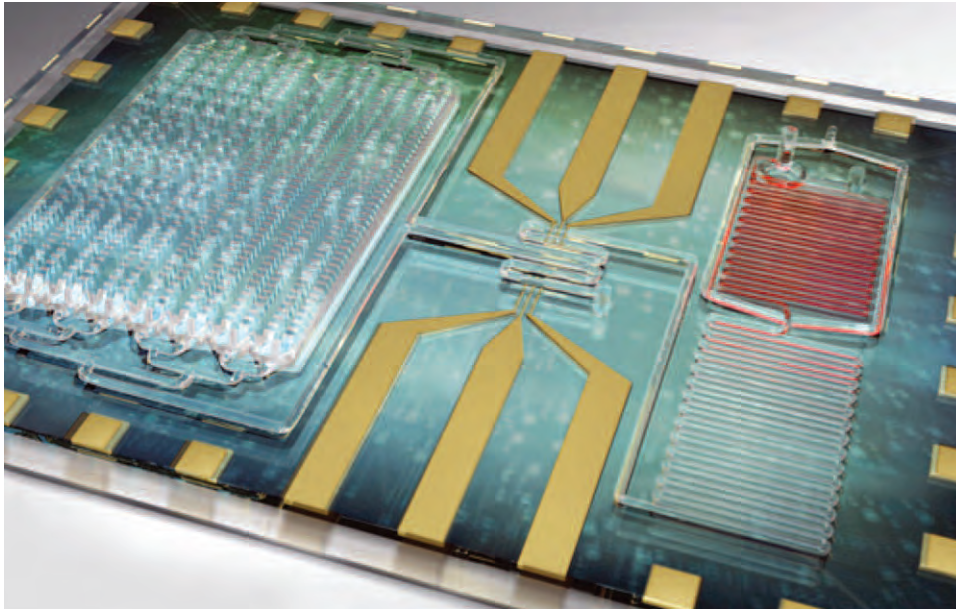
Findings have been published in *Analytical Chemistry*, demonstrating detection of four respiratory diseases in horses, and in *Biomedical Micro-devices*, where the system was used to detect and quantify the presence of Zika, Dengue, and Chikungunya viruses in a droplet of whole blood.

The system is composed of an unmodified smartphone and a portable 3D-printed cradle that supports the optical and electrical components and interfaces with the rear-facing camera of the smartphone. The software application gathers information about the tests conducted on the microfluidic card, patient-specific information, and assay results, which are communicated to a cloud storage database. The system represents the only platform to date that can multiplex detection of viral and other nucleic acid targets on a portable point-of-care setup using one droplet of bodily fluid.

The work was funded by a grant from the National Science Foundation (NSF).

Process illustration





*UI researchers and physicians at Carle Foundation Hospital developed a rapid test for sepsis that counts white blood cells and certain protein markers on their surface to monitor a patient's immune response.*

## Quick Blood Test Finds Signs of Sepsis in Single Drop of Blood

A team of researchers from the University of Illinois and Carle Foundation Hospital in Urbana, Illinois completed a clinical study of a new portable device designed to quickly find markers of deadly, unpredictable sepsis infection from a single drop of blood. A first of its kind, the device will provide rapid, point-of-care measurement of the immune system's response without any need to process the blood.

This can help doctors identify sepsis at its onset, monitor infected patients, and could even point to a prognosis, said research team leader **Rashid Bashir**, Professor of Bioengineering and the Executive Associate Dean of the Carle Illinois College of Medicine. The researchers published their findings in the journal *Nature Communications*.

"We are looking at the immune response, rather than focusing on identifying the source of the infection," Bashir explained. "One person's immune system might respond differently from somebody else's to the same infection. In some cases, the immune system will respond before the infection is detectable. This test can complement bacterial detection and identification. We think we need both approaches: detect the pathogen, but also monitor the immune response."

The Center for Integration of Medicine and Innovative Technology Innovation in Boston supported this work through a Point-of-Care Technology Research Center in Primary Care grant. Additional support came from Carle Foundation Hospital and the University of Illinois.

*"We are looking at the immune response, rather than focusing on identifying the source of the infection."*

## Nanopores Could Map Small Changes in DNA that Signal Big Shifts in Cancer

“DNA methylation is actually a starting process for cancer. So we want to detect how many of them there are and how close together they are. That can tell us at which stage the cancer is.”

Detecting cancer early, just as changes are beginning in DNA, could enhance diagnosis and treatment as well as further our understanding of the disease. A new study led by ECE Professor and MNTL affiliate **Jean-Pierre Leburton**, describes a method to detect, count, and map tiny additions to DNA called methylations, which can be a warning sign of cancer, with unprecedented resolution.

“One or a few methylations is not a big deal, but if there are many of them and they are packed close together, then it’s bad,” said Leburton. “DNA methylation is actually a starting process for cancer. So we want to detect how many of them there are and how close together they are. That can tell us at which stage the cancer is.”

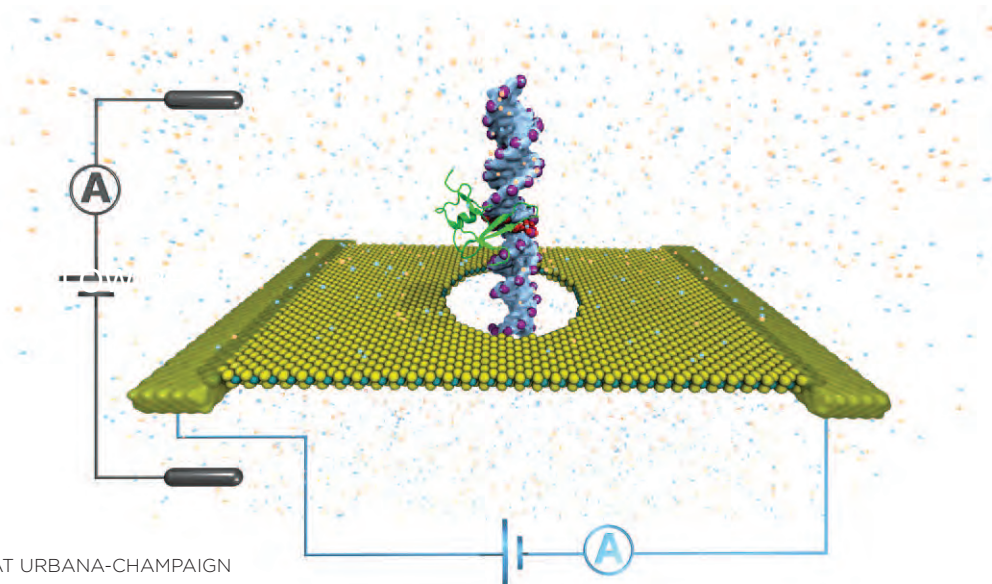
Other attempts at using nanopores to detect methylation have been limited in resolution, but Leburton’s research group tried a slightly different approach. They applied a current directly to the conductive sheet surrounding the pore. Working with

**Klaus Schulten**, a Professor of Physics at Illinois, they used advanced computer simulations to test applying current to different flat materials, such as graphene and molybdenum disulfide, as methylated DNA was threaded through.

