Microsystems Technology Laboratories

The mission of the Microsystems Technology Laboratories (MTL) is to foster world-class research, education, and innovation at the nanoscale. Nanoscale science and technology can help solve some of the world's greatest problems in energy, communications, water, health, information, and transportation. In all of these important areas of human concern, researchers at MIT are engineering new materials, structures, devices, circuits, and systems using MTL's facilities and services in search of new solutions to persistent problems. MTL's research program is highly interdisciplinary and encompasses integrated circuits, systems, electronic and photonic devices, microelectromechanical systems (MEMS), biomedical MEMS (bio-MEMS), molecular devices, nanotechnology, sensors, and actuators. MTL core faculty and the students and researchers in their labs are conducting breakthrough research in areas encompassing nanoscale transistors, medical devices, microfluidics, organic lasers, and perovskite photovoltaics, among others.

At present, our core faculty comprises 51 members representing seven departments across the Schools of Engineering and Science. While our faculty are principally drawn from the Departments of Electrical Engineering and Computer Science (EECS), Mechanical Engineering, and Materials Science and Engineering, we continue to see expanding interest and engagement from faculty in the Departments of Biological Engineering, Chemical Engineering, Chemistry, and Physics. In addition, because circuits, sensors, and devices are integral to a virtually unlimited range of applications, we have built and continue to strengthen collaborations and interactions with many other research labs and centers across the Institute, including the Research Laboratory of Electronics, the MIT Energy Initiative, the Institute for Medical Engineering and Science (IMES), the Materials Processing Center, the Center for Materials Science and Engineering, the Computer Science and Artificial Intelligence Laboratory, the Koch Institute for Integrative Cancer Research, and the Institute for Soldier Nanotechnologies. MTL core faculty serve MIT and the global community in significant leadership positions across the Institute. We are honored to note that MTL's faculty include MIT president Rafael Reif, Provost Martin Schmidt, Associate Provost Karen Gleason, School of Engineering dean Anantha Chandrakasan, and Associate Dean Vladimir Bulović.

MTL manages a set of shared experimental facilities in Buildings 24 and 39 that house more than 150 fabrication and analytical tools. We strive to provide a flexible fabrication environment capable of long-flow integrated processes that yield complex devices and to offer low-barrier access to fast prototyping of structures and devices for users with varied levels of experience. Our fabrication capabilities include diffusion, lithography, deposition, etching, packaging, and many others. Our lab handles substrates ranging from odd-shaped small pieces to 6-inch wafers. These materials continue to expand well beyond silicon and germanium to include compound semiconductors, nitride semiconductors, graphene and other two-dimensional (2D) materials, polymers, glass, and organics. MTL's facilities are open to the entire MIT community and the outside world. MTL also manages an information technology infrastructure that supports state-of-the-art computer-aided design (CAD) tools for device, circuit, and system design. MTL has fostered strong relationships with major semiconductor manufacturers, enhancing our ability to make available to our community some of the most advanced commercial

integrated circuit fabrication processes available in the world today. In all, nearly 600 MIT students and postdocs from 21 different departments, laboratories, and centers carried out their research in MTL's facilities or used MTL's design services in the last fiscal year. In addition, many researchers from for-profit companies, government research laboratories, and domestic and international universities use MTL's facilities each year.

Industry Engagement

MTL partners with industry through the Microsystems Industrial Group (MIG) consortium. The member companies within MIG support MTL research and operations through a membership fee and, in some cases, by providing access to state-of-the-art semiconductor fabrication design tools and processes and donating equipment. Members of MIG's Industrial Advisory Board (IAB) provide guidance in shaping MTL's vision.

In FY2017, MTL welcomed one new member to MIG: DSM Biomedical B.V. DSM, based in the Netherlands, is a leading medical device materials development and manufacturing company. For more than 25 years, DSM has partnered with medical device companies in developing products that address growing trends in medicine, from treating an aging population to caring for a more active one. As part of the launch of the DSM membership, MTL and MIT.nano jointly hosted a visit from the senior management of DSM and welcomed Pieter Wolters, vice president of the DSM Innovation Center, as the company's IAB representative.

