Microsystems Technology Laboratories

The mission of MIT's 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 these important areas of human concern, researchers at MIT are engineering new materials, structures, devices, circuits, and systems using MTL's facilities and services. MTL's research program is highly interdisciplinary and encompasses integrated circuits, systems, electronic and photonic devices, MEMS (microelectromechanical systems), bio-MEMS (biomedical microelectromechanical systems), molecular devices, nanotechnology, sensors, and actuators. MTL core faculty and the students and researchers in their laboratories are conducting breakthrough research on a scale of from 1 nm (nanometer) to 1 m in areas encompassing nanoscale transistors, medical devices, microfluidics, organic lasers, and perovskite photovoltaics, among others.

At present, our core faculty consists of 50 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 Sciences, 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 Nanotechnology. MTL core faculty serve the Institute and the global community in significant leadership positions. We are honored to note that MTL faculty include President L. Rafael Reif, Provost Martin Schmidt, Associate Provost Karen Gleason, School of Engineering Associate Dean Vladimir Bulović, and EECS Department Head Anantha Chandrakasan.

MTL manages a set of experimental facilities in buildings 39 and 24 that host in excess of 150 fabrication and analytical tools. We strive to provide a flexible fabrication environment capable of long-flow integrated processes that yield complex devices while, at the same time, presenting 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 from odd-shaped small pieces to 6-inch wafers. The range of materials continues to expand well beyond silicon and germanium to include III-V compound semiconductors, nitride semiconductors, graphene and other 2D materials, polymers, glass, organics, and many others. MTL's facilities are open to the entire MIT community and the outside world. Nearly 600 MIT students and postdoctoral researchers from 21 different departments, laboratories, and centers carried out their research in MTL's facilities 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 annually. 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.

Industry Engagement

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

In FY2016, MTL welcomed two new members to the MIG: Charles Stark Draper Laboratory, Inc. and HARTING, Inc. Draper is a not-for-profit research and development laboratory focused on the design, development, and deployment of advanced technological solutions for our nation's most challenging and important problems in security, space exploration, healthcare, and energy. Richard Russell, director of materials science and applications, is the Draper representative on MTL's Industrial Advisory Board.

Headquartered in Germany, HARTING is a global leader in the connector industry and develops, manufactures and sells connectors, device connection technology, and network components for use in mechanical and plant engineering, broadcasting and entertainment, factory automation, power generation and distribution, and industrial electronics and telecommunications. At a launch event for the new members, MTL hosted a visit from the senior management of HARTING and welcomed Jon DeSouza, president and CEO of HARTING, Inc. of North America, as the HARTING representative on the IAB.

MTL hosted its annual Industrial Advisory Board meeting on Friday, January 22, 2016, with all 16 MIG member companies in attendance. Core faculty members presented their current research initiatives, and IAB representatives participated in wide-ranging and thoughtful discussions on the current state and future of nanofabrication research and facilities at MIT. Representatives in attendance included Michael DeLaus and James Fiorenza (Analog Devices), Chorn-Ping Chang and Namsung Kim (Applied Materials), Richard Russell and Jeffrey Borenstein (Draper), Anthony Keen and George Courville (Edwards Vacuum), Yihui Qui and Jeng Feng Lee (Foxconn), Frank Brode and Jon DeSouza (HARTING), Takashi Irie (Hitachi High Technologies), Ghavam Shahidi (IBM), Scott List (Intel), Nerissa Draeger (Lam Research Corporation), Shinichi Yozoru (NEC Corporation), Scott Davenport (Qualcomm), Jake Harrison (Samsung), Marco De Fazio (STMicroelectronics), Dennis Buss (Texas Instruments), and Wilman Tsai (Taiwan Semiconductor Manufacturing Company).

Group photo of the Industrial Advisory Board meeting, 2016 (photo: Paul McGrath/MTL).