“Our simulations indicate that measuring the current through the membrane instead of just the solution around it is much more precise,” Leburton noted. “If you have two methylations close together, even only 10 base pairs away, you continue to see two dips and no overlapping. We also can map where they are on the strand, so we can see how many there are and where they are.”

Grants from Oxford Nanopore Technology, the Beckman Institute for Advanced Science and Technology, the National Institutes of Health, and the National Science Foundation supported this work. The study was published in the inaugural issue of the journal *2D Materials and Applications*.

*Simulations indicate that measuring the current through the membrane instead of just the solution around it is much more precise.*



# Update on Research Theme: Omics Nanotechnology for Cancer Precision Medicine

The Omics Nanotechnology for Cancer Precision Medicine (ONC-PM) Theme is a good case study in how peer networking, collegiality across institutions, and interdisciplinary collaboration contribute to meaningful research that can change the world.

The Theme got its start when Professor **Andrew Smith** and Professor **Brian T. Cunningham** co-organized an on-campus symposium in 2015 on the topic of “Super-Resolution Imaging Technologies.” Dr. **Manish Kohli** from Mayo Clinic attended, leading to discussion amongst the three regarding the topic of cancer diagnostics. Cunningham explained “The symposium led to some discussion between the three of us, and developing some concepts for new cancer diagnostics that would be capable of being ultrasensitive for the most demanding applications, like detecting a handful of miRNA or mRNA molecules in a single droplet of blood. Manish already had a great collaborator at the Medical College of Wisconsin, Professor **Liang Wang**, with expertise in bioinformatics. Together, they had already been clinically validating which biomarkers had

concentrations that tracked with successful response to drug therapy.”

Cunningham took the lead in preparing a proposal to establish a new Theme at the Carl R. Woese Institute for Genomic Biology (IGB) at Illinois. Previously, there had not been a similar Theme focused on genomics-based diagnostics. “A campus as strong as ours needs to be at the forefront of this area. IGB is the perfect environment for supporting interdisciplinary science with very ambitious goals,” said Cunningham.

Kohli’s efforts to obtain seed funding from a benefactor at Mayo Clinic helped the research team get the technical work off to a strong start and build some preliminary data that would strengthen their grant proposals.

Their chief goal is to develop use-at-home sample collection assays that can be employed to identify sub-classes of cancer, as well as to track treatment efficacy and progress. MNTL and IGB facilities will be used to conduct Theme research. The group was awarded a five-year grant from the National Institutes of Health (NIH), starting in May 2018.

“A campus as strong as ours needs to be at the forefront of this area. IGB is the perfect environment for supporting interdisciplinary science with very ambitious goals.”

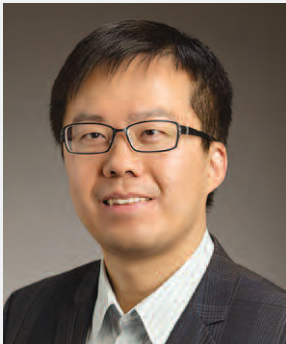


Theme research team members include: Theme lead, Brian T. Cunningham (Electrical & Computer Engineering, Bioengineering, Director of MNTL); Rashid Bashir (Bioengineering); Timothy M. Fan (Veterinary Clinical Medicine); Auinash Kalsootra (Biochemistry); Benita Katzenellenbogen (Molecular & Integrative Physiology); Manish Kohli (Medical Oncology, Mayo Clinic); Zeynep Madak-Erdogan (Food Science & Human Nutrition); Olgica Milenkovic (Electrical & Computer Engineering); Andrew Smith (Bioengineering); and, Liang Wang (Pathology, Medical College of Wisconsin).

# New Faculty

Scholarly achievement and research activities are an integral part of a top research university like the University of Illinois. Active research fosters future curriculum development and builds relevancy in what students are taught. From a more global perspective, research has significant economic and quality-of-life impact. Moreover, today's researchers are training the next generation of researchers and educators.

Here we celebrate the arrival of new colleagues and highlight some of the awards and recognition that they have received this past year.



Kejie Fang

**Kejie Fang**, Assistant Professor of Electrical & Computer Engineering, received his Ph.D. in physics from Stanford University in 2013. Prior to joining the University of Illinois faculty, Fang was a postdoctoral scholar and senior research scientist at the California Institute of Technology (Caltech). His research interests center around nanophotonics and quantum photonics, with an emphasis on physics exploration and chip-scale integration.

He studies light manipulation and light-matter interaction at micro- and nano-scales, with a focus on synthesizing emergent optical states and making quantum photonic devices. His goal is to address emerging technology challenges from manipulation of single photons on chips to large-scale integration. He has authored 17 articles and papers, which have appeared in *Nature Physics*, *Nature Photonics*, and *Physical Review Letters*.



Joseph Irudayaraj

**Joseph Irudayaraj** has joined the faculty at the University of Illinois at Urbana-Champaign as a full professor, Founder Professor in Bioengineering, and Associate Head for Graduate Programs in the Department of Bioengineering. He comes to Illinois from Purdue University, where he served as a professor of biological engineering and deputy director of the Bindley Bioscience Center. Irudayaraj conducts bionanotechnology research, developing tiny (nano) diagnostic tools to understand cellular mechanisms that could lead to targeted therapies or better prognosis for cancer or neurodegenerative diseases.

At Illinois, his focus is to “develop optical technologies and nanoparticle sensors for epigenetic regulation and dynamic phosphorylation monitoring to understand disease etiology—with a primary focus on cancer and immunotherapy,” he said.

Irudayaraj's appointments at Illinois include the Beckman Institute for Advanced Science and Technology, the Carl R. Woese Institute for Genomic Biology, and the Micro & Nanotechnology Laboratory.

Irudayaraj holds an M.S. degree in biosystems engineering and an M.S. in information and computer science, both from the University of Hawaii, and he earned his Ph.D. in biological engineering at Purdue University.



In 2017, MNTL welcomed **Jean-Pierre Leburton** to our ranks, as he moved from the Beckman Institute for Advanced Science and Technology to facilitate key collaborations with several MNTL faculty researchers. A member of the Illinois ECE faculty since 1981, Leburton's chief areas of expertise are nanostructure and device physics, including transport in quantum structures and carbon-based nanostructures, spin effects in nanostructures, and nano-biotechnology. "I develop physical models to understand the behavior and operations on novel nanoscale electronic and optical devices," Leburton explained. "I also use these models to explore new properties of nanostructures." Most recently, he's been doing research that merges semiconductor physics with biology.