MTL hosted its annual IAB meeting on February 2, 2017, with representatives from 14 MIG member companies in attendance. Members of the core faculty presented their current research initiatives, and the IAB representatives participated in a wide-ranging and thoughtful discussion on the current state and the future of nano-fabrication research and facilities at MIT. A new, and very well received, component of this year's meeting was StartUP@MTL, which showcased seven MTL-related startups whose senior leadership presented their technologies, future products, and business plans to the MIG members in attendance. MIG company representatives attending the meeting included Susan Feindt (Analog Devices [ADI]), Chorn-Ping Chang (Applied Materials), Richard Russell (Draper), Pieter Wolters (DSM), Neil Condon (Edwards Vacuum), Jon DeSouza (HARTING), Kazunori Nemoto (Hitachi), Dirk Pfeiffer (IBM), Nerissa Draeger (Lam Research), Shinichi Yozoru (NEC), Jake Harrison (Samsung), Marco De Fazio (ST Microelectronics), Dennis Buss (Texas Instruments), and Chih-Hang Tung (Taiwan Semiconductor Manufacturing Company).

MIG member companies engage with MTL core faculty, students, and researchers in many ways, including assistance with recruiting events on campus, exclusive access to MTL's annual research conference, faculty visits, and priority access to MTL resources. One of the unique benefits that member companies receive is the opportunity to have a scientist or engineer participate in the research activities of an MTL-affiliated faculty member or research center. This past year, there have been nine visitors from MIG member companies:

- James Fiorenza (ADI), with Professor Tomas Palacios
- Tom O'Dwyer (ADI), with Professor Charles Sodini

- Sam Fuller (ADI), with Professor Sodini
- Anthony Taylor (Edwards), with Dr. Luis Velasquez-Heller
- Vivek Dave (HARTING), with Professor Jesús del Alamo
- Masahiro Sakuta (Hitachi), with Professor Duane Boning
- Arun Paidimarri (IBM), with Professor Chandrakasan
- Marco De Fazio (ST Microelectronics), with Professor Palacios
- Dennis Buss (TI), with MTL

In October 2016, Applied Materials hosted an "MTL Day" at its research facility in Santa Clara, CA, with eight MTL faculty, researchers, and students in attendance. Jesús del Alamo, Jurgen Michel, Tomas Palacios, and Sang-Gook Kim delivered presentations on their current research initiatives. Graduate students and postdocs Xiang Ji, Rushabh Shah, Jiawei Zhou, Suman Bose, and SiWon Choi described their research projects as well. The visit also provided an opportunity for Applied Materials researchers to engage with faculty and students.

In November 2016, MTL hosted the annual "Lam Day at MIT" event. Jing Kong, Max Shulaker, Luqiao Liu, Duane Boning, Jesús del Alamo, and Luis Velásquez-García hosted technical seminars for a full audience of students, postdocs, and faculty, followed by a poster session with submissions from members of the MTL community and from Lam researchers. Dr. Richard Gottscho, executive vice president of the Global Products Group at Lam Research, delivered a luncheon keynote address titled "The Arcane World of Atomic Layer Etching and Deposition."

In June 2017, MIG member company ADI hosted an "MIT.nano Day" at its Wilmington, MA, research campus, with 12 MTL faculty, researchers, and students in attendance. Professors Jesús del Alamo, Vladimir Bulović, Mircea Dinca, Max Shulaker, Joel Voldman, and Michael Watts delivered presentations on their current research initiatives, as did research scientists Jorg Schlovin and Brian Anthony. Graduate students and postdocs Farnaz Niroui, Rabia Yazicigil, German Parada, and Walker Chan also gave talks on their research projects. The visit provided an opportunity for ADI researchers to engage with faculty and students.

Launch of MIT.nano

MTL devoted substantive effort in FY2017 to preparations for the launch of the MIT.nano initiative in June 2018 and the transfer of fabrication facilities from MTL to MIT.nano at that time. Notable accomplishments in the past year include the establishment of a seven-year agreement, crafted by MTL director Jesús del Alamo and School of Engineering associate dean Vladimir Bulović and endorsed by MIT provost Martin Schmidt, that outlines the terms under which MTL's MIG consortium and the newly created MIT.nano consortium will collaborate. FY2017 examples of this collaboration include MTL and MIT.nano enlisting ADI as the first member company of the MIT.nano consortium in November 2016 and MTL's full engagement in welcoming DSM into both the MIT.nano and MIG consortia in December 2016.

Research Centers

Four centers affiliated with MTL provide an opportunity for MIG member companies and other companies to become engaged in focused research initiatives: the Center for Integrated Circuits and Systems (CICS), the MIT/MTL Gallium Nitride Energy Initiative (MIT GaN), the Medical Electronic Device Realization Center (MEDRC), and the MIT-MTL Center for Graphene Devices and 2D Systems (MIT-CG).