MIG member companies engage with MTL core faculty, students, and researchers in many ways, including online access to the MTL resume site, 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 13 visitors from MTL member companies:

James Fiorenza (Analog Devices [ADI]) with Tomás Palacios

Tom O'Dwyer (ADI) with Charles Sodini

Sam Fuller (ADI) with Sodini

Anthony Taylor (Edwards) with Luis Velasquez-Garcia

Jeng-Feng Lee (Foxconn) with Anantha Chandrakasan

Vivek Dave (HARTING) with Jesús del Alamo

Masahiro Sakuta (Hitachi) with Duane Boning

Melissa Alyson Smith (IBM) with Tayo Akinwande

Arun Paidimarri (IBM) with Chandrakasan

Brian Brandt (Maxim Integrated Products) with Charles Sodini and Joel Voldman

Marco De Fazio (STMicroelectronics) with Palacios

Dennis Buss (Texas Instruments) with Microsystems Technology Laboratories

Ginger Wang (Taiwan Semiconductor Manufacturing Company) with Sodini

In May 2016, MIG member company Intel hosted an "MIT Day" at their Hillsboro, OR, research campus with eight MTL faculty and students in attendance. Professors del Alamo, Palacios, and Ruonan Han delivered presentations on their current research initiatives, assisted by Nicholas Fang, Qiong Ma, Phillip Nadeau, Ujwal Radhakrishna, and Yi Song. The visit also provided an opportunity for Intel researchers to engage with the faculty and students.

Research Centers

Four MTL-affiliated centers provide an opportunity for MIG member companies and other companies to become engaged in focused research initiatives. These are the Center for Integrated Circuits and Systems, the MIT GaN Energy Initiative, the Medical Electronic Device Realization Center, and the MIT-MTL Center for Graphene Devices and 2D Systems.

The mission of the Center for Integrated Circuits and Systems (CICS) 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 RF (radio frequency) circuits, microsensor/actuator systems, imagers, digital and analog signal processing circuits, biomedical circuits, and power conversion circuits, among others.

The MIT-MTL Gallium Nitride (MIT GaN) Energy Initiative is an interdepartmental program focused on the advance the science and engineering of GaN-based materials and devices for energy applications. The GaN Energy Initiative provides a holistic approach to GaN research for energy applications and it coordinates work on the growth, technology, novel devices, circuits and systems to take full advantage of the unique properties of GaN. MIT GaN is especially interested in 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 (silicon) fabrication technologies in close collaboration with industrial partners to accelerate the insertion of these devices into systems.

The vision of the MIT Medical Electronic Device Realization Center (MEDRC) is to revolutionize medical diagnostics and treatments by bringing health care directly to the individual and by creating enabling technology for the future information-driven healthcare 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 the data communication from these devices and instruments to healthcare providers and caregivers. MEDRC embodies the interdisciplinary focus of MTL's research through its close association with MIT's Institute for Medical Engineering and Science (IMES), which serves as a focal point for researchers with medical interest across MIT. 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 will serve as the catalyst for the deployment of medical devices that will reduce the cost of healthcare in both the developed and developing world.

The MIT-MTL Center for Graphene Devices and 2D 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 these applications, MIT-CG supports the development of the science, technology, tools, and analysis for the creation of new systems enabled by 2D materials.

Research Highlights

MTL faculty and students regularly receive recognition for their research contributions and accomplishments with numerous national and international awards. A few of MTL's notable research initiatives are highlighted below. The MTL website contains more comprehensive details on MTL activities, people, awards, and research accomplishments and directions.

Anantha Chandrakasan, Jing Kong, Pablo Jarillo-Herrero, and Tomás Palacios: Graphene Thermopile for Thermal Imaging

Infrared detectors have a large range of applications from infrared thermography, chemical spectroscopy, and active night vision systems. Graphene, due to its symmetric conical band structure and broadband optical absorption, is interesting as a new material for infrared photon-based detectors. Current technologies, such as HgCdTe detectors, often require cryogenic cooling to mitigate noise sources such as thermally excited carriers or stray blackbody optical photons. These drawbacks can be avoided at infrared wavelengths by using thermal detectors that offer higher sensitivities at 300 K. This research leverages graphene's band structure not for optical detection but rather for thermal detection in the mid-infrared range. By integrating graphene-based ambipolar thermopiles with silicon MEMS structures, thermal imaging of a blackbody source is performed, achieving sensitivities high enough to detect the emitted radiation from a human hand. Analysis shows that the ultrahigh carrier mobility of graphene can enable intrinsic performance surpassing state-of-the-art thermopile imagers, potentially enabling new classes of low-cost, transparent, and flexible thermal imagers.