Leburton earned his Ph.D. from the University of Liege, Belgium, where he also received his B.S. degree.

Leburton is the Gregory Stillman Professor of Electrical and Computer Engineering, Professor of Physics, and a research professor at the Coordinated Science Laboratory, the Frederick Seitz Materials Research Laboratory, and the Micro & Nanotechnology Laboratory.



*Jean-Pierre Leburton*

A pioneer in advancing biomedical nanotechnology, **Shuming Nie** joined the University of Illinois Department of Bioengineering as the Grainger Distinguished Chair in Engineering in September 2017. In addition to his faculty position with Bioengineering, Nie will hold joint appointments in the Electrical & Computer Engineering Department and the Micro & Nanotechnology Lab. A Fellow of both the AAAS and IAMBE, Nie has received the Millipub Club Award, Merck Award, Nature Publishing's Achievement Award in Nanomedicine, and the UK's Rank Prize in Optoelectronics. He earned his Ph.D. from Northwestern University.

Nie comes to Illinois from Emory University and the Georgia Institute of Technology, where he had been the Wallace H. Coulter Distinguished Chair Professor in Biomedical Engineering for more than 10 years. Nie's academic work is primarily in the areas of nanomedicine, molecular engineering, and image-guided/minimally invasive/robotic surgery.

Most recently, Nie has explored the use of bioconjugated nanoparticles for therapeutic drug delivery, making it possible to deliver the drugs directly to tumors with minimal damage to non-cancerous cells. This type of therapeutics could result in more effective cancer treatment with far fewer side effects. During the last five years, his collaborative teams have been engaged in seven clinical trials for image-guided cancer surgery, enrolling more than 300 cancer patients at multiple hospital sites.



*Shuming Nie*

# Faculty Awards & Recognition

MNTL values the hard work of faculty and recognizes the importance of awards in developing and sustaining excellence across the wide range of activities involved in teaching, research, and public service.

Below are just a few examples of MNTL faculty achievements and recognition for 2017.

## Select Faculty Awards

2017 Benjamin Franklin Medal in Electrical Engineering—Nick Holonyak Jr.

2017 Distinguished ECE Alumni Award—Milton Feng

NSF CAREER Award 2017—Wenjuan Zhu; Can Bayram

2017 Dean's Award for Excellence in Research—Jean Paul Allain

2017 NASA Early Career Faculty Award—Songbin Gong

2017 Fellow of American Institute for Medical & Biological Engineering—Kyekyoon Kim

Faculty Entrepreneurial Fellow (2016-2017)—Jean Paul Allain

President, IEEE Photonics Society—Kent Choquette

Sandia National Labs Faculty Fellow—Kent Choquette

IEEE Fellow 2017—Xiuling Li

2017 Power List (published by *The Analytical Scientist*)—Shuming Nie



Peter Dragic

## Journal Paper Selected as “Editor’s Pick”

In December 2017, ECE Professor and MNTL researcher **Peter Dragic** and his research team were notified that they had a journal paper selected as an Editor’s Pick, based on “its excellent scientific quality.” Featured in *Optics Letters*, the paper is entitled “Highly nonlinear yttrium-aluminosilicate optical fiber with high intrinsic stimulated Brillouin scattering threshold.”

Vital to the Information Age and just a bit thicker than a human hair, optical fibers carry enormous amounts of information around the world and are used in countless applications including the Internet, weapons systems, and medicine. Typically developed from silica, today’s optical fibers are reaching the limits of their information-and-power-carrying capacity, due to a phenomena known as nonlinear optical effects.

Dragic and his colleagues are working on ways to reduce or eliminate such nonlinear effects, particularly by addressing stimulated Brillouin scattering (SBS), an adverse interaction between optical and acoustic waves. Key to their research is further investigation and development of different materials that can be used to produce optical fibers, such as yttrium-aluminum-garnet.

As demonstrated in this paper, Dragic said that the team has “...figured out a way to significantly suppress SBS to record level in these fibers by their design, via materials and waveguide, thus without the need to stretch or heat the fiber.”

The team’s research funding comes from the U.S. Department of Defense (DOD), High Energy Laser Joint Technology Office.

## Bayram and Zhu Receive NSF Career Awards

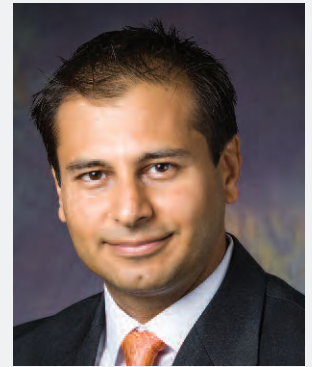
The National Science Foundation (NSF) announced that **Can Bayram** and **Wenjuan Zhu**, both assistant professors of Electrical & Computer Engineering (ECE), have earned 2017 NSF CAREER Awards, which will provide each of them with \$500,000 over the next five years in support of their research and educational activities. NSF CAREER Awards empower promising junior faculty to build a firm foundation for a lifetime of leadership through integrating research and education.

Bayram is using his award to explore the fundamental properties of cubic phase light emitting diodes (LEDs) that will provide the critical knowledge required to close the "green gap" in the visible spectrum. Current commercial LEDs consist of a mixture of red, green, and blue LEDs to produce white spectrum light. Red and blue LEDs do not rely on phosphor-down conversion, however, conventional green LEDs do, limiting green light output power only to a fraction of its theoretical limit.

In parallel to the research activities, Bayram will develop a solid-state lighting theme-based interactive K-12 outreach program and new curriculum materials for middle schoolers and undergraduates. Bayram will make these educational resources available online to enable a significant global reach. He has already created a new ECE course entitled "LEDs and Solar Cells," which was offered in the Spring 2017 semester.

Next-generation information technology is driving the need for integrated circuits, devices, and architectures to process unprecedented amounts of real-time data in increasingly efficient and cost-effective manners. Wenjuan Zhu's research seeks to establish fundamental knowledge of a new hybrid material platform that consists of novel ferroelectric metal oxides (hafnium and zirconium oxide), stacked with a layer of two-dimensional material like graphene and mono/di-chalcogenides.

On the educational front, Zhu is creating a new graduate/undergraduate course on 2D materials to train the next-generation workforce in nanoelectronics. She also plans to implement a science education program for elementary students called "Little Einstein" and for middle school girls called "Girls Go Tech" that focuses on cultivating their passion and interest in a future career in STEM fields.



