MIT Industrial Liaison Program Faculty Knowledgebase Report

Microphotonics Everywhere (Repeat)

November 3, 2020 7:30 pm - 9:30 pm

7:30pm

Welcome and Introduction
Jewan Bae

Program Director, MIT Corporate Relations

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Jewan John Bae comes to MIT Corporate Relations with more than 20 years of experience in the specialty chemicals and construction industries. He facilitates fruitful relationships between MIT and the industry, engaging with executive level managers to understand their business challenges and match them with resources within the MIT innovation ecosystem to help meet their business objectives.

Bae's areas of expertise include new product commercialization stage gate process, portfolio management & resource planning, and strategic planning. He has held various business leadership positions at W.R. Grace & Co., the manufacturer of high-performance specialty chemicals and materials, including Director of Strategic Planning & Process, Director of Sales in the Americas, and Global Strategic Marketing Director. Bae is a recipient of the US Army Commendation Medal in 1986.

Carl V. Thompson
Director, Materials Research Laboratory (MRL)

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Professor Thompson joined the MIT faculty in 1983. He is Director of MIT's Materials Research Laboratory and co-Director of the Skoltech Center for Electrochemical Energy Storage. His research interests include processing of thin films and nanostructures for applications in microelectronic, microelectromechanical, and electrochemical systems. Current activities focus on development of thin film batteries for autonomous microsystems, IC interconnect and GaN-based device reliability, and morphological stability of thin films and nano-scale structures. Thompson holds an SB in materials science and engineering from MIT and a PhD in applied physics from Harvard University.

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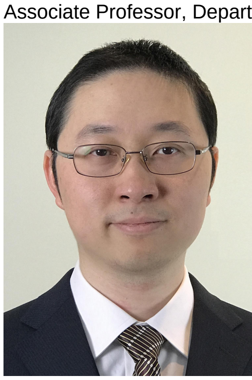
7:35pm

Microphotonic innovations: materials moving up the food chain
Juejun (JJ) Hu
Associate Professor, Department of Materials Science & Engineering



Juejun (JJ) Hu
Associate Professor, Department of Materials Science & Engineering

Juejun (JJ) Hu received the B.S. degree from Tsinghua University, China, in 2004, and the Ph.D. degree from Massachusetts Institute of Technology, Cambridge, MA, USA, in 2009, both in materials science and engineering. He is currently the Merton C. Flemings Career Development Associate Professor at MITs Department of Materials Science and Engineering. His primary research interest is enhanced photonmatter interactions in nanophotonic structures, with an emphasis on on-chip spectroscopy and chemical sensing applications using novel infrared glasses. Prior to joining MIT, he was an Assistant Professor at the University of Delaware from 2010 to 2014., Hu has authored and coauthored more than 60 refereed journal publications since 2006 and has been awarded six U.S. patents. He has been recognized with the National Science Foundation Faculty Early Career Development award, the Gerard J. Mangone Young Scholars Award, the University of Delaware College of Engineering Outstanding Junior Faculty Member, the University of Delaware Excellence in Teaching Award, among others.,Dr. Hu is currently the Deputy Editor of the OSA journal Optical Materials Express, and he is a Member on technical program committees for conferences including MRS, CLEO, OSA Congress, ACerS GOMD, ICG, and others. *(Based on document published on 13 September 2016)*

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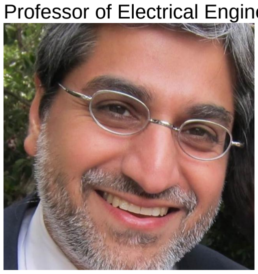
Microphotonics, which replaces traditional bulk optical systems with their miniaturized chip-scale counterparts, has enabled broad applications ranging from communications to sensing and imaging. New materials are playing a pivotal role in microphotonics both to enable new optical functionalities and to enhance device and system performances. This talk will provide an overview on photonic material innovations at MIT that empowers the microphotonic revolution on the horizon.

8:05pm

The Dawn of Integrated Photonics
Rajeev Ram
Professor of Electrical Engineering, Electrical Engineering and Computer Science (EECS)



Rajeev Ram
Professor of Electrical Engineering, Electrical Engineering and Computer Science (EECS)

Rajeev J. Ram has worked in the areas of physical optics and electronics for much of his career. In the early 1990's, he developed the III?V wafer bonding technology that led to record brightness light emitting devices at Hewlett-Packard Laboratory in Palo Alto. While at HP Labs, he worked on the first commercial deployment of surface emitting lasers. In the early 1990's, he developed the first semiconductor laser without population inversion, semiconductor lasers that employ condensation of massive particles, and threshold-less lasers.