Jesús del Alamo: Sub-20 nm Fin-width Self-aligned InGaAs Fin Field-Effect Transistors

InGaAs is a promising candidate as channel material for CMOS (complementary metal oxide semiconductor) technologies beyond the 10 nm node. In this dimensional range, only high aspect-ratio 3D transistors with a fin or nanowire configuration can deliver the necessary performance. Impressive fin and nanowire-based InGaAs FinFET prototypes have recently been demonstrated, but to date InGaAs FinFETs with fin widths below 30 nm and channel aspect ratio better than unity have yet to be demonstrated. Furthermore, the channel sidewall slopes are typically lower than 80°. For insertion in a sub-10 nm node, InGaAs FinFETs with sub-10 nm fin widths and steep sidewalls will be required. In this work, we present the first self-aligned InGaAs FinFETs with sub 20-nm fin width, high channel aspect ratio, vertical sidewalls, gate lengths as short as 20 nm and CMOS-type manufacturability. For this, we use a top down process based on a combination of RIE (reactive ion etching) and digital etch. Our transistors are the most aggressively scaled InGaAs FinFETs to date.

Anantha Chandrakasan: Secure Wireless Authentication Tag

Counterfeiting is a major problem plaguing global supply chains. While small low-cost tagging solutions for supply-chain management exist, security in the face of fault-injection and side-channel attacks remains a concern. Power glitch attacks, in particular, attempt to leak key bits by inducing fault conditions during cryptographic operation through the use of over-voltage and under-voltage conditions. Our work presents the design of a secure authentication tag with wireless power and data delivery optimized for compact size and near-field applications. Power-glitch attacks are mitigated through state backup on FeRAM-based (Ferroelectric Random Access Memory) non-volatile flip-flops. The tag updates the key before each protocol invocation, limiting side-channel leakage to a single trace per key.

Vivienne Sze: Energy-efficient Reconfigurable Accelerator for Neural Networks

Deep learning using convolutional neural networks (CNN) gives state-of-the-art accuracy on many computer vision tasks (e.g. object detection, recognition, segmentation). Convolutions account for over 90% of the processing in CNNs for both inference/testing and training, and fully convolutional networks are increasingly being used. To achieve state-of-the-art accuracy requires CNNs with not only a larger number of layers, but also millions of filters, weights, and varying shapes. This results in substantial data movement, but consumes significant amounts of energy. This research developed an accelerator that delivers state-of-the art accuracy with minimum energy consumption by using two key methods: (1) efficient dataflow and supporting hardware (spatial array, memory hierarchy, and on-chip network) that minimize data movement by exploiting data reuse and different shapes; and (2) efficient energy flow by exploiting data statistics to minimize energy through zeros skipping/gating, which avoids unnecessary reads and computations, as well as data compression to reduce off-chip memory bandwidth, which is the most energy-expensive data movement.

Luis Velasquez-Garcia: 3D Printed Coaxial Electrospray Source

Done with the participation of Daniel Olvera Trejo, a postdoctoral fellow visiting the Velasquez-Garcia group under the Tecnológico de Monterrey program described below, this work reports the design, fabrication, and characterization of the first MEMS coaxial electrospray sources for uniform generation of core-shell microparticles. These microparticles are important in applications such as feedstock microencapsulation, controlled drug release, and self-healing microstructured composites. Coaxial electrospray is an electrohydrodynamic process that creates core-shell microdroplets by atomization of a coaxial electrified jet composed of two immiscible liquids. Through multiplexing of the emitters, coaxial electrospray has the potential to overcome the low throughput of state-of-the-art microencapsulation methods without sacrificing particle size uniformity. Unlike well-studied uniaxial electrospray, coaxial electrospray was discovered in 2002 and no MEMS coaxial electrospray source had previously been reported. High-resolution stereolithography (SLA) is used to provide a solution to the three-dimensional complexity of the coaxial hydraulic system, making it possible