*Can Bayram*



*Wenjuan Zhu*

## MNTL Faculty Selected as Associates at Center for Advanced Study

One of Illinois' most respected resources for public events programming and co-sponsorship, the Center for Advanced Study (CAS), has named two of MNTL's faculty researchers as Associates for the 2018-19 year. Such recognition incentivizes scholarly achievement and advances the university's intellectual work.

Professor **Brian T. Cunningham** is the Director of MNTL and a Professor of both Electrical & Computer Engineering (ECE) and Bioengineering. Professor **Lynford Goddard** is also a Professor of ECE and heads the Photonic Systems Laboratory research group, whose work is based at MNTL.

On an annual basis, CAS invites U of I faculty to submit creative and scholarly proposals for competitive consideration by the Center's permanent Professors. Tenured faculty whose proposals are selected are appointed Associates. Such an appointment grants one semester of teaching release time to pursue an individual scholarly project of merit, in addition to participation in a yearly roundtable discussion of research interests.



*Brian T. Cunningham*



*Lynford Goddard*

# Faculty Awards & Recognition

## Gong Receives NASA Early Career Award



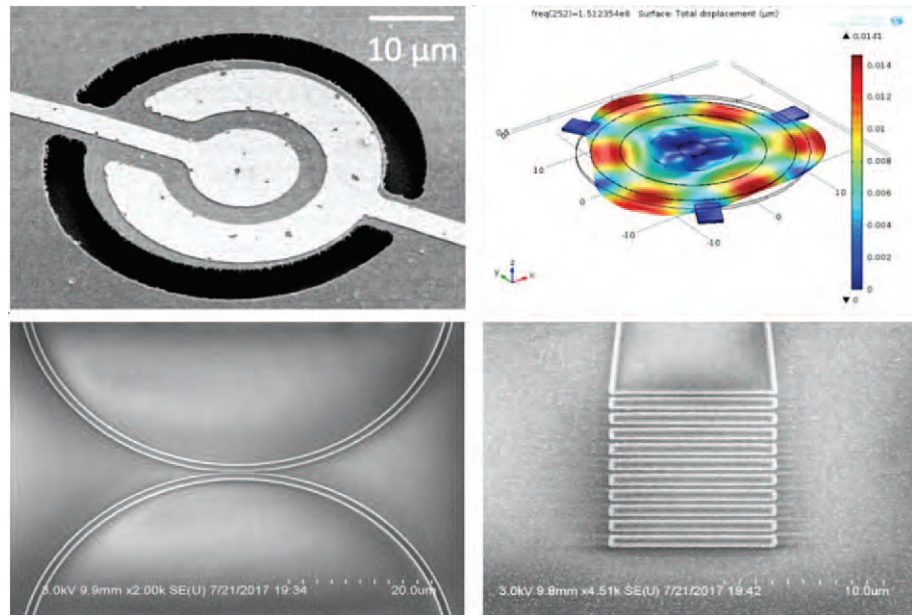
Songbin Gong

The National Aeronautics and Space Administration (NASA) has awarded Electrical & Computer Engineering (ECE) Professor **Songbin Gong** an Early Career Faculty Award. The highly coveted award comes with \$600,000 in funding support for a proposed research project.

Gong's proposed research seeks to develop photonic integrated circuits (PIC) that can surpass the state-of-the-art for performing widely tunable and highly sensitive microwave and millimeter-wave radiometry. The project will do so "by exploiting the pronounced photonic, electro-optic and piezoelectric properties of ion-sliced lithium niobate thin film platforms for signal modulation, filtering and detection," Gong said in his proposal.

Gong is excited about the opportunity to work with NASA and is looking forward to bringing his proposed concept to fruition. "The outcome of this research will enable a new chip-scale solution for passive microwave radiometry over a wide frequency range with fine spectral selectivity," said Gong.

Gong currently leads the Illinois Integrated RF Microsystems Research Group (ILIRM). The group's research leverages micro/nano electro mechanical systems (N/MEMS) and integrated photonic technologies to enable radio and microwave frequency chip-scale hybrid microsystems.



*Enabling Subsystems in the LN PIC platform exploiting interactions among microwave, photons, and phonons' from Gong's proposal.*

## Anming Gao Recipient of the 2017 Lam Outstanding Graduate Student Award

**Anming Gao**, whose primary research area is microelectronics and photonics, was selected as a recipient of the 2017 Lam Outstanding Graduate Student Award. Patience and perseverance were key to his accomplishment.

Gao is presently working on his Ph.D. in electrical and computer engineering at the University of Illinois, and is on schedule to graduate in 2018. He received a master's degree in electrical engineering from Shanghai Jiao Tong University.

Gao's research requires a lot of cleanroom time, working on micro-nano fabrication. If a given fabrication project does not come out well, the researcher must be willing and able to trace back and identify the issues experienced and de-bug the project, often repeatedly. It's time-consuming work that requires a high degree of patience. Gao explained "Failures make you feel frustrated, but they are valuable and will finally lead you to success."

Songbin Gong, Assistant Professor of Electrical & Computer Engineering, is his graduate advisor. Gao has been a member of Gong's research team since he came to Illinois in 2014. He credits his research success to a strong teamwork ethos at MNTL. "I am very honored to be selected as a recipient of the 2017 Lam Outstanding Graduate Student Award," he said. "My research would not have been possible without guidance from my supervisor, help from my group members, MNTL staff, and all the resources provided by MNTL."

After graduation, Gao is planning to continue working in the micro and nanotechnology area, preferably in academia or as a research scientist in industry.

Gao is also a past recipient of the Nick and Katherine Holonyak, Jr. Graduate Student Fellowship for 2015-2016.



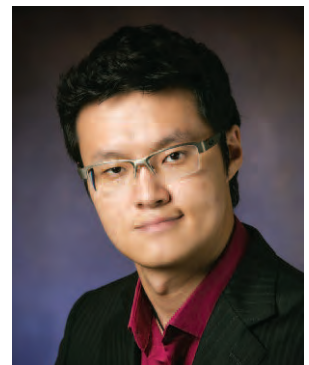
*Anming Gao*

## Grad Student Honored with NASA Space Technology Research Fellowship

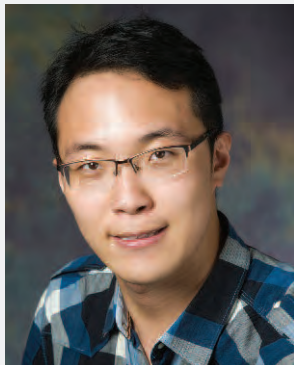
Electrical & Computer Engineering (ECE) graduate student **Dicky Liu** decided to pass on an NSF Graduate Research Fellowship in 2017. While he was honored to be among the three ECE students who were offered a place in one of the nation's oldest and most prestigious programs, he decided to decline in favor of a different honor, a NASA Space Technology Research Fellowship.