The mission of the Center for Integrated Circuits and Systems is to promote new research initiatives in circuits and systems design, as well as a tighter technical relationship between MIT's research and relevant industry. CICS investigates a wide range of circuits and systems, including wireless and wireline communication, high-speed and radio frequency (RF) circuits, microsensor/actuator systems, imagers, digital and analog signal processing circuits, biomedical circuits, and power conversion circuits. In FY2017, MTL supported CICS in hosting two research reviews on campus, one in November 2016 and the other in May 2017.

MIT GaN is an interdepartmental program focused on advancing the science and engineering of GaN-based materials and devices for energy applications. The initiative involves a holistic approach to GaN research for energy applications, and it coordinates work on technology, novel devices, circuits, and systems to take full advantage of the unique properties of GaN. MIT GaN is especially focused on developing new beyond-state-of-the-art solutions to system-level applications in RF power amplification, mixed signal electronics, energy processing, and power management, as well as advanced optoelectronics. Most of the work is done on GaN materials and devices that are compatible with Si fabrication technologies, and there is close collaboration with industrial partners to accelerate the insertion of these devices into systems. In December 2016, MIT GaN held its annual review with support from MTL.

The vision of MEDRC is to revolutionize medical diagnostics and treatments by bringing health care directly to the individual and to create technology for the future information-driven health care system. This vision will, in turn, transform the medical electronic device industry. Specific areas that show promise are wearable or minimally invasive monitoring devices, medical imaging, portable laboratory instrumentation, and data communication from these devices and instruments to health care providers and caregivers. MEDRC embodies the interdisciplinary focus of MTL's research through its close association with the Institute for Medical Engineering and Science, which has been charged with serving as a focal point for researchers across MIT with medical interests. MEDRC has been able to create strong connections with the medical device and microelectronics industry, venture-funded startups, and the Boston medical community. With the support of MTL and IMES, MEDRC serves as the catalyst for the deployment of medical devices that will reduce the cost of health care in both the developed and the developing world. In May 2017, MTL supported MEDRC in hosting its ninth annual research conference, which featured workshops with physicians, health care professionals, engineers, and researchers in nanotechnology, electronics, medical devices, and systems.

MIT-CG brings together MIT researchers and industrial partners to advance the science and engineering of graphene and other two-dimensional materials. Specifically, the

center explores advanced technologies and strategies that enable 2D materials, devices, and systems to provide discriminating or breakthrough capabilities for a variety of system applications ranging from energy generation/storage and smart fabrics and materials to optoelectronics, RF communications, and sensing. In all of these applications, MIT-CG supports the development of the science, technology, tools, and analysis needed to create a vision for the future of new systems enabled by 2D materials. In November 2016, the center held its annual review with support from MTL.

Research Highlights

Professors Jeehwan Kim, Eugene Fitzgerald, and Jing Kong

Remote Epitaxy through Grapheme Enables 2D Material-Based Layer Transfer. Epitaxy—the growth of a crystalline material on a substrate—is crucial for the semiconductor industry but is often limited by the need for lattice matching between the two material systems. This strict requirement is relaxed for van der Waals epitaxy, in which epitaxy on layered or 2D materials is mediated by weak van der Waals interactions and facile layer release from 2D surfaces is possible. It has been thought that 2D materials are the only seed layers for van der Waals epitaxy. However, the substrates below 2D materials may still interact with the layers grown during epitaxy (epilayers), as in the case of the so-called wetting transparency documented for graphene. In a recent *Nature* publication, the authors showed that the weak van der Waals potential of graphene cannot completely screen the stronger potential field of many substrates. They used density functional theory calculations to establish that adatoms will experience remote epitaxial registry with a substrate through a substrate-epilayer gap of up to 9 ångströms. This gap can accommodate a monolayer of graphene. They confirmed their predictions with homoepitaxial growth of GaAs(001) on GaAs(001) substrates through monolayer graphene and showed that their approach is also applicable to InP and GaP.