to manufacture freeform microfluidics at a small fraction of the cost per device, infrastructure cost, and fabrication time of a typical silicon-based microfluidic system. The SLA 3D-printed devices are made of polymer and have one or two 12-mm tall internally-fed coaxial electrospray emitters fed by two high-impedance helical channels (700 μm diameter, 37 mm long) that regulate and maintain uniformity of the flows. The small footprint is compatible with high emitter density. The emitter nozzle is designed to produce a coaxial flow and to enhance the electric field on the liquid menisci.

Program Highlights

In July 2015, upon his joining MIT as an assistant professor in EECS, MTL welcomed Luqiao Liu as a new member of our core faculty. An expert in the properties of magnetic materials and their application to nonvolatile memory and spin based logics, Professor Liu's research aims to use spin-based electronics to solve the power, scaling, and speed issues associated with conventional semiconductor devices.

In FY2016, MTL welcomed the first cohort of visiting faculty and postdocs under the formal relationship MIT established with Tecnológico de Monterrey in FY2015. Three faculty members and five postdoctoral fellows were hosted by faculty in seven labs across MIT and at the Brigham and Women's Hospital for stays of from one semester to one year. The visiting researchers' interests ranged from the creation of nanostructures for tissue engineering applications to multi-layer and multi-material microfabrication for microfluidic devices. In the first full year of this program, their work resulted in several papers submitted for publication or for presentation in peer-reviewed journals and conferences. As a further component of the program, MTL hosted 24 students, postdocs, and faculty members for three separate one-week sessions that were part of the MTL nanoLab hands-on course on nanotechnology.

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 highlighting diverse technical areas. Seminars are organized by a committee chaired by Luis Velasquez-Garcia, and all seminars are open to the public. In addition to these regular seminars, MTL hosts one doctoral dissertation seminar per semester that features a recent MTL PhD graduate, as well as hosting occasional executive seminars featuring senior leaders from the MIG member companies. In December 2015, MTL core faculty member and the EECS department head hosted the visit of Dr. Sophie Vandebroek, chief technology officer at Xerox Corporation and president of the Xerox Innovation Group, who delivered an executive seminar titled "Three Pillars Enabling the Internet of Everything: Smart Everyday Objects, Information-Centric Networks, and Automated Real-Time Insights." In March 2016, MTL director Jesús del Alamo hosted the visit of Richard Templeton, chairman, president, and CEO of Texas Instruments. Mr. Templeton delivered an executive seminar titled "Yes, Industry, There is a Future for Semiconductors."

Every January, MTL holds the Microsystems Annual Research Conference (MARC) run by MTL graduate students. The 2016 MARC was co-chaired by students Priyanka Raina (from Professor Chandrakasan's group) and Wenjie Lu (from Professor del Alamo's group). MARC is broadly attended by industry, faculty, students, and staff since it

provides a unique opportunity to learn about the diverse MTL research areas while fostering interactions among the MTL community. The 2016 event was held January 20 and 21 at the Omni Mount Washington Resort in Bretton Woods, New Hampshire. Approximately 175 students, postdocs, faculty, staff, and industry partners attended, including 20 MIG company guests. MTL students, postdocs, and researchers presented almost 100 posters and nine featured talks, including a dinner keynote delivered by Mary Lou Jepsen, executive director of engineering at Facebook/Oculus, and a conference-opening technical keynote delivered by John Rogers, Swanlund Professor and professor of materials science and engineering at the University of Illinois Urbana/Champaign.