"I chose to go with NASA [because of] the mentorship and the visiting technologist experience," he said. "I will spend ten weeks every year at a NASA center conducting my research with help from experts in the field. In addition, I will be assigned a personal research advisor from NASA to help coach me in my endeavors." At Illinois, he is an MNTL affiliate and advised by ECE Professor Can Bayram, who is also an MNTL researcher.

Liu's research interests align well with NASA's initiatives. As he explained, ultraviolet radiation has shown important applications in space technology, including gravitational wave observation, light detection and ranging, planetary atmospheric measurements, and chemical spectroscopy.



*Dicky Liu*



Ruochen Lu

## 2017 International Frequency Control Symposium Best Paper Award

A student research group mentored by Songbin Gong, Assistant Professor of Electrical & Computer Engineering, has received the 2017 International Frequency Control Symposium Best Paper Award. The paper is titled “Lithium Niobate Phononic Crystals for Radio Frequency SHO Waves.”

**Ruochen Lu**, a Ph.D. candidate in the Department of Electrical & Computer Engineering at Illinois, explained the significance of the research team’s project: “From our work, the LiNbO<sub>3</sub> thin film platform has been demonstrated to manipulate phonon propagation with unprecedented wide bandwidth and low loss, potentially promising a new paradigm of radio frequency signal processing in the acoustic domain.”

Research at MNTL is a team sport, and Lu counts on his group for their insights and assistance in the micro fabrication process. He collaborates with Tomas Manzaneque, Yansong Yang, and Gong, who is his advisor.

This paper is part of a project named “DARPA Near Zero Power RF and Sensor Operations (DARPA N-ZERO).” The goal of the overall project is to build a low power budget wake-up radio capable of being triggered upon a faint signal. The research team is working to integrate piezoelectric devices after the antenna to passively amplify the voltage swing across the follow-on CMOS circuit. With phononic crystal utilization, they are able to move some of the signal processing functions to the mechanical domain from the CMOS circuit, without consuming extra power, which will further reduce the power budget of the system. Additional applications using phononic crystals to build other RF devices are underway, as the research group moves forward with its work.



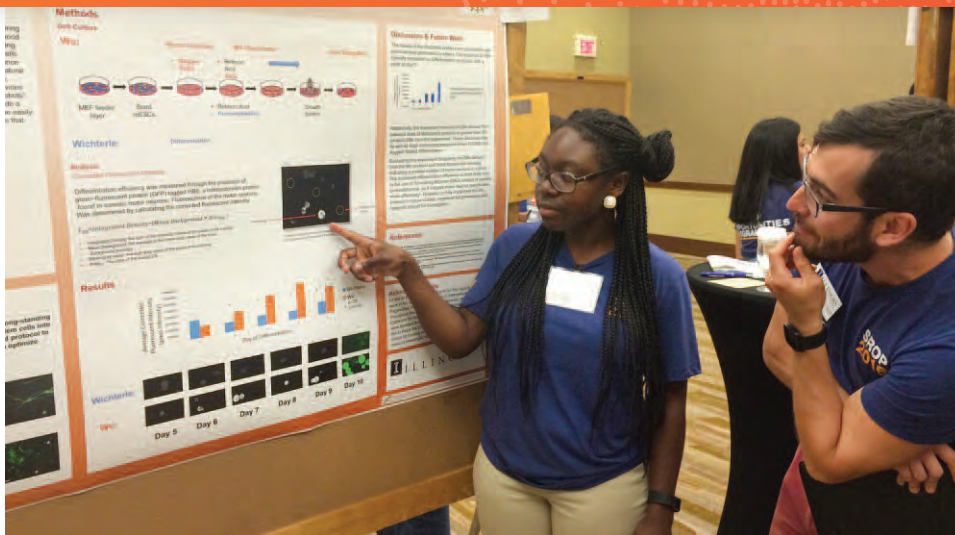
Dennis Rich

## Undergrad Named Goldwater Scholar

**Dennis Rich** was named a 2017 Goldwater Scholar in honor of his dedication to research. Rich is a junior advised by Can Bayram, Assistant Professor of Electrical & Computer Engineering and an MNTL affiliate.

The award was established in 1986 to honor Senator Barry Goldwater, who served for 30 years in the U.S. Senate. Recipients receive stipends toward covering the cost of tuition, fees, books, and room and board. Through this program, outstanding students are encouraged to pursue careers in math, the natural sciences, and engineering. “This recognition is single handedly the top award for any undergrad in the country,” said Bayram. “Dennis has been working with me since his first day as a freshman, and I am very pleased to see him bring this national recognition to our department. This is largely due to the undergraduate research opportunities created in our department, as well as the rigorous course, education, and outreach opportunities available to our undergrads. I also thank AFOSR YIP [The Air Force Office of Scientific Research Young Investigator Research Program] for partial support of Dennis’s work.”

When asked about his current research with Bayram, Rich enthusiastically explained that they are engaging an effort to demonstrate a new method of inexpensively producing thin-film semiconductor devices. They believe this paper-thin computer chip will improve performance due to thermal dissipation being better in thinner devices.



An REU participant explains her poster presentation findings.

## Research Experience for Undergraduates

MNTL shares in the Illinois mission to educate students, to challenge them to solve real-world problems, and to grow professionally. An important part of the nano@Illinois Research Experience for Undergraduates (REU) program, funded by the National Science Foundation, is generating student interest in high-quality scientific research and encouraging them to pursue graduate school education.

What do REU participants do? They commit to spending 10 weeks with the program and agree to participate in all program activities. They typically work about 40 hours per week in the lab, as determined by their mentors. REU focuses on diversity in student recruiting and this means that participants have the chance to engage with fellow learners from across the nation and around the world. Each participant is assigned a faculty mentor and a research mentor.

### EBICS REU Leaders

Rashid Bashir, *Emergent Behaviors of Integrative Cellular Systems, Leadership*  
 Catherine Murphy, *Principal Investigator*  
 Umberto Ravaioli, *Co-PI*  
 Irfan Ahmad, *Executive Director, Center for Nanoscale Science and Technology*

### REU offers students:

#### Financial Assistance

- \$4,500 stipend per student
- Free housing & allowances for meals & travel

#### Career Mentoring

- Grad school prep
- Faculty mentoring
- Professional development
- Student networking & social engagement
- Build resume with important research experience

#### Hands-on Research Experience

- 10 weeks of active research work at Illinois, MIT, or Georgia Tech
- Poster & oral presentation as program wrap-up
- Potential opportunities to contribute to publications & present at conferences



## Research Experience for Teachers

A key complement to the Research Experience for Undergraduates program is the Research Experience for Teachers (RET) program, also funded by the National Science Foundation. Selected educators conduct research in our world-class labs and engage in other professional development activities over six weeks during the summer, on a full-time basis. The teacher profile is diverse: elementary, high school, and community college instructors participate. They are from around the nation, Maryland to California, Illinois to Texas, and they come from urban, suburban, and rural communities.