Professor Ruonan Han

Rapid and Energy-Efficient Molecular Sensing Using Dual Millimeter-Wave Combs in 65-nm CMOS—A 220 to 320 GHz Spectrometer with 5.2 mW Radiated Power and a 14.6 to 19.5 dB Noise Figure. Millimeter-wave/terahertz rotational spectroscopy offers an ultra-wide-detection range of gas molecules for chemical and biomedical sensing. Therefore, wideband, energy-efficient, and fast-scanning complementary metal-oxide-semiconductor (CMOS) spectrometers are in demand. Given a typical 10 kHz resolution and 1-ms integration time, scanning a 100 GHz bandwidth with a single tone takes as long as three hours. The proposed comb architecture of this 220 to 320 GHz CMOS spectrometer prototype enables scalability to higher bandwidths with extended cascading of narrowband channels. The maximum scanning speed of a single-tone spectrometer with certain sensitivity is determined by the probing signal power, which is fundamentally limited by the population saturation of molecular states. In comparison, in a comb, each probing channel reaches such maximum speed, leading to a much shorter total scanning time through parallel operation. A high-energy efficiency of 0.17 mJ per point (1-ms integration time) is achieved through rapid combing of the spectrum, demonstrating a new path for broadband sensing via parallelism. This work was presented at the 2017 International Solid-State Circuits Conference (ISSCC) in San Francisco, CA.

Professors Tomas Palacios, Jing Kong, Dimitri Antoniadis, and Anantha Chandrakasan

High-Yield Large Area MoS2 Technology—Material, Device, and Circuit Co-Optimization. Two-dimensional electronics based on single-layer (SL) MoS2 offer significant advantages for realizing large-scale flexible systems owing to the ultrathin nature, good transport properties, and stable crystalline structure of MoS2. However, the reported devices and circuits based on this material have low yields because of variation sources inherent to the growth and fabrication technology. In this work, presented at the 2016 IEEE (Institute of Electrical and Electronics Engineers) International Electron Devices Meeting (IEDM) in Washington, DC, the authors developed a variation-aware design flow and yield model to evaluate the MoS2 technology and provide a guideline for the co-optimization of the material, devices, and circuits. Test chips with various inverters and basic logic gates were fabricated as demonstrations of the close-to-unit yield of the proposed technology platform.

Professor Anantha Chandrakasan

An Actively Detuned Wireless Power Receiver with Public Key Cryptographic Authentication and Dynamic Power Allocation. There has been rapid growth in the number of devices with resonant wireless recharging capabilities. Protecting these devices from harsh transients imposed by counterfeit wireless chargers and ensuring equitable power delivery under heavily skewed coupling remain challenging issues. Professor Chandrakasan designed a wireless power receiver that mitigates these disparate issues by leveraging a new detuning technique that does not rely on switched passives. Public key authentication of genuine chargers is implemented using low-resource elliptic curve cryptography. Additionally, the skew in received power imposed by a 4:1 distance ratio between receivers is overcome using a cooperative scheme. This work was presented at the 2017 ISSCC in San Francisco.

Professors Dimitri Antoniadis and Tomas Palacios

RF-Circuit Linearity Performance of GaN HEMT Technology Using the MIT Virtual Source GaNFET Compact Device Model. This study is a first demonstration of the use of a physical compact model to identify technology bottlenecks in the linearity performance of emerging devices such as GaN high-electron mobility transistors (HEMTs) and to provide solutions to improve linearity through both device-design and circuit-design techniques. GaN-based HEMTs are emerging as key technology solutions in wireless communication systems that can address the increasing demand for highly efficient linear amplification of digitally modulated information to cater to new applications such as personal communication and the Internet of Things. GaN HEMTs and their higher bandgap, carrier mobility, and charge density can yield better output power; however, the linearity behavior of GaN-based power amplifiers remains to be understood. Nonlinearity results in adjacent channel interference, spectral regrowth, and degrading error vector magnitudes that lead to bandwidth constraints and higher bit error rates for complex modulated signals. This work was presented at the 2016 IEDM in Washington, DC.

Program Highlights

In July 2016, MTL welcomed Max Shulaker as a new member of its core faculty upon his joining MIT as an assistant professor in EECS. Max is launching an experimental research program aimed at realizing his vision for the next generation of electronic systems based on transformation nanosystems; specifically, he seeks to leverage the unique properties of emerging nanotechnologies and nanodevices to create new systems and architectures with enhanced functionality and improved performance. Max received his PhD from the Department of Electrical Engineering at Stanford University in 2016.