Group photo taken at MARC2016 (photo: Paul McGrath/MTL)

Facilities Update

During the past year, MTL replaced aging tools, extended the usefulness of existing tools, and acquired new capabilities. Tools acquired and installed in FY2016 include a user-friendly, material-conserving Brewer spin developer for the Technology Research Laboratory, as well as an Angstrom Engineering EvoVac deposition system, which allows thermal, e-beam and sputtering deposition without breaking vacuum; the latter is a mission-critical tool in the Integrated Circuits Laboratory, purchased with funds from a research grant obtained by Professor Akinwande. Using funds from Biological Engineering, Mechanical Engineering, EECS, the Microsystem Technology Laboratory, and the Manalis and Boyden groups, a high throughput STS Pegasus DRIE (deep reactive ion etcher) and associated endpoint detector were purchased, as well as an improved electrostatic chuck, along with several other upgrades. With support provided by the Vice President for Research replacement fund, a new electron-beam evaporator for the Exploratory Materials Laboratory was ordered to replace the one inherited from the defunct Microlab, which dated to 1989. With these new tools, MTL is able to support new programs and strategic initiatives.

In addition to equipment renewal, MTL accommodated a new faculty member's lab and is working with two others who need space that is not otherwise available at MIT. Presumably these needs will be satisfied when MIT.nano opens.

Outreach and Educational Activities

In support of MTL's 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 its outreach program. During the reporting period, MTL supported the activities of seven different companies, including two startups founded by MIT alumni.

MTL supports MIT's educational mission by providing $3,000 of subsidized access to MTL computational or fabrication facilities for all MIT undergraduate students, as well as through three courses held at the laboratory: 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 the opportunity 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 microfabricated tools for the life sciences.

MTL also supports two Department of Electrical Engineering and Computer Science Initiatives: the Women's Technology Program and the Super UROP Program, as described below.

Women's Technology Program

The Women's Technology Program was created in 2002 to encourage high school aged 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. Students in the Women's Technology Program can participate during the summer in a hands-on experience in the microfabrication facilities of MTL. 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.

Electrical Engineering and Computer Science Super-UROP Program

SuperUROP (Undergraduate Research Opportunities Program) 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 AY2016, almost two dozen students in the

program worked in the Microsystems Technology Laboratory. Six of them 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 FY2016:

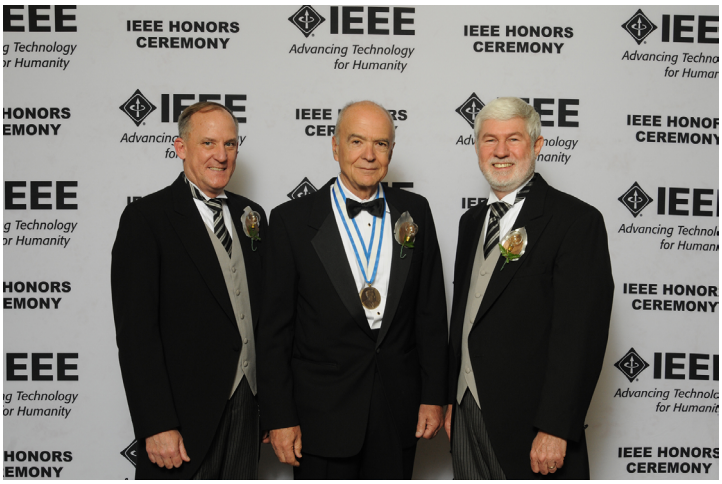
- Luqiao Liu was appointed as assistant professor in the Department of Electrical Engineering and Computer Science. He was also given the Robert J. Shillman Career Development Professorship.
- Evelyn Wang, associate professor in the Department of Mechanical Engineering, was appointed as associate director of MTL.
- School of Engineering dean Ian Waitz appointed Anantha Chandrakasan to the Vannevar Bush Professorship, an Institute-wide professorship established in 1982 as a memorial to one of the most outstanding scientists and engineers of the 20th century (who was also MIT's first dean of the School of Engineering).
- Michael Watts, associate professor in the Department of Electrical Engineering and Computer Science, was awarded tenure.
- Tomás Palacios was promoted to full professor in the Department of Electrical Engineering and Computer Science.
- Luca Daniel was promoted to full professor in the Department of Electrical Engineering and Computer Science.
- Jing Kong was promoted to full professor in the Department of Electrical Engineering and Computer Science.
- Dirk Englund was promoted to associate professor in the Department of Electrical Engineering and Computer Science.
- MTL associate director Duane Boning was named the Clarence J. LeBel Professor of Electrical Engineering.