The final targeted outcome for the participants is creating a high-caliber, multi-day instructional module, along with related learning resources—all based on the research that they conducted throughout the summer.

### Who's Eligible to Participate?

- Practicing STEM educators
- Bachelor's degree or higher in STEM, or pre-service STEM teachers currently enrolled in an undergrad program (a rising junior or higher)

These educators take what they have learned and developed back to their schools, to their students, who then benefit year-by-year. Often, they also end up sharing their learning and accomplishments via conference presentations, with peers and other education professionals.

### What they say about the experience—

Diana Rodriguez commented, "Amazing! I learned a lot of things about research and techniques. I learned to experiment and how to keep a lab notebook, participate in lab group meetings...I wanted to get out of my comfort zone."

### nano@Illinois RET Leaders

Xiuling Li, *Principal Investigator*

Lynford Goddard, *Co-PI*

Irfan Ahmad, *Executive Director, Center for Nanoscale Science and Technology*

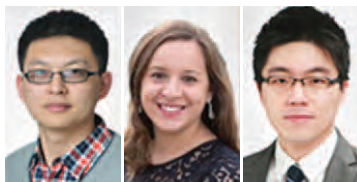
RET Stats	
Year	Participants
2014	4
2015	12
2016	11
2017	14



Diana Rodriguez analyzes her research for nano@illinois co-PI Lynford Goddard, Professor of Electrical & Computer Engineering.



## Q&A with 2017 Grads



Left to right: Chen, Cvetkovic, Yu

To see the full interview, be sure to check out our News section at [mntl.illinois.edu](http://mntl.illinois.edu).

During the fall, three 2017 UI graduates who conducted research at MNTL while pursuing their Ph.D.s at Illinois participated in a Q&A session about their lives after graduation.

**Weili Chen** is a sensing hardware engineer at Apple, whose work at MNTL involved optics design and biosensor development. **Caroline Cvetkovic** is a postdoc fellow at the Center for Neurogeneration at the Houston Methodist Research Institute, looking at ways to address problems associated with neurodegenerative diseases such as stroke or spinal cord injury. **Hojeong Yu** is a postdoc research fellow at Harvard Medical School/Massachusetts General Hospital, and works with medical doctors and researchers from various disciplines.

Both Chen and Yu agree that Professor Brian T. Cunningham's research helped influence their decision regarding the research group that they wanted to join while at the U of I. Cvetkovic was part of the Laboratory of Integrated Biomedical Micro/Nanotechnology and Applications with Rashid Bashir, Professor of Bioengineering, and she appreciated the novelty of the research, the interdisciplinary focus, and the chance to merge science and creativity.

Aside from their current professional pursuits and accomplishments, all three were extremely productive during their time at Illinois. In collaboration with his advisor and colleagues at MNTL, Chen published 10 papers, and the group provided trailblazing optical biosensing systems for the next generation of biomedical detection tools. Both Chen and Yu worked with innovative portable, point-of-care device ideas for mobile detection of infectious diseases.

Funding is always vital to a researcher's career and research achievements, and Cvetkovic was funded by a National Science Foundation (NSF) Science and Technology Center—in this case, the Emergent Behaviors of Integrated Cellular Systems (EBICS) initiative—during her time here, as well as an Integrative Graduate Education and Research (IGERT) traineeship, and a Support for Underrepresented Groups in Engineering (SURGE) fellowship.

## Corporate Relationship Building

Consistent with MNTL's strategic plans and identified research directions, our faculty researchers and gifted students can provide significant insights, strategic perspectives, and new solutions for problems and opportunities faced by companies across the nation and around the world. We encourage you to review our Industry Affiliates Program details on the web at [mntl.illinois.edu/industry/](http://mntl.illinois.edu/industry/). Or contact:

Greg Pluta, Managing Director  
1260 Micro & Nanotechnology Laboratory  
University of Illinois  
Urbana, IL 61801  
217-244-2132  
[gpluta@illinois.edu](mailto:gpluta@illinois.edu)

## Alumna Zhuo Receives Postdoctoral Scholar Award

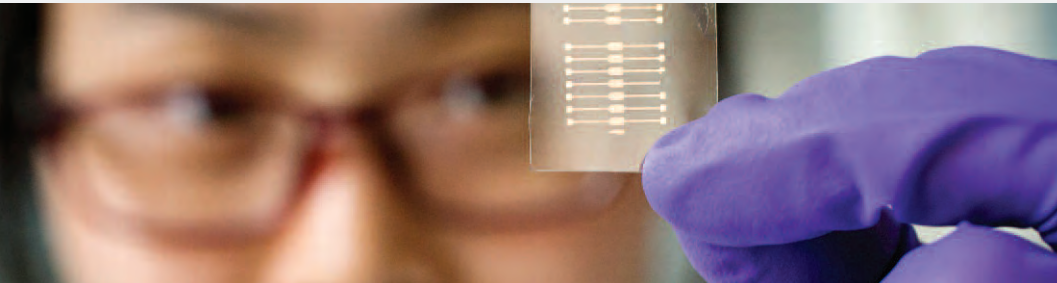
**Yue Zhuo**, PH.D. '15 BIOE and postdoctoral fellow at the University of Illinois at Urbana-Champaign, earned the 2017 Microscopy and Microanalysis Postdoctoral Scholar Award for her conference paper, "Label-free Imaging of Stem Cell Adhesion and Dynamic Tracking of Boundary Evolution using Photonic Crystal Enhanced Microscopy" (PCEM). The Microscopy Society of America presented the award in August 2017 at the Microscopy and Microanalysis annual meeting in St. Louis.

The PCEM imaging system relies on photonic crystal biosensors to enable label-free monitoring of live cells. The system is a new tool for measuring single-cell behavior that may hold great potential for studying cell-surface attachment profiles, cell-substrate interactions, and cell-drug responses. The ultimate goal is to assist research in wound healing, stem cell therapy, and cancer treatment.

Zhuo, who is collaborating on this project with UI professors Brian T. Cunningham and Brendan Harley, is a fellow at the Beckman Institute for Advanced Science and Technology and a member of Cunningham's nanosensors research group. Zhuo provides a more complete description of the research in her recent paper, "Quantitative Imaging of Cell Membrane-associated Effective Mass Density Using Photonic Crystal Enhanced Microscopy," published November 2016 in the journal *Progress in Quantum Electronics*.