Professor Jeehwan Kim, who holds dual appointments in the Department of Mechanical Engineering and the Department of Materials Science and Engineering, became a core member of the MTL faculty in January 2017. Professor Kim joined MIT in September of 2015. His group focuses on innovation in nanotechnology for electronic/photonic/energy applications. In particular, he is pursuing the development of an epitaxial random access memory structure for neuromorphic computing. In addition, his group is developing a graphene-based layer transfer technology that offers infinitive growth and transfers of high-quality single-crystalline semiconductor films on single-crystal graphene. This will enable low-cost fabrication of high-performance electronic/photonic/photovoltaic devices. Professor Kim received his PhD in materials science from the University of California, Los Angeles, in 2008.

In FY2017, MTL welcomed the second cohort of visiting faculty, postdocs, and students under the formal relationship MIT established with Tecnológico de Monterrey in FY2015. One faculty member, two postdoctoral fellows, and five graduate and undergraduate students were hosted by faculty in six labs across MIT and at Brigham and Women's Hospital for stays of one semester to one year. The visiting researchers' interests ranged from the development of microfluidic systems for analysis of blood chemistry and platelets to tissue engineering scaffolding using 3D printed hardware and 3D printing for MEMS applications. Again this year, the work of program participants resulted in several papers submitted for publication in peer-reviewed journals or for presentation at conferences. As a further component of this program, MTL hosted 24 students, postdocs, and faculty this year in three separate one-week sessions of the MTL nanoLab hands-on nanotechnology course.

MTL engages the community in a number of technical events and programs. In both the fall and spring of each academic year, the laboratory hosts a seminar series spanning diverse technical areas. The seminars, which are open to the public, are organized by a committee chaired by Dr. Luis Velasquez-Heller. In addition to these regular seminars, MTL hosts one doctoral dissertation seminar each semester featuring a recent MTL PhD graduate, as well as occasional executive seminars featuring senior leaders from MIG member companies. In March 2017, MTL core faculty member Luqiao Liu hosted a visit from Dr. Dario Gil, vice president of science and solutions at IBM Research, who delivered a seminar titled "Beautiful Ideas: AI, Quantum Computing and the Power of (non)Consensus."

Every January, MTL holds its annual research conference run by MTL graduate students. The 2017 conference was co-chaired by students Xiaowei Cai (from Professor

del Alamo's group) and Ujwal Radhakrishna (from Professor Antoniadis's group). The conference is broadly attended by industry representatives, faculty, students, and staff, as it provides a unique opportunity to learn about research in the diverse areas encompassed by MTL while fostering interactions among the MTL community. The 2017 event was held from January 31 to February 1 at the Omni Mount Washington Resort in Bretton Woods, NH. Approximately 200 students, postdocs, faculty, staff, and industry partners were in attendance, including 26 MIG company guests and 30 student/postdoc organizers. MTL students, postdocs, and researchers presented almost 100 posters and nine featured talks, including a dinner panel ("The MTL Launchpad: Perspectives from Alumni in Academia, Startups, and Industry") moderated by MTL postdoc Phillip Nadeau and a conference-opening technical keynote delivered by Vladimir Bulović.

Facilities Update

During the past year, MTL continued to replace aging tools, extend the usefulness of existing tools, and acquire new capabilities. With support provided by the Vice President of Research Replacement Fund, a new MLA-150 direct-write exposure system was acquired to replace an aging mask aligner. With this new tool, our student users have been able to do rapid prototyping for their devices without incurring the cost of making masks. It allows exposure on warped wafers and is compatible with all standard photoresists. In addition to this new tool, a Brewer spin developer was installed in the Technology Research Laboratory. It produces very uniform bakes and can accommodate piece samples, wafers, and masks. Finally, we installed an Angstrom Engineering EvoVac deposition system in the Integrated Circuits Laboratory that can carry out sputtering and thermal evaporation; this machine was purchased with funds from a research grant awarded to Professor Tayo Akinwande.

In addition to equipment renewal, MTL accommodated a new faculty member's lab and continues to work with two other faculty who have space needs.

Outreach and Educational Activities

In support of its mission to provide access to advanced fabrication technologies, MTL makes its facilities available to industry users through the Fabrication Facilities Access Program and to users from academia and government agencies through the Outreach Program. Over the past year, MTL supported the activities of half a dozen different companies, including two MTL startups.