Since 1997, Ram has been on the Electrical Engineering faculty at the Massachusetts Institute of Technology (MIT) and a member of the Research Laboratory of Electronics. He has served on the Defense Sciences Research Council advising DARPA on new areas for investment and served as a Program Director at the newly founded Advanced Research Project Agency-Energy. At ARPA?e, he managed a research portfolio exceeding $100M and consulted with the Office of Science and Technology Policy and the White House.

His group at MIT has developed record energy-efficient photonics for microprocessor systems, microfluidic systems for the control of cellular metabolism, and the first light-source with greater than 100% electrical-to-optical conversion efficiency. His group's work on small-scale solar thermoelectric generation is being deployed for rural electrification in the developing world as SolSource and was recognized with the St. Andrews Prize for Energy and the Environment.

Ram holds degrees in Applied Physics from California Institute of Technology and Electrical Engineering from the University of California, Santa Barbara.

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Integrated photonics encompasses all forms of microscopic optical elements which are fabricated on a single chip and connected by waveguides. After decades of development, integrated photonics is transforming many aspects of our lives - from the internet, AI and computing, to self-driving cars and augmented reality, to medical diagnostics and sensing. Today, MIT photonic innovations power dozens of companies and products - but the Age of Integrated Photonics is just beginning.

8:35pm

Invited Presentation Lightning Talks – Invited MIT Students and Postdocs

- Superconducting detectors
- 2-D materials
- Quantum materials
- Quantum cascade lasers
- Metamaterials
- Metamaterial design
- Polymer fibers
- Organic materials
- Phase change materials
- Infrared materials
- Chalcogenides
- Magneto-optical materials

As part of the program for this webinar, we are offering breakout discussions with our presenting graduate students and postdocs. **In order to participate in these breakout rooms, you will need the latest version of Zoom (version 5.3.2)**. (If you need help determining your version of Zoom, please follow the instructions here.)

If you do not already have this version, **please update your Zoom client/application before joining the discussion**. Follow the instructions here to update Zoom.

8:55pm Parallel Lightning Presentation Break-out Discussions

Breakout Room #	Invited Presenter	Position/ Supervisor	Title and Abstract
1	Yifei Li	Graduate Student Prof. Rafael Jaramillo	**Layered and 2D Materials for Integrated Photonics** Layered materials are exciting for manipulating light in the confined geometry of photonic integrated (PIC) circuits, where key material properties include strong and controllable light-matter interaction, and limited optical loss. Layered materials feature tunable optical properties, phases that are promising for electro-optics, and a panoply of polymorphs that suggest a rich design space for highly-nonperturbative PIC devices based on martensitic transformations: phase changes and ferroelastic domain switching. These features are manifest in materials with band gap above the photonics-relevant near-infrared (NIR) spectral band (~ 0.5 – 1 eV), meaning that they can be harnessed in refractive (i.e. low-loss) applications.
2	Carlos Rios	Post Doc Prof. Juejun Hu	**Phase-change materials: the promise of zero-power reconfigurable microphotonics** The integration of Phase-Change Materials (PCMs) to photonic devices such as integrated circuits, metasurfaces, plasmonic structures, etc. has enabled the additional functionality of nonvolatile reconfiguration. This functionality allows photonic systems to be active, i.e. to have multiple optical responses, using low power to switch between configurations (PCM states) but zero power to retain any. This exceptional combination of properties is possible because PCMs (chalcogenides exemplified by Ge-Sb-Se-Te alloys) exhibit large and stable optical properties modulation upon a fast and controlled solid-state phase transition. This presentation will provide the fundamentals of this novel, fast-growing field together with its challenges and potentials. Furthermore, we will discuss the research conducted at MIT on PCMs for low-energy phase and amplitude modulators, reconfigurable metalenses, and optical data storage and computing.
3	Marc de Cea	Graduate Student Prof. Rajeev Ram	**Realizing beyond-CMOS systems in commercial CMOS processes** Computing systems with reduced power and increased speed are required for the ubiquitous data era - from artificial intelligence to sensing to high performance computing. While such advancements are increasingly hard to achieve with conventional CMOS logic, CMOS fabrication processes (which produce billions of systems per year at low cost and complexity rivaling the human genome) allow for a host of devices beyond electronics – including nanoscale photonics - that could tackle the aforementioned challenges. Here, we will discuss a variety of functionalities enabled by these native photonic components in CMOS: high bandwidth and low power optical I/O, cryogenic

9:30pm	Wrap-up