Zhuo receives her award.



## Advancing the Future

Research leads to beneficial product development, observable enhancements to the quality of life, ranging from food safety to life-saving medical devices and treatments. Advancement, private giving, has become an important engine for research innovation and student growth for universities. Private gift support can help facilitate MNTL's efforts to create the future, enabling infrastructure for empowering innovation, such as the best-of-breed equipment that is so vital for 21st century research in micro and nanotechnology.

There are many ways to be engaged with our work—sponsorship of symposia and workshops, naming opportunities for lab and research facilities, or even support of further development of MNTL's atrium displays, which highlight important milestones in our research and development history. You can help us continue to pursue a bold, interdisciplinary research agenda with real-world impact.

To learn more about how your private gift support can help MNTL advance the future, please contact:

Dale L. Wright  
Associate Dean for  
Advancement, Engineering  
1308 W. Green St.  
310 Engineering Hall  
Urbana, IL 61801  
217-244-0604  
dlwright@illinois.edu

# New & Noteworthy for 2018



John Bowers

MNTL is excited to announce that we are inaugurating the **Stillman Lecture Series**. Lecture events will take place in the spring and fall each year.

The first Stillman Lecture was delivered by the distinguished Professor **John Bowers**, from the University of California Santa Barbara Electrical and Computer Engineering department. Professor Bowers holds the Fred Kavli Chair in Nanotechnology, and he is the Director of the Institute for Energy Efficiency. He worked for AT&T Bell Laboratories and Honeywell prior to joining UCSB. Bowers was excited to be the first speaker for the new Stillman Lecture Series: “Greg Stillman was a hero of mine, and a model of a great faculty member and scientist. I will do my best to deliver a lecture worthy of this honor.”

Bowers’s talk was entitled “Progress in Bonding and Epitaxial Growth for Heterogeneous Photonic Integrated Circuits.”



The Stillman Lecture Series honors the many extraordinary contributions of Professor **Gregory Stillman** to the University of Illinois family. A native Nebraskan, Stillman graduated from the University of Nebraska in 1958 with a B.S. in electrical and computer engineering. He next served in the U.S. Air Force as an officer and pilot affiliated with the Strategic Air Command, before entering the University of Illinois graduate program in electrical engineering in 1963. After earning his Ph.D. in 1967—his mentor was Professor Nick Holonyak, Jr.—he joined the MIT Lincoln Laboratory, working there until he was invited to serve as a member of the U of I’s Electrical Engineering faculty in 1975.

His research and teaching were key to building and sustaining engineering’s legacy at Illinois, with contributions including the growth and characterization of compound semiconductor materials and devices. Today’s wireless and broadband communications owe much to Stillman’s work. He contributed to the development of advanced characterization techniques for carrier mobility, photoconductivity, far infrared emission, and photothermal methods of studying impurities, and many of these evaluation techniques are now widely used for compound semiconductors. A prolific researcher and author in the field, he published over 300 papers. One of the most consistent and notable observations made by those asked to describe him is that he was always a caring mentor; he supervised the doctoral work of 40 students while at Illinois and taught hundreds.

Coupled with financial backing from the state of Illinois and the visionary expectations of semiconductor industry leaders at the time, Stillman’s leadership was critical to the opening of the Microelectronics Laboratory in 1989, the precursor to today’s MNTL. Stillman also served as the first director of the Microelectronics Laboratory, setting a long-term pattern for the growth and impact of the 21st century’s Micro & Nanotechnology Laboratory.

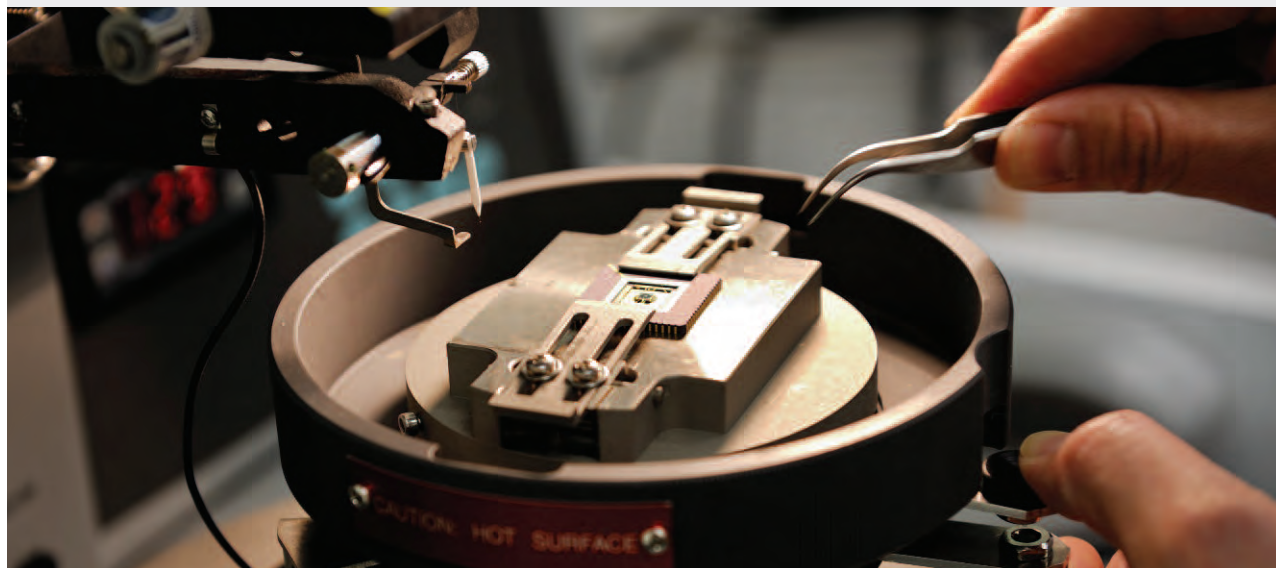
Stillman received widespread industry recognition for his research and discoveries. He was elected a Fellow of the Institute of Electrical and Electronics Engineers (IEEE) in 1977, followed by election to the National Academy of Engineering in 1985. In 1990, Stillman received the IEEE Morton Award and was also awarded the GaAs Symposium Heinrich Welker Medal in 1990. On multiple occasions over the years, he was the recipient of the College of Engineering D.C. Drucker Eminent Faculty Award and the ECE Faculty Outstanding Teaching Award.