In addition to providing subsidized access to MTL computational or fabrication facilities for MIT undergraduate students, MTL supports MIT's educational mission through three courses held at the laboratories: 6.152J Micro/Nano Processing Technology, which introduces the theory and technology of micro/nano-fabrication; 3.042 Materials Project Laboratory, which provides student project teams with the capability to design and fabricate a working prototype using materials processing technologies; and 6.07J Projects in Microscale Engineering, which is a project-based introduction to manipulating and characterizing cells and biological molecules using micro-fabricated tools for the life sciences.

Also, as described below, MTL actively engages in a pair of School of Engineering Initiatives: the Women's Technology Program and the SuperUROP Program.

Women's Technology Program

The Women's Technology Program was created in 2002 to encourage young women with strong math, science, and analytical abilities to pursue studies in engineering and computer science. The program provides these women with positive female role models, college-level computing and engineering experience, and an understanding of what engineers and scientists do and how they work. Program participants have an opportunity during the summer for a hands-on experience in MTL's fabrication facilities under the guidance of a female graduate student whose research depends heavily on using these facilities. The young women go through the fabrication steps needed to transfer a group photograph onto a silicon wafer. Each student receives a wafer that displays the image of the group. Feedback from students has been very positive, and the "picture wafers" are a great reminder of their summer at MIT.

SuperUROP Program

SuperUROP engages MIT undergraduate students in a yearlong research experience in which they participate in the course Preparation for Undergraduate Research. SuperUROP promotes direct interaction with faculty and industry sponsors, cultivates student creativity and professional development, and encourages students to consider the ethical and entrepreneurial aspects of their work. In 2016–2017, almost two dozen students in the program worked in MTL. Five of these students were qualified to work in the MTL fabrication facilities as part of their SuperUROP project.

Core Faculty Appointments and Promotions

The following appointments and promotions involving MTL faculty took place in FY2017:

- Anantha Chandrakasan, head of EECS and former director of MTL, was appointed dean of MIT's School of Engineering.
- Max Shulaker was named an assistant professor in EECS.
- Martin Schmidt, MIT provost and former MTL director, was appointed to the Ray and Maria Stata Professorship.
- MTL associate director Duane Boning was named head of the Leaders for Global Operations program.
- Vivienne Sze was promoted to associate professor without tenure in EECS.

Awards and Honors

MTL faculty and students regularly receive recognition for their research contributions and accomplishments, with numerous national and international awards. The following awards and distinctions were collected by MTL-affiliated faculty, staff, and students over the past year:

- Professor Tomas Palacios was elected as an IEEE Fellow for 2017.
- Professor Vivienne Sze received a Young Investigator Award from the Air Force Office of Scientific Research.
- Professor Dirk Englund was awarded the Optical Society's 2017 Lomb Medal for noteworthy contributions to optics at an early career stage. He also received the 2017 ACS Photonics Young Investigator Award.
- Professor Henry Smith was awarded the IEEE Noyce Medal.
- Professors Luqiao Liu and Ruonan Han received National Science Foundation CAREER Awards.
- PhD student Yu-Hsin Chen received the IEEE Solid-State Circuit Society Predoctoral Achievement Award at the 2017 ISSCC in San Francisco.
- PhD graduate Alex Guo received the Best Student Paper Award at the 2017 IEEE International Reliability Physics Symposium in Monterey, CA.
- PhD student Apoorva Murarka was the $15,000 Lemelson-MIT "Use it!" graduate winner. Murarka developed a 125-nanometer-thick membrane—approximately one thousandth the width of a human hair—to produce high-fidelity sound more efficiently.
- PhD student Wenjie Lu received the Best Student Paper Award at the 2017 Compound Semiconductor Week event in Berlin, Germany.
- EECS undergraduate student Allison Lemus received the SuperUROP Outstanding Research Project Award at the EECS awards and recognition event on May 21, 2017. Her project, performed under the supervision of MTL director Jesús del Alamo, investigated time-dependent dielectric breakdown in gallium nitride transistors for power management applications.

Administrative Updates

MTL's staff is integral to its success and infrastructure. Staffing updates over the past year are as follows:

- Patricia Burkhart retired from MIT in July 2016 after almost 25 years of outstanding service to MTL as environmental health and safety coordinator.
- In January 2017, MTL hired Whitney Hess as environmental health and safety coordinator. Dr. Hess received her PhD in chemistry from MIT in December 2016.
- MTL financial officer Luda Leoparde received an MIT School of Engineering Infinite Mile Award.

Jesús A. del Alamo
Director
Donner Professor and Professor of Electrical Engineering