Awards and Honors

The following awards and distinctions were collected by MTL affiliated faculty, staff, and students during AY2016:

- MTL core faculty members Karl Berggren and Rajeev Ram were elected as Institute of Electrical and Electronics Engineers (IEEE) fellows for 2016.
- MTL core faculty members Anantha Chandrakasan, Karen Gleason, L. Rafael Reif, and MTL alumnus Dr. Ghavam Shahidi were elected to the National Academy of Engineering.
- MTL Director Jesús del Alamo was awarded doctor honoris causa by the Universidad Politécnica de Madrid.
- Charles Sodini received the Hong Kong University of Science and Technology Honorary Fellowship Award.

- Dimitri Antoniadis received the 2015 IEEE Jun-Ichi Nishizawa Medal, an award honoring outstanding contributions to material and device science and technology.
- Karen Gleason was presented with the 2015 Charles M.A. Stine Award at the MESD (Materials Engineering and Sciences Division) Plenary Session at the American Institute of Chemical Engineers annual meeting in recognition of her work on "new chemical insights into the scientific understanding of vapor deposition of organic materials and their translation to pioneering technologies for polymer coating of surfaces."
- Karen Gleason also received the Distinguished Women in Chemistry/Chemical Engineering Award presented by International Union of Pure and Applied Chemistry.
- Graduate students Winston Chern, Jamie Teherani, and Pouya Hashemi along with Professors Antoniadis and Judy Hoyt were awarded the 2015 George E. Smith Award (best Electron Device Letters paper award) by the IEEE Electron Devices Society.
- Graduate student Zheng Zhang was selected to present the fall 2015 MTL Doctoral Dissertation Seminar. Professor Daniel supervised his research.
- Dr. Bichoy Bahr was selected to present the Spring 2016 MTL Doctoral Dissertation Seminar. Professors Dana Weinstein and Luca Daniel supervised his research.
- Recent PhD graduate Jianqiang Lin received first place in the 2015 Jin-Au Kong Doctoral Thesis Award for best PhD thesis in Electrical Engineering at MIT.
- Jianqiang Lin was also selected as a recipient of the 2015 Dimitris N. Chorafas Foundation Award. Professors del Alamo and Antoniadis supervised his research.



Professor Dimitri Antoniadis receiving the 2015 IEEE Jun-Ichi Nishizawa Medal (Photo, IEEE).

Administrative Update

Our staff is integral to the Microsystem Technology Laboratory's success. The following are staffing updates that occurred during AY2016:

- Sherene Aram joined MTL in August 2015 as the new administrative officer. She comes to MTL with more than 12 years of MIT experience, having formerly served as administrative officer in the Harvard-MIT Division of Health Sciences and Technology.
- Benjamin Snedeker, senior financial officer, left MIT in October 2015 after a decade of service. He and his family moved to Arizona where he joined a startup software company.
- In February 2016, Ludmila Leoparde was promoted to financial officer, MTL Service Center, in recognition of her exceptional performance in her prior role as MTL's senior financial assistant.
- In May 2016, William Holber, associate director for industry relations, left MIT to devote his full attention to his work at Plasmability, a company for which he currently serves as president and chief technical officer.
- MTL support staff member Joseph Baylon received the MIT School of Engineering's 2016 Infinite Mile Award.

MTL had a number of support staff transitions in FY2016, including the hiring of four new administrative assistants: Mary O'Neil as senior assistant to the MTL director; Joanna MacIver as assistant to Professors Sodini and Han; Jami Hinds as assistant to Professors Boning and Palacios, and Lindsay Shanahan as assistant to Professor Chandrakasan. We also celebrated the retirement of Carolyn Collins, following her more than three decades of service to many of MTL's core faculty.

Joseph Baylon receiving the 2016 Infinite Mile Award (Photo, School of Engineering).

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