# By the Numbers

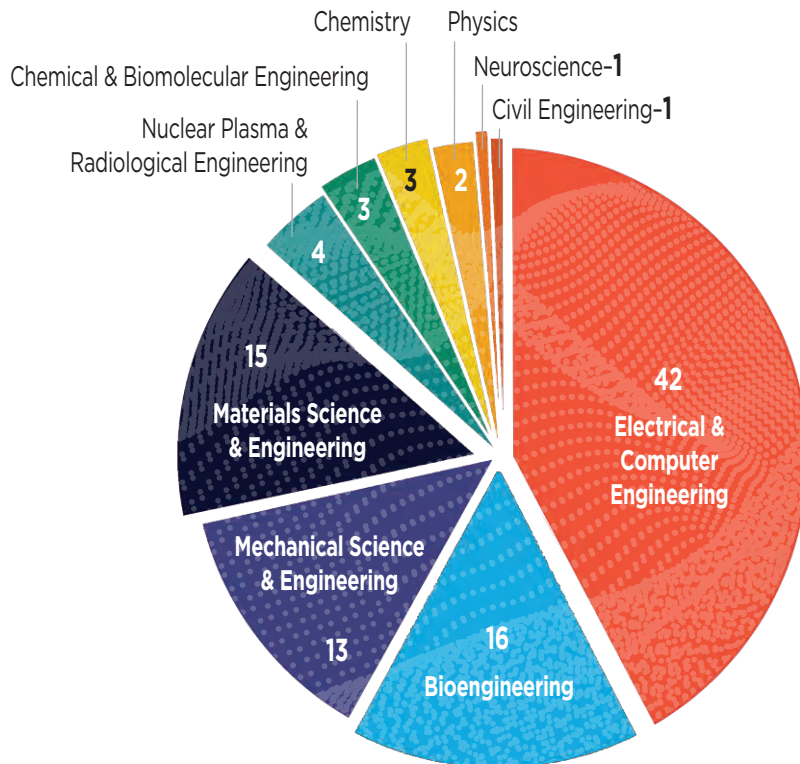
## New Grants in FY17

Selected Examples

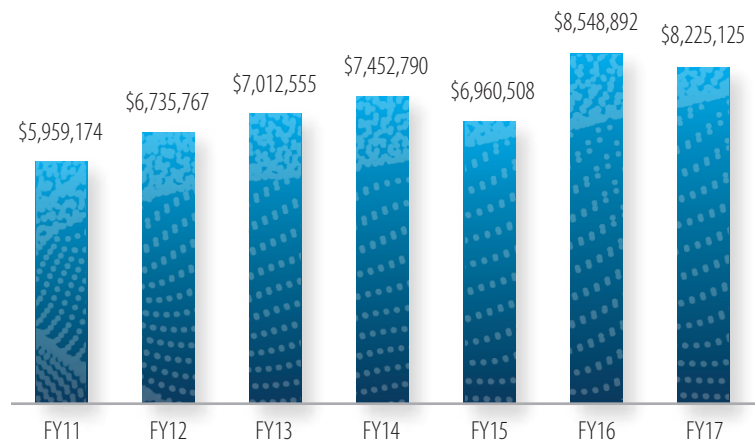
PI	Sponsor	Title	Award Amount
Ahmad, Irfan	SERDP	Mechanism of Fungal Degradation on Military Aircraft Coatings	\$ 199,981
Bashir, Rashid	LANL	Optogenetically Patterned-NMJs Using Interfaces for Screening of CWAs	\$ 337,500
Bayram, Can	NSF	CAREER: Cubic Phase Green Light Emitting Diodes for Advanced Solid State Lighting	\$ 500,000
Cunningham, Brian	Stanford/NIH	Portable Nanostructured Photonic Crystal Devices for HIV Viral Load	\$ 178,572
Dallesasse, John	NSF	E2CDA: Type I: Collaborative Research: Electronic-Photonic Integration Using the Transistor Laser for Energy-Efficient Computing	\$ 509,747
Eden, James Gary	AFOSR	Internal Cooling of Fiber and Disc Lasers by Radiation Balancing and Other Optical or Phonon Processes	\$ 841,633
Gong, Songbin	DARPA	Chip-scale Anti-Reciprocal Platform of Electromechanical Elements CARPE	\$ 204,558
Gruev, Viktor	NSF	Bioinspired Multispectral Imager for Near Infrared Fluorescence Image Guided Surgery	\$ 441,774
Lee, Larry	NSF	Growth of Tensile Germanium Nanowires Embedded in a III-V Matrix	\$ 352,135
Li, Xiuling	NSF	PFI:AIR-TT: Technology Translation: Rolled-up 3D Passive Electronic Component Prototype Development	\$ 200,000
Zhu, Wenjuan	NSF	CAREER: Transforming Electronic Devices Using Two-dimensional Materials and Ferroelectric Metal Oxides	\$ 500,000



## 2017 MNTL User Distribution by Department



## Research Expenditures, FY11—FY17



“The Quintessential Engineer” was installed outside the Micro & Nanotechnology Laboratory in the Spring of 2017. Created by Chicago sculptor Julie Rotblatt-Amrany, the statue is meant to encourage and inspire female students to reach for and attain their engineering dreams. Sakshi Srivastava was a junior in the Department of Electrical & Computer Engineering when she started the movement behind the project. The statue is a gift from Texas Instruments.





## Ways to Engage with MNTL

Help us continue to pursue a bold, interdisciplinary research agenda with real-world impact.

- Advance our research via your private giving
- Subscribe to our quarterly enews at <https://forms.illinois.edu/sec/3845917>
- Join us on LinkedIn at [www.linkedin.com/company/micro-nanotechnology-lab/](http://www.linkedin.com/company/micro-nanotechnology-lab/)
- Share your expertise by presenting a seminar to our students
- Sponsor symposia or workshops at MNTL
- Build a corporate scientific research relationship with MNTL

### MNTL Leadership Team

Brian T. Cunningham, *Director*

Gregory C. Pluta, *Managing Director*

Nandini Topudurti, *Associate Director, Financial Operations*

Ken Tarman, *Manager, MNTL Facilities*

Mark J. McCollum, *Manager, Cleanroom*

Angana Senpan, *Manager, Bionanotechnology Lab*

Janet L. McGreevy, *Assistant Director, Communications*

### MNTL Annual Highlights Report Credits

*Writers:* Corey Blumenthal, Victoria Halewicz, Khushboo Jain, Mike Koon, Rick Kubetz, Jonathan Lin, Janet McGreevy, Susan McKenna, Laura Schmitt, Julia Sullivan, Liz Ahlberg Touchstone, Allen Xu, Lois Yoksoulain

*Photography/Images:* Thompson-McClellan Photography, Janet Sinn-Hanlon, Brian Stauffer, Engineering at Illinois

**I ILLINOIS**

Micro & Nanotechnology Laboratory

COLLEGE OF ENGINEERING

208 N. Wright Street  
Urbana, IL 61801

217-333-3097  
[mntl.illinois.edu](http://mntl.illinois.edu)

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